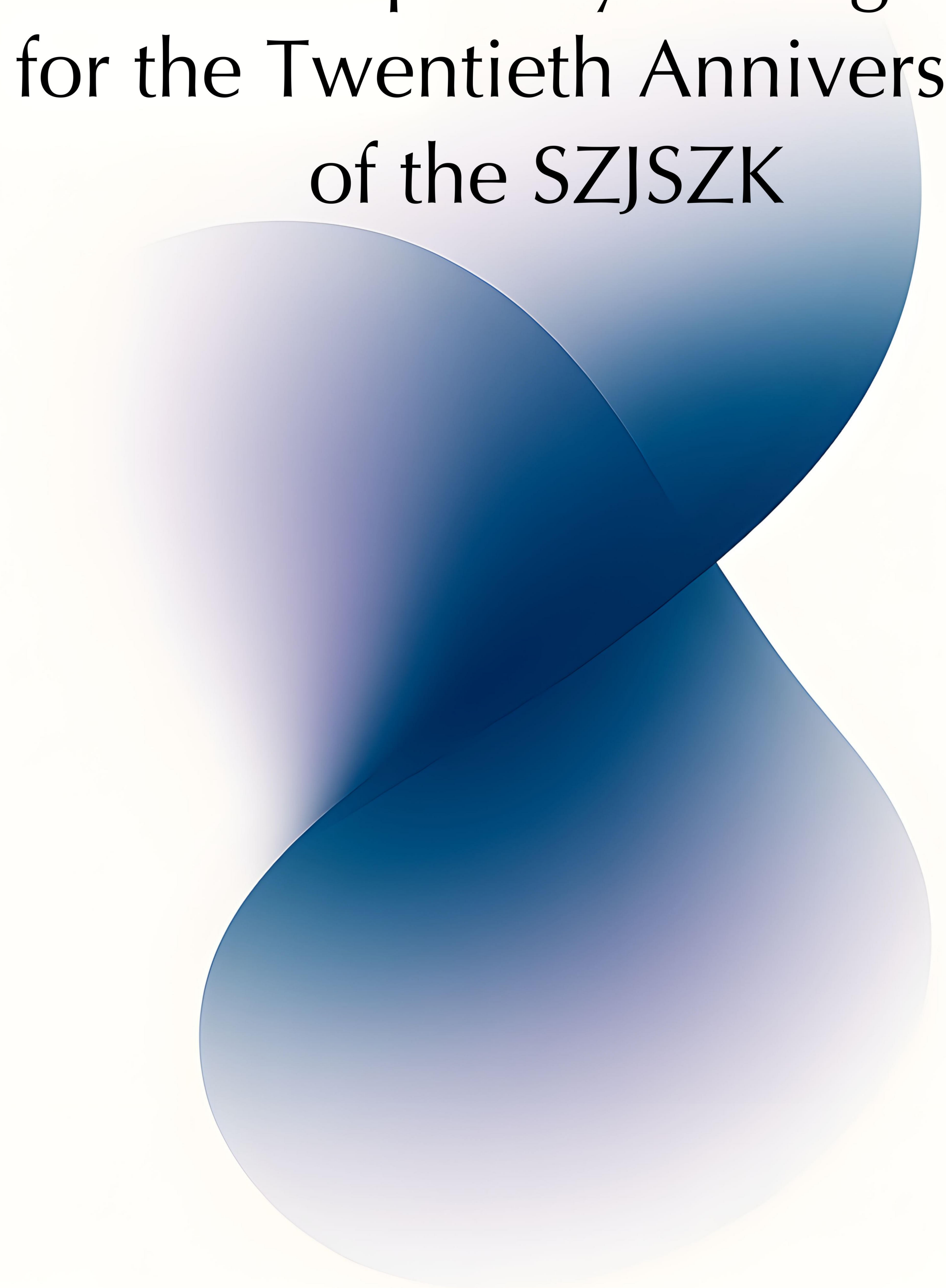
Interdisciplinary Dialogues for the Twentieth Anniversary of the SZJSZK



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Editors:

András Béres
Doctoral School of Earth Sciences
University of Pécs

&

Tibor Kovács
Faculty of Sciences
University of Pécs

Language Editors:

Sára Kárpáti & Kata Kumli
Faculty of Humanities and Social Sciences, University of Pécs

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Dean's Welcome

It is with great pleasure that I acknowledge the English-language collection of studies, meticulously edited by the staff of the János Szentágothai College of Advanced Studies. I was equally enthusiastic in responding to the organisers' initial call for opening the interdisciplinary international conference. My commitment to this initiative is rooted in several key beliefs, foremost among them the necessity of fostering talent, a role that the College of Advanced Studies, hosted by our faculty, undertakes decisively.

I hold a strong conviction that today's youth require a nurturing environment characterised by creativity and community, where their attachment to their profession and institution may deepen. Such an atmosphere facilitates the preparation for an intellectual career under careful guidance, with well-defined milestones along the journey. Furthermore, the János Szentágothai College of Advanced Studies serves as an interdisciplinary workshop where members can gain insights into the tasks, professional challenges, concerns, and successes experienced by their peers across various fields, thereby enhancing their own chosen areas of expertise.

This interdisciplinary approach aligns seamlessly with the traditions and contemporary vision of the Faculty of Sciences at the University of Pécs. Historically, our predecessor institution was one of the most esteemed teacher training colleges in the country. Through the intentional development of natural science disciplines, it evolved into a university faculty. Classical physical education training has transitioned into sports science, and information technology has become established and further developed. Recently, our academic portfolio has been expanded to include agricultural programs. Our training program variety offers bachelor's, master's and PhD programs in the above fields both in Hungarian and English.

Through our diverse programs, we actively maintain educational and research partnerships with various faculties within the university, ensuring that interdisciplinarity is consistently integrated into our daily operations. Alongside our extensive range of training options and a considerable student population, we boast a highly qualified teaching community that is both accessible and supportive. This creates an optimal environment for personalised, small-group interactions, problem-oriented progress, and crucially, talent development.

I am particularly gratified that by organising this conference and publishing the present volume, we have been able to share our distinctive characteristics with an international audience, thereby enhancing our reputation. I extend my sincere respect to all the participants, organisers, and editors of this volume and recommend this collection to readers. It is notable that although many authors are still in the early stages of their professional and academic journeys, the quality of their approaches and results is commendable and certainly warrants attention.

András Trócsányi PhD

Dean

University of Pécs
Faculty of Sciences

Editorial Foreword

We are pleased to present *Interdisciplinary Dialogues for the Twentieth Anniversary of the SZJSZK*, the first English-language volume in the *SZJSZK Series*, published in honor of the 20th anniversary of the János Szentágothai College of Advanced Studies. This peer-reviewed collection brings together 24 English-language papers, most of which were originally delivered at our international jubilee conference. The authors include both members of the College and distinguished colleagues from Hungary and abroad, representing a wide range of disciplines from natural sciences to humanities and social sciences. Each study was reviewed by at least one expert in the relevant field who provided constructive feedback and valuable suggestions to the authors. We extend our deepest gratitude to all the reviewers for their devoted work, without which this volume could not have reached its present standard.

These contributions reflect the College's longstanding commitment to interdisciplinary dialogue and academic excellence. Biological sciences are represented by **Dávid, K.**, who examined plant-derived compounds with potential antiepileptic effects in zebrafish models, as well as by **Tóth, G. L., Pollák, E., & Molnár, L.**, who investigated the regeneration of earthworm segments, highlighting the role of collagen synthesis in tissue renewal. In the field of educational sciences, **Ambach, Zs., & Szrés, R. K.** explore the motivational impact of a Harry Potter-inspired house system on student engagement; **Béres, A.** analyzes demographic shifts and institutional burdens in Hungarian public education after 2021, drawing attention to spatial inequalities; and **Borbándi, B.** provides a comprehensive literature review of the representation of the Roma minority in Hungarian textbooks since the turn of the millennium. From engineering, **Dudás, N.** considers the role of artificial intelligence in contemporary Hungarian architectural practice, while **Horváth, J., Darányi, A., & Ruppert, T.** develop a genetic algorithm to optimize multi-agent collaboration in wire harness assembly. Historical studies enrich the volume with diverse perspectives: **Kovács, D. L.** reconstructs the relationship between prestige and salaries among the Somogy county elite in the early 19th century; **Nagy, P.** traces the cosmonaut cult in Baranya county during the Cold War; **Ruppert, F. A.** interprets the symbolism of the cypress in Orphic-Bacchic gold tablets; **Vojcsik, J.** demonstrates how mountaineering feats such as climbing Mount Elbrus were appropriated into Nazi propaganda; and **Vörös, Zs.** brings to light the fate of chaplain Rezső Bohuss during the Serbian occupation after World War I. In legal studies, **Fekete, K. B.** examines the unresolved issue of judicial remuneration under the Quadrilateral Agreement, and **Vörös, E. H.** evaluates the implementation of the Digital Decade 2030 Strategy across member states. Turning to literary scholarship, **Rétfalvi, P. Zs.** re-evaluates Imre Madách's early poetry collection and its place in the interpretation of his oeuvre. Medical sciences are strongly represented: **Hajdú, A., Nagy, P., Szabó, N., Felső, R., Masszi, Gy., Bokor, Sz., & Molnár, D.** investigate cardiovascular risks among obese adolescents; **Hlaj, I., Bonet, S., & Heffer, M.** conduct a systematic review of methodologies in lipid raft research; **Plunárová, N.** documents the benefits of spa rehabilitation for pediatric asthma patients; and **Bonet, S., Labaj, A., & Soldo Koruga, A.** present a remarkable case report of coexisting multiple sclerosis and retinitis pigmentosa. Philosophy is represented by **Ambrozy, M.**, who traces Heidegger's reflections on science and emphasizes their continuity. Psychological studies form the closing section: **Hajma, N.** explores Hungarian attitudes toward euthanasia and suicide; **Kárpáti, S., & Kumli, K.** analyze the impact of humor styles on anxiety and coping; **Luksik, L.** investigates the relationship between chronic illness, self-esteem, and self-efficacy; and **Trixler, B., & Pusztafalvi, H.** validate the Hungarian adaptation of the Brief Autism Mealtime Behavior Inventory, extending its applicability to family contexts.

Taken together, these papers not only showcase the intellectual diversity of our college community but also illustrate the vitality of international academic exchange. They reaffirm that research conducted by young scholars can engage with global challenges while remaining grounded in rigorous local inquiry. We hope that this volume will serve as both a worthy commemoration of our twentieth anniversary and an inspiration for the next decades of scholarship at the János Szentágothai College of Advanced Studies.

On behalf of the Editorial Board and the Organizing Committee, I wish all readers a stimulating encounter with the studies collected here and once again thank the authors, reviewers, and colleagues who made this achievement possible.

András Béres

On behalf of the Editorial Board
and the Organizing Committee

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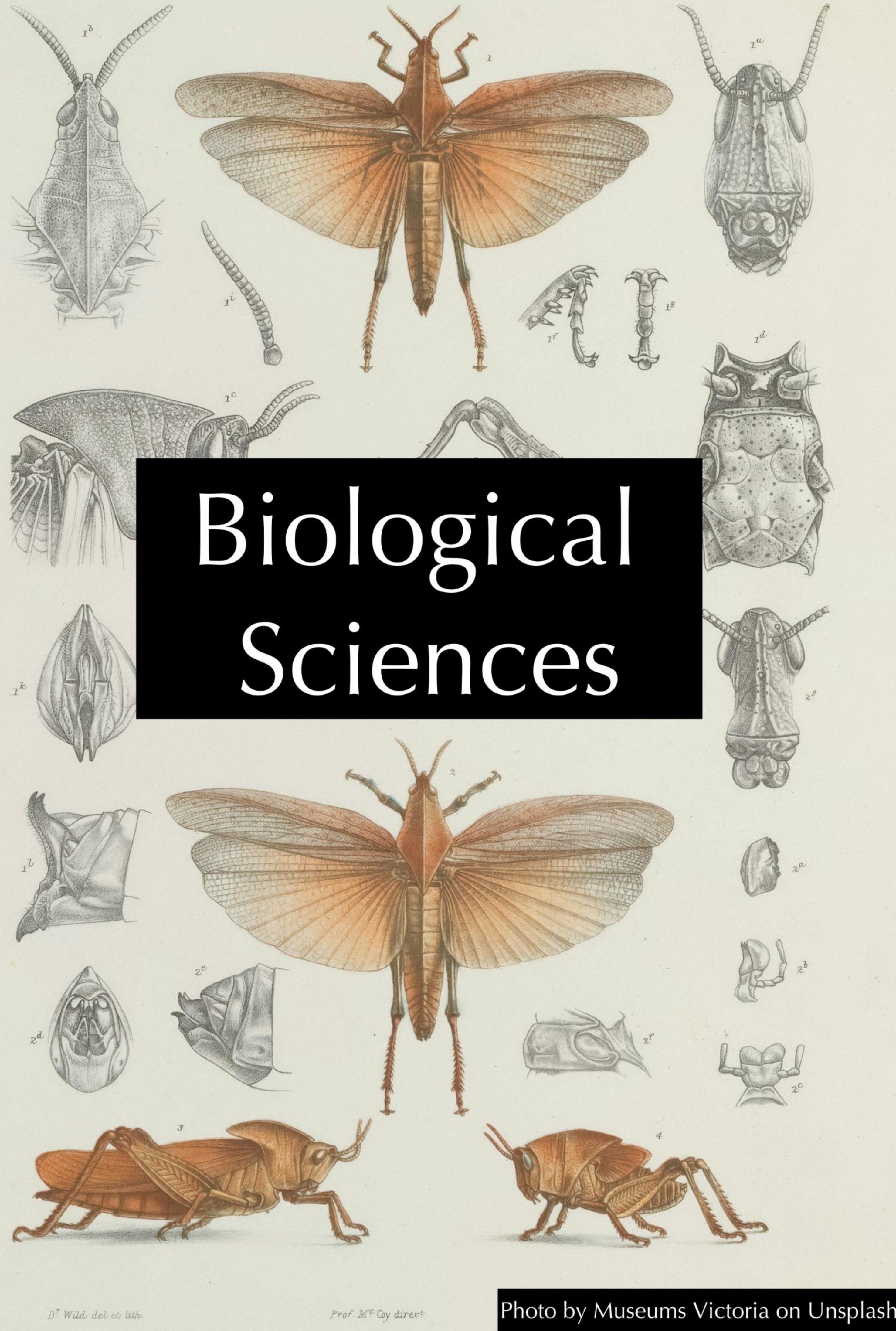

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Evaluating plant-derived compounds for antiepileptic potential

Insight from zebrafish models

Dávid Kinga
Department of Neurobiology, Institute of Biology, Faculty of Natural Sciences, University of Pécs

ABSTRACT

Epilepsy is a chronic neurological disorder in which brain neurons and neuron groups transmit abnormal signals, resulting in seizures. Epilepsy affects tens of millions of people, many of whom do not respond to currently available antiepileptic drugs, highlighting the urgent need for the development of new medications. Zebrafish (Danio rerio) are frequently used as model organisms in the study of antiepileptic drugs. Despite their relatively simple nervous system, they exhibit many similarities to that of mammals. A major advantage of using zebrafish is their high fecundity, which allows for the rapid testing of a large number of compounds. Preliminary tests on zebrafish larvae make it possible to select the most promising compounds for further testing on mice and rats, thereby saving time and reducing animal use and suffering. To test substances with potential antiepileptic effects, convulsant agents such as pentylenetetrazole (PTZ) are used. The epilepsy-like symptoms induced by PTZ manifest as increased movement and can be monitored using behavioral analysis systems (e.g., Noldus). Additionally, heightened brain activity and seizures can be detected through electroencephalographic (EEG) measurements. In our research, we investigated the antiepileptic effects of four plant-derived active compounds. Apigenin and luteolin are two flavonoids extracted from peppers. In addition, we used two phenolic compounds: chlorogenic acid derived from coffee and caftaric acid extracted from grapes. Among the four compounds tested, behavioral pattern analysis revealed that chlorogenic acid significantly reduced PTZ-induced seizure activity. Apigenin, luteolin, and caftaric acid did not significantly alter PTZ-induced seizure activity. Our observations are currently being further validated using EEG measurements. Based on our findings, chlorogenic acid appears to be a promising candidate for further pharmaceutical research. Chlorogenic acid appears promising and warrants further preclinical investigation in mammalian models.

Keywords: EEG, Epilepsy, Herbal active substance, Noldus, Zebrafish

Introduction

In the scientific community, countless researchers work with model animals, typically mice or rats. However, there are other invaluable species used in research, such as the zebrafish (*Danio rerio*). Zebrafish serve as excellent experimental animals for several reasons. One of their main advantages is their small size, which results in low food consumption and allows them to be housed in relatively compact spaces. Additionally, they require minimal care and maintenance requirements for water quality, feeding and lighting. Their lifespan is about three years, and they reach sexual maturity within three months, allowing for their gradual integration into experiments. Moreover, they reproduce rapidly and in large numbers, with a single zebrafish capable of laying up to ten thousand eggs per year. This makes them ideal for large-scale studies on various diseases (Cho et al., 2017).

A notable advantage of working with zebrafish is that ethical approval is not required until reaching the free-feeding stage. Zebrafish are particularly suitable for research due to the fact that about 80% of human diseases have a counterpart in zebrafish, and approximately 70% of human protein-coding genes are shared. Several types of epilepsy models exist in zebrafish, including genetically modified lines and epilepsy induced by various chemical agents. It should be noted that in genetically modified zebrafish, the occurrence of seizures is inconsistent, making systematic investigation more difficult (Smith et al., 2020; Vermoesen et al., 2011). In the present study, experiments were carried out on 5-day-old wild-type lines. In addition, knockout of the *scn1Lab* gene can generate a zebrafish epilepsy model resembling Dravet syndrome (Griffin et al., 2017). Despite their relatively simple nervous system, they show significant similarities to mammals, including humans (Howe et al., 2013). These characteristics make zebrafish a powerful model for studying human diseases such as epilepsy.

Epilepsy is a central nervous system disorder characterized by the simultaneous firing of a large number of excitatory neurons, leading to behavioral, neurological, and molecular changes—these are seizures (Szep et al., 2023). It affects 1% of the global population, around 80 million people (McNamara, 1999; Sillanpää & Schmidt, 2006), making it a widespread condition. It is most common in the young and elderly and has a high mortality rate. Although antiepileptic drugs exist to control symptoms, they are ineffective in about one-third of patients. Our research group, therefore, aimed to identify compounds that could effectively mitigate or even eliminate the effects of epilepsy in all patients.

Materials and Methods

We investigated four plant-derived compounds with potential antiepileptic properties: two flavonoids (apigenin and luteolin) extracted from peppers, and two phenolic acids—chlorogenic acid from coffee and caftaric acid from grapes. These compounds were selected based on their known antioxidant, anti-inflammatory, and neuroprotective properties. Luteolin has been shown to reduce seizure frequency in rats (Birman et al., 2012), and apigenin is known for its antiepileptic properties and ability to reduce neuronal cell death (Nikbakht et al., 2023). To examine their effects, we first needed to induce epilepsy in zebrafish larvae.

To induce epileptic seizures, we tested several compounds, such as pilocarpine and picrotoxin; however, PTZ proved to be the most effective, and therefore, we continued the experiments using this agent. Epileptic effects in the larvae were induced using pentylenetetrazole (PTZ), a GABA (gamma-aminobutyric acid) antagonist (Hortopan et al., 2010). Zebrafish larvae display spontaneous seizures following PTZ treatment. Notably, different PTZ concentrations trigger different levels of motor activity (Baraban et al., 2005). At high concentrations (60 mM), PTZ induces convulsions, measurable via electroencephalography (EEG). At lower concentrations (10 mM), PTZ increases movement activity, which can be tracked using behavioral analysis software such as Noldus.

Noldus Method

For the behavioral experiments (Zhang et al., 2020), we used the DanioVision system and EthoVision software (Noldus Information Technology), along with an optimized protocol that specifies a 10-minute light period as the ideal recording time (Szep et al., 2023). Using these methods, we examined 1,152 larvae across all four compounds, with each compound tested in triplicate across 96-well plates. The larvae were distributed across the wells, and a laser system measured the distance traveled by each. Among the available parameters, we focused on distance traveled as the basis for our statistical analysis. Measurements were performed at 28 °C (Szep et al., 2023). During the assays, larvae were placed in egg water, which consisted of 60 µg/ml "instant ocean" sea salt dissolved in distilled water.

Before initiating the experiments with the selected compounds, we conducted preliminary toxicological tests. In these assays, the tested compounds were first tested at different concentrations, and the non-toxic doses (no mortality, malformations or behavioral changes) were selected for further experiments. Each compound was tested across four groups based on pretreatment conditions. All groups, except the control, were pretreated 12 hours in advance using the compound dissolved in dimethyl sulfoxide (DMSO). The compounds were dissolved in DMSO (≥99.7%), with a final concentration of 0.01 µg/ml, except for caftaric acid, which was applied at 0.04 µg/ml. Based on the toxicological assays, the four examined compounds were administered to the larvae at different concentrations (Table 1). The control group received only DMSO in the appropriate amount corresponding to the tested compound. Additional groups included one treated with PTZ (added 30 minutes before the test) and one combined treatment group receiving both the compound and PTZ, each at the appropriate time.

Table 1
Active substance concentrations

	Apigenin	Luteolin	Chlorogenic acid	Caftaric acid
Final concentration	0.01 mg/ml	0.01 mg/ml	0.01 mg/ml	0.04 mg/ml
Amount of added solution	678 µl	662 µl	50µl	200 µl

Note. To reach the final concentrations, 5 mL of water was added to the solutions.

EEG Method

In parallel with the Noldus experiments, we also tested all four compounds using EEG, with 50 larvae undergoing evaluation following strict procedural guidelines. Each larva was pretreated 12 hours before the test with one of the compounds. Ten minutes before recording, they were immobilized with tubocurarine, a muscle relaxant. The larvae were then placed under a microscope in a Petri dish filled with agarose. A drop of agarose was placed on their tail to keep them still, and a capillary was precisely positioned behind their eye (Figure 1). The capillary, filled with potassium chloride, transmitted electrical signals through a noise filter to a computer, where they were visualized using dedicated software (Zdebik, 2021). A one-minute baseline EEG was recorded, followed by PTZ application on the larva's head. EEG signals were recorded for thirty minutes to detect any changes in brainwave activity.

Figure 1
Capillary positioned behind the zebrafish larva's eye during the EEG recording.

Results and Evaluation

We presented the results for each compound in bar charts with four columns. These charts showed the total distance traveled, either with combined treatments or separately. Asterisks indicated the level of statistical significance, and the error bars showed standard deviation. For flavonoids, apigenin and luteolin were tested. In the case of apigenin (Figure 2), the control and apigenin-only groups showed similar activity levels, suggesting that apigenin alone did not induce seizure-like activity. The PTZ and combined groups were also similar, indicating that apigenin did not mitigate PTZ-induced effects, ruling it out as a promising antiepileptic candidate.

Similar results were found for luteolin (Figure 3). The control and luteolin-only groups had similar bar heights, as did the PTZ and combined groups. Thus, luteolin also did not reduce the epileptic effects of PTZ, and it will not be considered for further study.

For the phenolic compounds, chlorogenic acid and caftaric acid were tested. Compared to the previous diagrams, chlorogenic acid yielded drastic differences (Figure 4). The bar heights for the control, chlorogenic acid, and combined treatment groups were similar, while only the PTZ group had significantly higher values. This indicates that chlorogenic acid was able to counteract the epileptic symptoms induced by PTZ and shows strong potential as a future antiepileptic drug candidate.

Caftaric acid, however, produced results similar to the flavonoids (Figure 5). The height of the combined group was similar to that of the PTZ group, suggesting that caftaric acid was ineffective in reducing epileptic symptoms. Therefore, this compound will not be pursued further.

In summary, apigenin, luteolin, and caftaric acid did not reduce PTZ-induced seizure-like activity, representing a negative outcome. In contrast, chlorogenic acid successfully mitigated PTZ's effects, making it a promising candidate for further research.

Figure 2

Bar chart showing the differences in the distance moved (mm) by zebrafish larvae during the apigenin experiments. Asterisks indicate significant differences: *** p < .001.

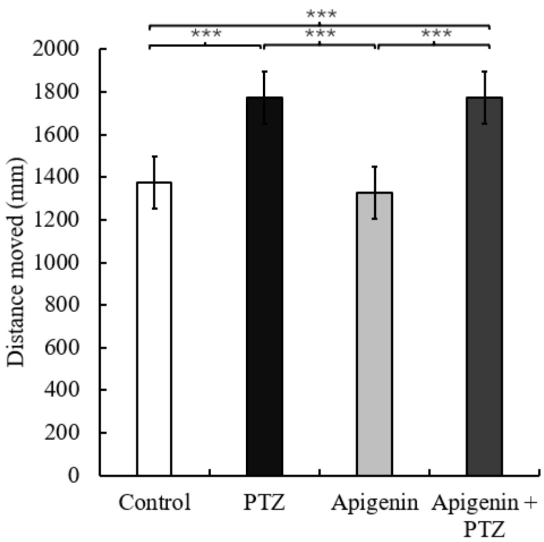


Figure 3

Bar chart showing the differences in the distance moved (mm) by zebrafish larvae during the luteolin experiments. Asterisks indicate significant differences: *** p < .001.

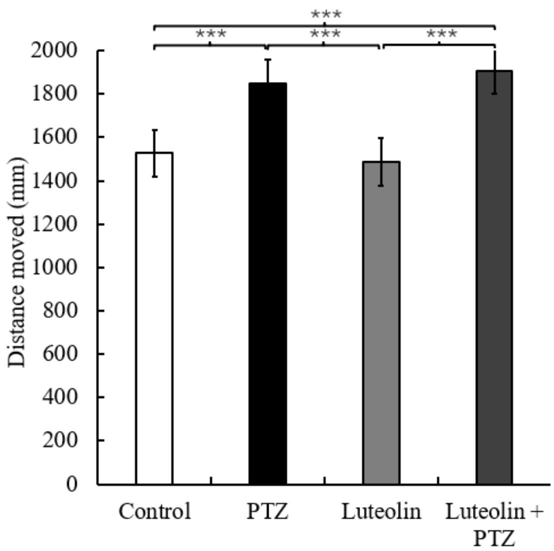


Figure 4

Bar chart showing the differences in the distance moved (mm) by zebrafish larvae during the chlorogenic acid experiments. Asterisks indicate significant differences: *** p < .001.

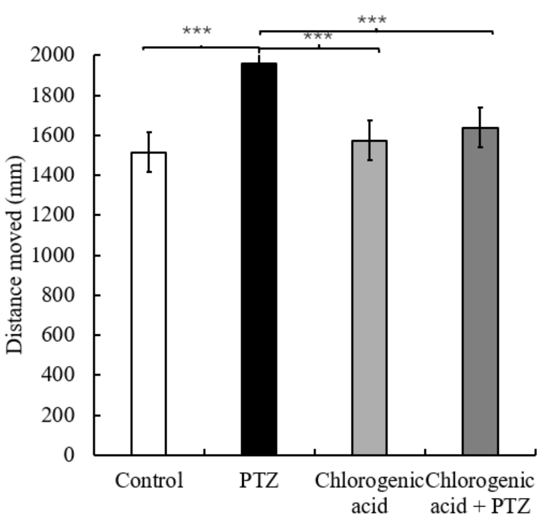


Figure 5

Bar chart showing the differences in the distance moved (mm) by zebrafish larvae during the caftaric acid experiments. Asterisks indicate significant differences: * p < .05.

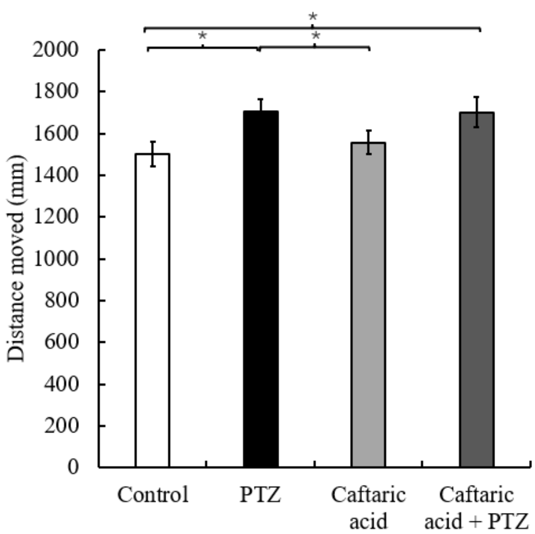
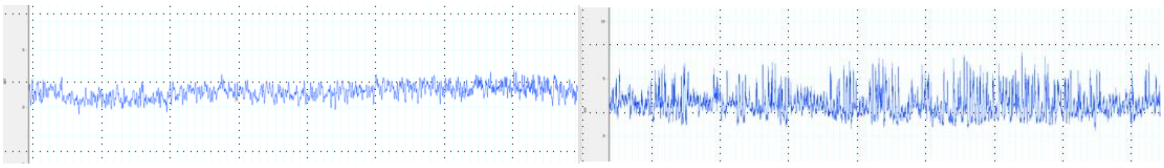


Figure 6 shows the EEG pattern of a control group larva before PTZ treatment. Normal brainwave activity and residual noise were observed. It also shows a significant increase in brainwave spikes after PTZ administration, representing seizure activity. These are the patterns we aim to reduce with effective compounds. While the EEG experiments have concluded, their evaluation is still ongoing.

Figure 6
EEG recordings showing the effects of PTZ treatment. On the left, normal brain activity before PTZ administration. On the right, a dramatic increase in brain activity with many peaks, which the tested compounds aim to mitigate.



Conclusion and future directions

In conclusion, our Noldus-based experiments showed that chlorogenic acid had a positive effect in reducing epileptic symptoms, while the flavonoids and caftaric acid did not perform well. Our next steps involve completing the evaluation of EEG data, followed by progressing promising compounds to mouse and eventually human trials. Our goal is to use zebrafish as a cost-effective, ethically uncomplicated model to pre-screen potential antiepileptic compounds, filtering out toxic or ineffective substances before reaching mammalian models. We believe these compounds hold promise for the development of future antiepileptic therapies.

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Kinga Dávid – Teacher Training Student
david.6.kinga@gmail.com
ORCID ID: 0009-0001-0202-4781

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Some new aspects of the earthworms' segment regeneration

Gabriella Laura Tóth[1,2]
Edit Pollák[1]
László Molnár[2]

[1]Department of Neurobiology, Institute of Biology, Faculty of Natural Sciences, University of Pécs
[2]Ecophysiological and Environmental Toxicological Research Group, HUN-REN Balaton Limnological Research Institute

ABSTRACT

Earthworms have an enormous capability to regrow lost tail segments. This process is known as regeneration and is considered a specialised form of genetically governed postembryonic morphogenesis. One of the key questions of regeneration is its fidelity: Are the renewing segments identical with the lost ones, or not? To answer this question, standardised laboratory experiments were conducted in which a fixed number of tail segments were removed from the animals, and the kinetics of segment regeneration were determined. Regeneration blastema, from which new segments develop, is formed from dedifferentiated cells of the existing tissues. Our gross anatomical observations supported the earlier findings that the organization of the original and renewed segments was the same, and no difference in the pattern of anatomical landmarks (chaetae, metanephridia, dorsal pores, ventral nerve cord ganglia) was found. In contrast, a marked difference was seen in the histological organization of the original and renewed tissues till the fifth postoperative week: no collagen deposition was found either in the circular or longitudinal muscles of the regenerated body wall or in the regenerated midgut. High amounts of collagen fibres were deposited in the original tissues close to the surgical intervention. These results strongly suggest that the regulation of collagen synthesis and deposition governs both the formation and maturation of renewing tissues; furthermore, the missing or weakly developed extracellular matrix is necessary for the regular regeneration of tissues.

Keywords: wound healing, dedifferentiation, regeneration, collagen

Introduction

Reparative regeneration (shortly regeneration) is a mysterious process of some metazoan species that can restore their lost body parts. During the last centuries, animals having regeneration ability were identified by the scientific community. The main finding of the detailed investigations was that the regeneration ability of animals does not exhibit phylogenetic dependence, as outstanding regenerative capacity is characteristic for Cnidarians, Platyhelminthes, Annelids, and some vertebrates, such as newts and salamanders (reviewed by Brockes & Kumar, 2008; Elchaninov et al., 2021). Moreover, sometimes in the same animal taxa, there are species with high regeneration capacity and no regeneration ability at all. For example, cnidarian polyps survive the loss of over 80% of their bodies, then regenerate the missing structures, while medusae do not tolerate tissue loss; they do not regenerate, instead they die (Bely, 2010; Giangrande et al., 2014). A similar situation is characteristic of the annelid earthworm and leeches (Bely, 2006), or the amphibian salamanders and frogs (Godwin & Rosenthal, 2014). Based on the comprehensive analysis of the regeneration ability of invertebrate and vertebrate species, the importance of the lifestyle of a species and the influences of ecological parameters were suggested (Alibardi, 2024).

It has also been revealed that regeneration is a special form of postembryonic morphogenesis, which is genetically governed (Chen & Poss, 2017; Goldman & Poss, 2020), but it is influenced by several internal and external factors (Aztekin, 2024). There is growing evidence for the neural dependence of regeneration. The presence of intact or damaged neural processes in the damaged structure is necessary for its regular reorganization. It was recognized that both electrical signals and chemical compounds of the neurons had a great impact on the formation of the regeneration blastema from which new tissues were differentiated (Davidian & Levin, 2022; Levin, 2009, 2021; McLaughlin & Levin, 2018; Whited & Levin, 2019). Stimulatory effects of some neurotransmitters, like gamma aminobutyric acid (GABA) (Romaus-Sanjurjo et al., 2018), serotonin (Alam et al., 2016; Blackiston et al., 2017; Barreiro-Iglesias et al., 2015) on tissue differentiation were demonstrated in distinct species. During the last two decades, the influence of the endocrine system on regeneration was also investigated, and the experimental results proved hormonal dependence in some phases of the reorganization of the tissues (reviewed by Easterling et al., 2019). Nowadays, a hot topic in regeneration biology is the influence of the immune system on wound closure, regeneration blastema formation and morphogenesis of the new tissues in vertebrates (Abnave & Ghigo, 2019; Arenas Gómez et al., 2020; Caballero-Sánchez et al., 2024; Eming et al., 2017; Mescher et al., 2017). However, it was not labelled as an immune system-influenced process. Liebmann (1943) had shown that the extraction of the coelomocytes (immune cells of the earthworms) strongly inhibited segment regeneration. Later, coelomocytes were found to contain high amounts of riboflavin, which is thought to act as a stimulating factor in various cellular processes, such as proliferation and differentiation (Molnár et al., 2015). Given this, the presence of coelomocytes with riboflavin was concluded to be essential for regular regeneration of the nervous system (Molnár et al., 2015).

The role of the external factors influencing regeneration seems to be indirect, but sometimes effective. External factors such as temperature alterations (Jesna & Livingstone, 2023; Rorat et al., 2017), toxication (Rorat et al., 2017; Takacs et al., 2016; Yuan et al., 2024), or radiation by X-ray (Moment, 1972) or electromagnetic waves (Abufadda et al., 2021) probably override the genetically determined program either by stimulating or inhibiting its fulfilment.

However, our knowledge of regeneration has intensely developed during the last decades; some questions remain unanswered by the scientific community. One of these questions is a basic question: what is the fidelity of regeneration? Are the renewed structures identical with the lost ones, both in structure and function? If yes, when and how much?

To answer the above questions, a convenient model is necessary that has a simple body plan, and the histological characteristics of both damaged and renewing tissues can easily be investigated by microscopical methods. Some earthworm species are eligible to be model animals of regeneration, since the kinetics of their segment restitution were already investigated in detail (for review, see Kostyuchenko & Kozin, 2021). However, it had been recognized that during the segment regeneration, no scar was formed between the original and renewing tissues, and the background of its histological phenomenon was not identified yet. Therefore, this study focuses on both the early and late phases of segment regeneration, analysing the development of tissues, focusing on the composition of the extracellular matrix, which has not been investigated yet. Since collagen deposition is a marked process of wound healing, which is the first step of the regeneration, a sensitive collagen labelling method (modified Van Gieson staining) was used at distinct phases of regeneration. The present results show that intense collagen deposition was characteristic at the boundary of the original tissues, while newly formed ones were free from collagen till the 5th week of regeneration, suggesting that the regulation of collagen synthesis and deposition is the key factor of scar-free wound healing and regeneration.

Materials and methods

Sexually matured (clitellated) specimens (n = 30) of *Eisenia andrei* were used in all experiments. After anaesthetisation with carbonated water, the last 25 tail segments were surgically removed from the body. The physiological state and healing of the transected segment were inspected every hour until the 6th postoperative hour, at which point the wound completely closed.

For histological observations, 5 original body segments with attached regeneration blastema or segments of 5 specimens were isolated by sharp scissors at the 1st, 7th, 21st, and 35th postoperative days. Isolated body parts were fixed in a formalin-acetic acid mixture (6 mL 38 % formaldehyde, 1 mL glacial acetic acid, and 18 mL distilled water) for conventional histology and collagen staining. After fixation, the tissue processing followed the protocol of histological handbooks (see Molnár & Gábriel 2001), and paraffin embedding was carried out. Sections with 10 µm were made and stained with haematoxylin and eosin for conventional histology and with modified Van Gieson staining for collagen staining. In the latter protocol, acid fuchsine was replaced by the more stable and fluorescent Sirius red.

For electron microscopy, pieces of the body parts were prefixed in a modified ice-cold Karnovsky solution (4 % paraformaldehyde and 2.5 % glutaraldehyde in 0.1 M cacodylate buffer, pH = 7.2), then postfixed in buffered osmium tetroxide. Washing, dehydration, and resin embedding protocols were applied according to the conventional description (Molnár & Gábriel, 2001). Semithin sections were cut with a Reichert ultramicrome and stained with uranyl-acetate and lead citrate, then investigated by a Jeol-200 electron microscope.

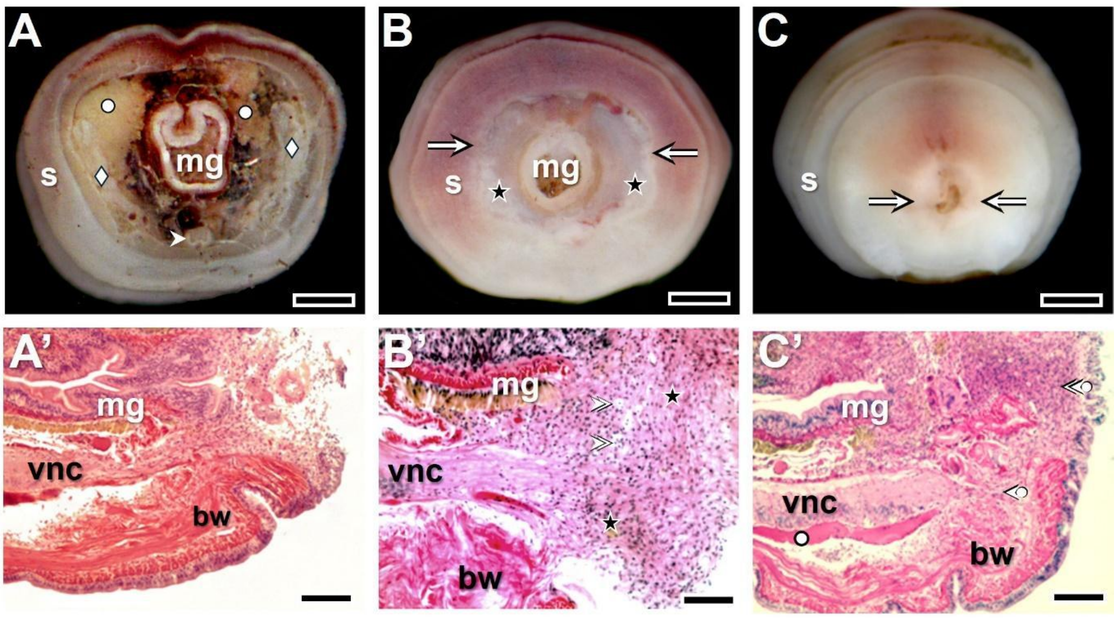
Results

Transection of the body at the segment furrow resulted in a smooth wound surface of all organs. Immediately after transections, the layers of both the body wall and the midgut, further grouped coelomocytes, metanephridia, and the ventral nerve cord ganglion were recognizable with a stereomicroscope (Fig. 1A). Histological observation of body pieces, fixed at about 5th postoperative minutes, revealed fast modification of damaged organs/tissues. Several dedifferentiated and a few degenerating cells were seen in the body wall and midgut. A marked alteration was the thickening of the transected ganglion, which anchored the body wall muscles (Fig. 1A').

By the third postoperative hour, the diameter of the wound had reduced, and the coelomic cavity was covered by the curved body wall. The remaining narrow space between the body wall and the midgut was filled with white cell mass (Fig. 1B). Histological investigations revealed the composition of the white tissue, which consisted of dedifferentiated (blast-like) cells. Dedifferentiation of tissue cells started at the connection of the ventral nerve cord and the body wall (Fig. 1A'), and the blast-like cells mainly accumulated close to the transected surface of the ganglion (Fig. 1B'). Coelomocytes, which can be easily identified based on their size and staining properties, were only seldom found between blast-like cells (Fig. 1B').

At the 6th postoperative hour, tissues of the transected midgut and body wall fused and closed the coelom (Fig. 1C, C'). A marked difference could be recognized among the groups of the coelom closing blast-like cells. Those cells located behind the ventral nerve cord were lightly stained with both haematoxylin and eosin, while those located in the fused region of the body wall and the midgut were characterised by a smaller size and a heavily stained, compact nucleus.

Fig. 1. Anatomical and histological changes of the transected segment of *E. andrei* from surgical intervention (A, A') to the 3rd (B, B') and 6th (C, C') postoperative hour. Note that a fast wound closure is characteristic of the earthworm, possessing a quick dedifferentiation of tissues in both the body wall and midgut. A marked difference can be seen in the coelom closing blast-like cells. The ones situated close to the transected ventral nerve cord ganglion (bullet arrowhead) are lightly stained, while the ones that are in the closing ring of the coelom, formed by the fused body wall and midgut, are heavily stained with haematoxylin (bullet double arrowhead). Labelling: s: segment; mg: midgut; vnc: ventral nerve cord; bw: body wall; circle: coelomocytes; deltoid: metanephridium; white arrowhead: transected ventral nerve cord; white double arrowhead: coelomocyte; asterisk: white tissue; arrows: boundary of the transected body wall. Scale bars: 100 μm.



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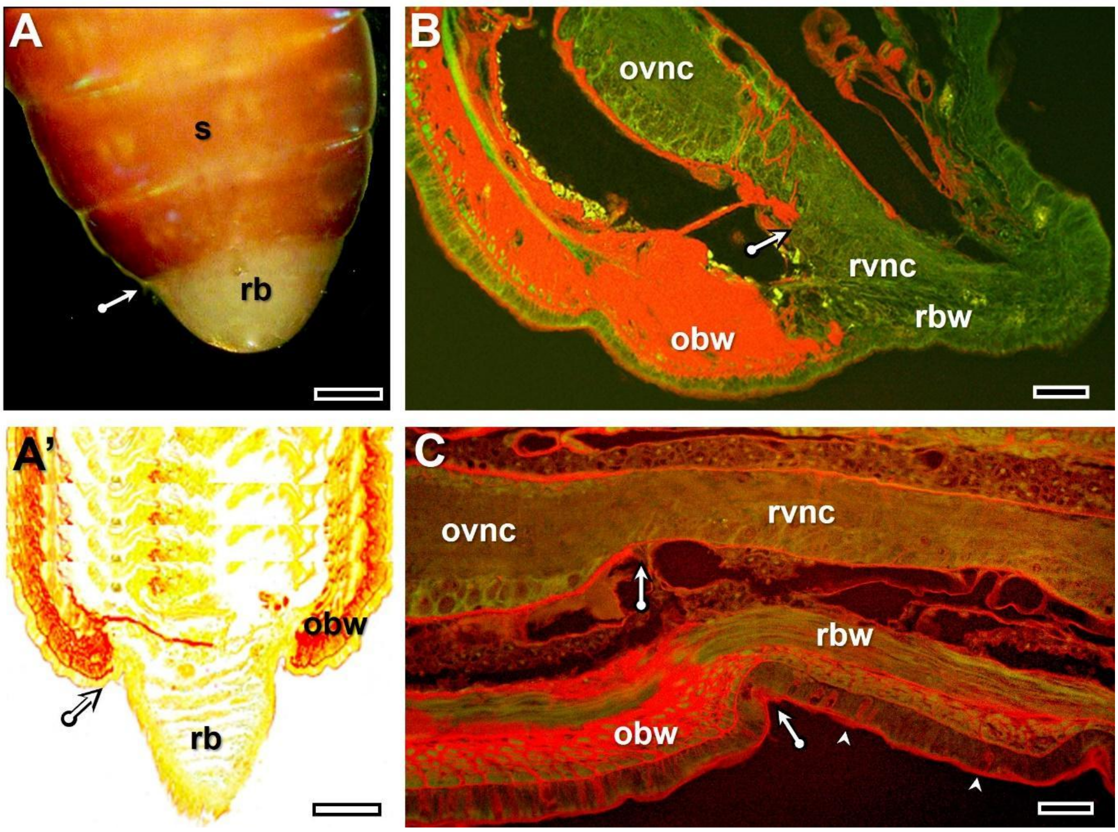
The occurrence and histochemical properties of the regeneration blastema show some unexpected characteristics. At the 1st postoperative week, a small blastema, consisting of white tissues, attached to the transected segment (Fig. 2A). Conventional histology did not show any difference in the organization of the original and newly formed tissues (not shown). In contrast, the collagen staining revealed an enormous variance in the organization of the old/original tissues and the renewed ones. While in old tissues a lot of collagen deposition was seen (Fig. 2A', B), the newly formed tissues were collagen-free. Collagen was missing from the regenerating body wall, ventral nerve cord, and midgut tissues as well. An amazing finding was the absence of the collagen fibres from the basement membrane and cuticle of the body wall epithelium and from the perineural sheet of the ventral nerve cord ganglia (Fig. 2B). Collagen deposition into regenerated tissues started at the 3rd postoperative week (not shown), but this process seemed to be slow. At the 5th postoperative week, the newly formed (regenerated) tissues had a significantly lower amount of collagen, except for the body wall cuticle (Fig. 2C).

Fig. 2. Form of the regeneration blastema at the 1st postoperative week (A) and the distribution pattern of collagen fibres in the old/original tissues of the body wall, and ventral nerve cord, and in their complementary structures (A'-C). Note that in all original tissues, a high deposition of collagen can be seen, while in newly formed ones, it cannot be seen. At the 5th postoperative week (C), collagen deposition is detectable in regenerating tissues with a lower level, except for the cuticle of the body wall epithelium (arrowhead). Labelling: s: segment; rb: regeneration blastema; obw: original body wall; rbw: regenerating body wall; ovnc: original ventral nerve cord; rvnc: regenerating ventral nerve cord; bullet arrow: site of the surgical intervention. Scale bars: 100 μm.



Ultrastructural investigations supported the light microscopic findings. In obliquely striated muscle fibres of the control (intact) body wall, groups of myosin filaments, and boundaries of the sarcomeres (Z-rods), further transversely oriented tubules, coupling with small peripheral vesicles, were clearly seen. Between the fibres, a small number of collagen fibres occurred (Fig. 3A).

By the 6th postoperative hour, marked cytological alterations were characteristic of the original/old body wall. Epithelial cells lost anchoring cell junctions and transformed into amoeboid-like cells having several pseudopodia-like processes. In their cytoplasm, some osmiophilic granules were located. Dedifferentiation of muscle fibres, being in distinct developmental stages, was a characteristic phenomenon at this stage of the regeneration. This process started with the disintegration of the sarcomeres, which lost both the Z-rods and transverse tubules, resulting in the extension of the contractile protein-free, clear cytoplasm (Fig. 3B). Later, the intense reduction of contractile proteins in muscle fibres was coupled with the swelling of the mitochondria that migrated to the plasma membrane. At this stage of the dedifferentiation, several enlarged vesicles occurred under the plasma membrane. These were remnants of the vesicles coupling with the transversely oriented tubules. Around the fibres, a thick layer of collagen fibres was located. Among the dedifferentiated muscle fibres, shrunken ones were seldom found (Fig. 3C, D).

The regeneration blastema consisted of distinct cell types at the 1st postoperative week (Fig. 4). All cells had dense cytoplasm in which endomembranes, except for the nuclear envelope, could not be seen. Based on their location and form, some cell types could be distinguished at the early phase of regeneration. Epithelial cells were located at the surface of the blastema with narrow extracellular spaces between them, and their apical domain was covered by cuticle, but there was no basement membrane at the basal domain yet. Their cytoplasm had several mitochondria and some osmiophilic granules (putative lysosomes). Under this developing tissue layer, small cells with a high nucleus-to-cytoplasm ratio were found. They had cytoplasmic processes that connected to the neighbouring cells, forming a syncytium-like pattern. In these cell junctions between the opposite plasma membranes very narrow space was found, filled with osmiophilic material (Fig. 4B), which is characteristic of gap junctions. In the intercellular spaces, no collagen fibre deposition was seen.

Fig. 3. Ultrastructural characteristics of the muscle fibres in control (A) and transected (B-D) body wall at the 3rd postoperative hour. The insert in A shows the pattern of thick contractile proteins (myosin), Z-rods (bullet arrowhead), transversely oriented tubules (double bullet arrowhead) and peripheral vesicles (arrowhead). Note that in the transected body wall, most of the muscle fibres dedifferentiated and were surrounded by collagen fibres, accumulating connective tissue (B-D). Distinct steps of the dedifferentiation can also be seen in muscle cells from the disintegration of the contractile proteins (C) to the migration of swollen mitochondria near the plasma membrane. Labelling: m: regular muscle cell; de: dedifferentiating epithelial cell; dm: dedifferentiating muscle fibres; square: basement membrane; circle: shrunken muscle cell; double arrow: collagen fibres; double arrowhead: mitochondrion; deltoid: swollen peripheral vesicle. Scale bars: 1 μm.

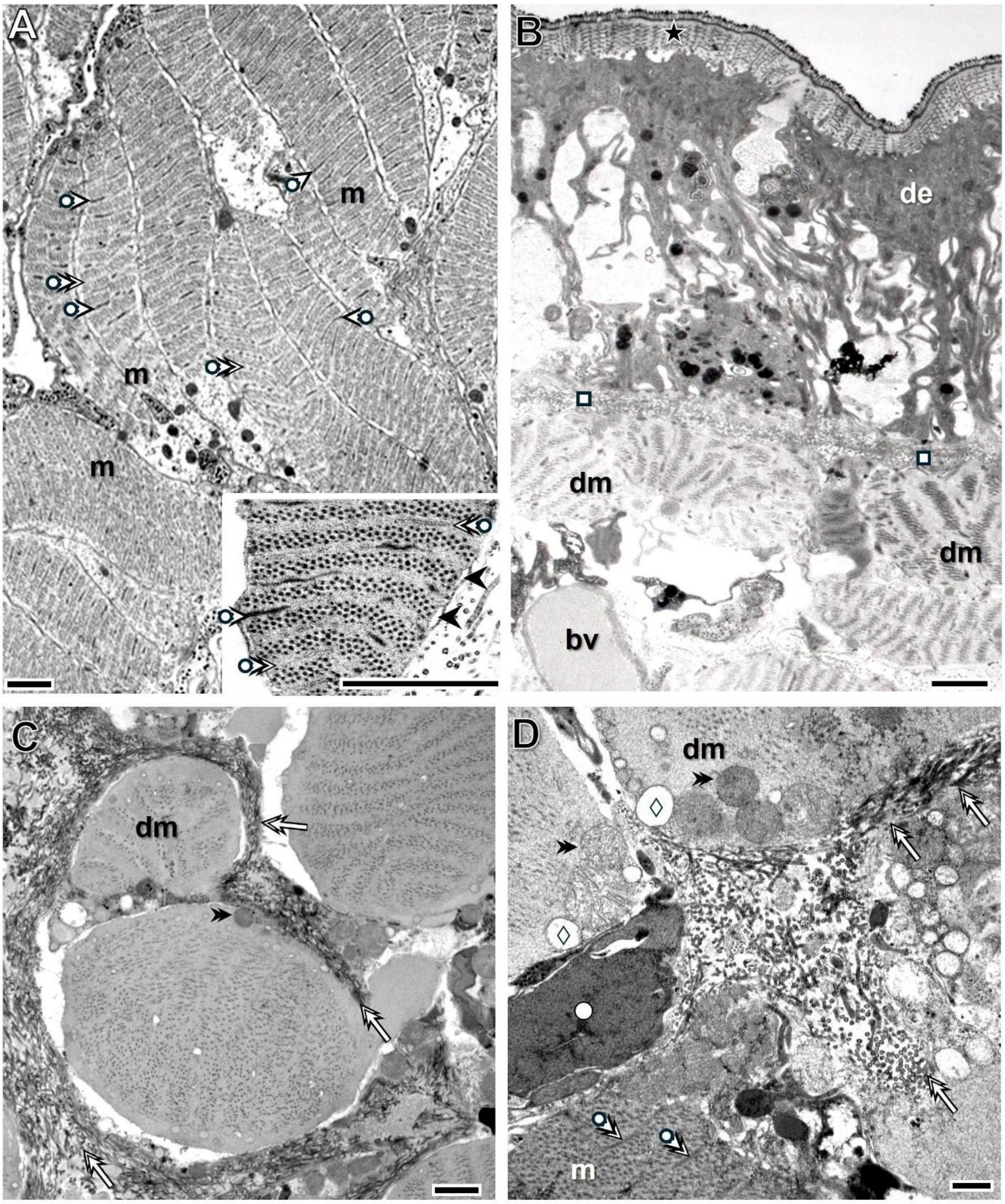
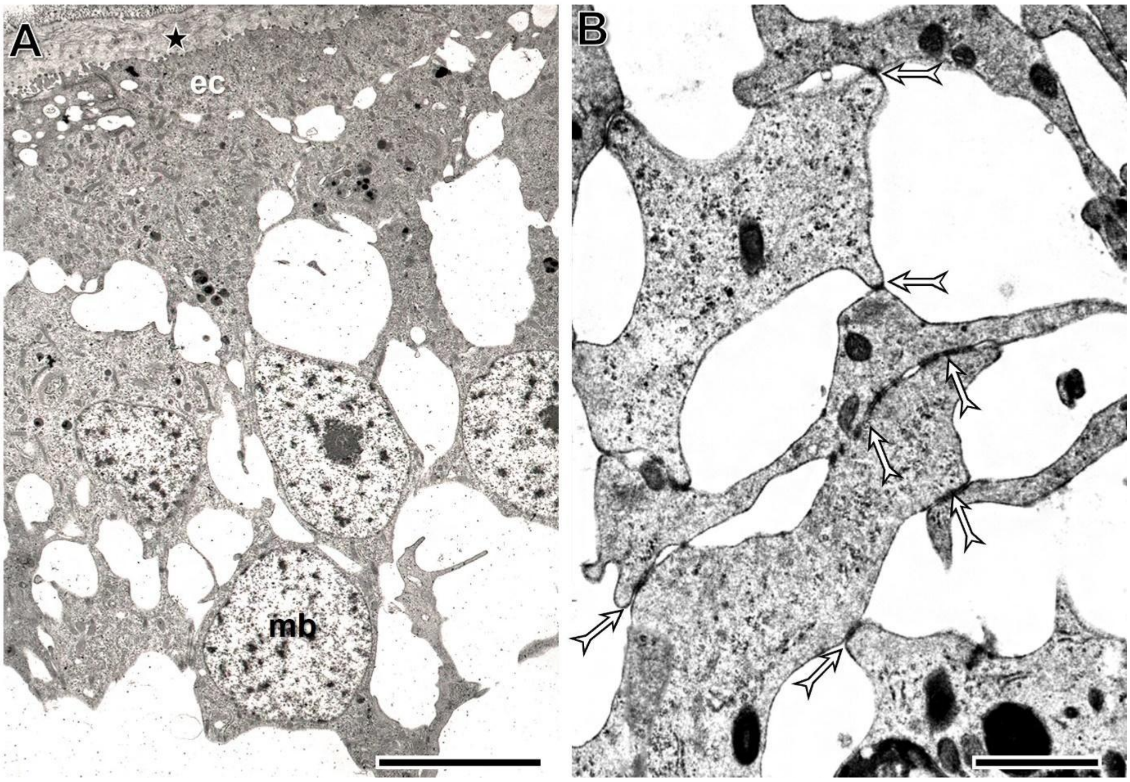


Fig. 4. Cells of the developing body wall in the regeneration blastema at the 1st postoperative week. Note that there are no collagen fibres in the extracellular spaces. Epithelial cells (ec) and myoblasts (mb) can be distinguished based on their morphological characteristics. Between the developing distinct tissue layers, there is no basement membrane yet (A). Differentiating epithelial cells have close connections with each other and are covered by cuticle (asterisk). Myoblasts (mb) have cytoplasmic processes connecting to the neighbouring cells. Higher magnification shows that cell junctions (forked arrows) are gap junctions. Scale bars: A: 5 μm, B: 1 μm.



Discussion

The presented results show that the earthworm regeneration is a miraculous process, starting with an extremely rapid and perfect wound healing, which does not leave scar tissue between the original and renewed tissues. The fast wound closure is an important step of the regeneration process, protecting the injured tissues against microbial attack and inhibiting loss of body fluids. The coelom closing cell plug has been identified as grouping coelomocytes by Amaroli et al. (2018), but our results do not support their interpretation. Detailed histological and cytological investigations revealed (Fig. 1 and Fig. 3) a fast dedifferentiation of obliquely striated muscle fibres of the body wall, resulting in the formation of a high number of myoblast-like cells that play a role in wound closure and formation of the regeneration blastema. However, while Park et al. (2013) suggested that the regeneration blastema is formed solely from the dedifferentiated longitudinal muscles of the earthworm, our findings indicate that tissues from all injured organs - including the body wall, midgut, and ventral nerve cord - contribute to blastema formation, as shown in Fig. 2B. Our experimental results also demonstrate that coelomocytes do not play a direct role in wound healing or blastema formation. Instead, they may influence the dedifferentiation, proliferation, and redifferentiation of distinct cells of tissues by their bioactive molecules. A possible role for riboflavin (Molnár et al., 2015) and pituitary adenylate cyclase-activating polypeptide (Várhalmi et al., 2008) transported by the coelomocytes has already been documented.

An unexpected result of our experiments was the absence of collagen fibres in the regeneration blastema and differentiating tissues at early phases of the regeneration. Collagen is a major extracellular protein that is continuously synthesised from the early phase of embryogenesis to adulthood. During both embryogenesis and physiological tissue regeneration, collagen serves as a substrate for cellular attachment and promotes cellular proliferation, growth, and differentiation (Schultz & Wysocki, 2009). Its presence in the extracellular matrix is necessary for the wound healing processes of animals from sponges to mammals (Arenas Gómez et al., 2020). Earthworms have at least two distinct types of collagen (Baccetti, 1967): a cuticular type synthesised by the body wall epithelium (Burke & Ross, 1975; Maser & Rice, 1962) and a muscular type located in the muscle layers of the body wall, perineural sheath, and alimentary canal (Vavoulidou et al., 2010). A recent study identified a novel collagen-like peptide, col4a1, in *E. andrei* and demonstrated its significant effects on wound healing both *in vitro and in vivo,* including enhanced viability, proliferation, and collagen deposition (Du et al., 2021). Our results show (Fig. 2B, Fig. 4) that newly formed tissues do not have any collagen fibres at early phases of the regeneration. Collagen deposition into differentiated tissues started at the 4^{th}–5^{th} week of the regeneration. Based on the histological and ultrastructural characteristics of the newly formed tissues, we propose that the regeneration process is similar to the embryonic wound healing process, during which collagen fibres do not occur and healing does not result in scar tissue (Redd et al., 2004). The outstanding regeneration capability of the earthworm may be the consequence of strictly regulated collagen synthesis and deposition of collagen fibres into the tissues. While the early phase of the earthworm regeneration (up to the third day) was investigated by single-cell RNA-sequencing and some candidates of genetic mechanisms of cellular mechanisms of regeneration were identified (Shao et al., 2020), the formation kinetics of the extracellular matrix remained unknown. Based on our histological and cytological findings, we propose that the investigation of the expression of those genes that determine the formation of the compounds of the extracellular matrix will help the understanding of the segment regeneration of earthworms.

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Gabriella Laura Tóth – Biology BSc student
toth.gabriella.laura@gmail.com

Edit Pollák – Associate professor
peditmail@gmail.com

László Molnár PhD – Senior research fellow
molnar.laszlo@blki.hu
ORCID ID: 0000-0002-0049-9679

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Unlocking the Magic of Motivation

Exploring House Sorting and Its Impact on Student Engagement

Zsófia Ambach, Ramóna Kitti Szrés
Faculty of Humanities and Social Sciences, University of Pécs

ABSTRACT

The world of Harry Potter continues to grow in popularity around the world, and an increasing number of schools are introducing house systems similar to those found in the books to increase students' motivation. This research explores how the introduction of a Harry Potter-inspired house system affects students' motivation. Our pilot study took place in a prestigious Hungarian high school among 11th-grade students during our teaching practice. We used a variety of data collection instruments to assess the effectiveness of the system. First, we used classroom observation to learn how students interact with each other and the teacher and to learn which tasks they find most engaging. Secondly, after the two-week-long practice, we asked the students to fill out a feedback questionnaire. Finally, in order to triangulate the findings, we also interviewed the teacher of the group, so we can interpret their professional input as well. Since the students were required to work individually and in groups as well, we saw major changes in their engagement; we saw that most of the students were engaged in participating and felt motivated by the house system to work harder and better in and out of class. Based on the findings, we can infer that the house system helped to motivate students and had a positive effect on their school experience. Furthermore, conclusions can be drawn about concrete material development and further usage of the house system.

Keywords: Harry Potter, house system, motivation, gamification, storification, point system, EFL

Introduction

The purpose of this study is to explore the potential benefits and challenges of implementing a house system into an educational setting. By examining existing models, such as the Ron Clark Academy, an American school, which has already implemented the house system with great success, and researching the impact on student performance, this study aims to prove that a house system can be successfully implemented into Hungarian schools and can achieve change in student engagement and in education itself.

Hudgens (2024, February 7) in her article: Why Every School Should Have a House System Like Hogwarts (https://www.boredteachers.com/post/school-houses-like-hogwarts), suggests a few positive effects of implementing the Harry Potter house systems in schools, such as allowing every student to feel a sense of belonging, contributing in something together, expressing identity and values, etc. In our research, we explored the idea of a gamified classroom and what changes it holds. While the Ron Clark Academy successfully implemented the house system, we learned that there are many successful implementations of gamification as well; most importantly, Gressick and Langston (2017, p.117) found that it resulted in a high level of participation, positive perception of peers and a strong sense of community.

Although we found many unsuccessful attempts in previous research, we intend to find an answer to whether the house and rewards system impacts students' motivation, how competitive tasks require collaboration, and what changes we need to focus on long-term integration. Unlike previous studies that primarily concentrate on a specific educational level, we set a goal to find answers during our short teaching practice, in a prestigious high school in Pécs with 11th-grade students.

With this exploratory research, we aim to help educational administrators by giving an insight into implementing a house system, and understanding the specific challenges and advantages associated with the house system, by providing a thorough theoretical background and a detailed overview of our implementation procedures. And also, the school staff, by giving them a base on fostering a more supportive and collaborative school environment and enhancing both student and teacher engagement.

Theoretical background

As part of the theoretical background, approaches that support the needs of learners were explored in this research paper. First, the relevant psychological frameworks were examined, such as the social cognitive theory (Montgomery et al., 2023), which explains that self-efficacy depends on the task and the confidence in the learners' ability to complete it successfully. On the other hand, competitive self-efficacy plays a crucial role in students' engagement, since this is one factor that makes students want to outperform their peers. Competitive self-efficacy requires cognitive engagement, which in the context of education can be defined as a student's level of participation, involvement, and motivation within a competitive environment (Bailey et al., 2023, p. 4).

Self-determination theory (Montgomery et al., 2023; Graham et al., 2022) was also examined and compared with invitational education theory (Moss, 2018). IET is based on the idea that teachers manage their classrooms with respect, dignity, and empathy (Moss, 2018, p. 19) and while SDT stresses the students' behavior, IET focuses on the educators. Both theories share focal points, including how people treat each other, behaviorism, teacher-student support, autonomy, and relatedness. This also relates to academic flow (Csíkszentmihályi, 1990; Dalton et al, 2014; Olcar et al., 2021), since our choices in giving out certain activities play a crucial role in shaping our students' engagement and can have an impact on their educational journey and development. This means flow is a mental state of being completely focused on what a person is doing.

The constructivist theory (Ahn & Class, 2011; Shah, 2019; Szabó & Csépes, 2023) helps students become active participants in the learning process and also creates an environment where teamwork and relying on each other are crucial for a beneficial learning experience, which is also similar to student-centered teaching. Vygotsky's (1978) Zone of Proximal Development (ZPD) claims that there are tasks that students can only do with guidance, and with the right support, they can grow their ability to do it on their own, while also relying not only on the learners' interpretations, but on the environment as well.

These frameworks have shown that learning is most successful when students can actively participate in and form their learning, and when they feel capable of overcoming the challenges they face. These frameworks have also highlighted the key role of teachers in learning: they can contribute to, or even destroy, students' motivation.

Gamification and storification were examined as two possible approaches to boost student engagement. The research paper focused on how these approaches can contribute to the above-mentioned factors. Amongst many things, their benefits, disadvantages, and possible barriers, as well as the possible implementation of *Harry Potter* and the house system, were considered. Researchers identified that both approaches have a positive effect on student engagement and motivation, foster student behaviour, and support positive perception of peers while making learning more enjoyable. On the other hand, some researchers have observed that gamification did not have the expected motivational effect (Furdu et al., 2017, pp. 59-60; Sanchez et al., 2019, p.24); what's more, it could be demotivating for some students (Majuri et al., 2018, p. 16). Other researchers highlighted that special needs students could be affected in a more negative way: in the study of Aura et al. (2021) student with ADHD preferred the assigned seating over the flexible seating of the storified classroom, as it helped her to focus better and gave her the opportunity to ask for help from his peers (p. 7). There are also various barriers of gamification, among which the top three are (1) a lack of technology, (2) disciplinary problems, and (3) a lack of motivation (Demirbilek et al., 2022). It should be noted that in order to realise these projects, teachers may need to invest a lot in the realisation of these approaches, be it financial resources, time, or energy, while students also need to stay open to them (Aura et al., 2021, p.8). Fridrich (2020) also tried to find possible weaknesses of gamified models used in Hungary. According to his research, the main problem is that these models are not problem-centered but are organised as a knowledge transfer process (p.8). As a response to these mentioned weaknesses, he introduced complex educational gamification based on a new gamification model he created (Fridrich, 2023).

The *Harry Potter* universe is a great candidate for gamification, since it is relatable for students and has a potential motivating factor. The story of Harry Potter is not only significant because of the role of academics, but also of the similarities that can be drawn between the life of Harry and that of the reader (Yager, 2015, p. 2). The study of Aura et al. (2023) is a perfect example of this; after the study, a teacher stated that the involvement of the Harry Potter theme was successful because "*a lot of their kids live in a situation similar to Privet Drive*" (p. 9). Harry Potter's well-known house system, in which students are sorted into one of the four houses (Gryffindor, Slytherin, Ravenclaw, Hufflepuff) and where their academic results are all added to their house's points, has already been successfully used in several cases (Gressick & Langston, 2017; Ron Clark Academy, 2022; Syed et al., 2018). We found a similar system in Gressick and Langston's research, in which they created the *EdPsych World* for teacher education candidates at a public regional state university campus (Gressick & Langston, 2017, p.112). Their research involved guilds, which were groups of five to six students that remained together during the semester (p.113). They found that their research resulted in high levels of participation, positive perception of other guild members and strong sense of community (Gressick & Langston, 2017, p. 117). In the case of *MS Creative Schools* (Syed et al., 2018) and RCA we saw a school-level implementation of the house system. The MS Creative Schools have four houses (Motivators, Inspirers, Leaders and Challengers), and each house has a house captain. Syed (2018) found that the house system had a positive effect on both the students and the staff. The *Ron Clark Academy* is one of the most successful and well-known examples of the real-life application of a house system. Originally consisting of four houses, this house system has now expanded to eight houses (the original four houses were Altruismo, Amistad, Isibindi and Rêveur, to which Sollevare, Nukumori, Onraka and Protos were later added). Similar to the MS Creative Schools, both teachers and students are part of the RCA house system. Furthermore, RCA has influence over more than twenty-six countries around the world. The Ron Clark Academy and the MS Creative Schools are proof that house systems can work in the long run and on a school level.

Research

Participants

We conducted our research at a prestigious high school in Pécs, which took place over two weeks during our practice teaching. We had thirteen Hungarian 11th-grade students, four male and nine female (m: 30.8%; f: 69.2%), who had B2-C1 proficiency and had been learning English since the first grade of primary school. From our mentor teacher, we learned that the group works well together, but they have some occasional friendly competitiveness among each other. Unfortunately, we had to remove a few students from our sample because they missed more than half of our lessons.

Research questions

Our study aimed to investigate the effectiveness of an experimental house system on the intrinsic motivation of the students. We set the research questions as follows:

- **RQ1:** How does the recognition and rewards system impact students' motivation in English studies based on available data?
- **RQ2:** How do competitive tasks that require collaboration, reinforced through the collection of house points within the house system, affect students' intrinsic motivation to learn English in the classroom?
- **RQ3**: Based on the results of the exploratory study, what changes are needed for the long-term integration of the house system in the high-school English classroom?

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Data collection instruments

This study aimed to examine the effectiveness of a house system in motivating students within a classroom setting. We adopted a mixed-method approach that allowed us to evaluate this system effectively. Using both qualitative and quantitative data collection methods enabled us to assess the effectiveness of the pilot house system from both educator and student perspectives. In the following, the various data collection instruments are discussed individually.

With the personality-based sorting quiz, we aimed to use questions to evaluate various sides of personality, such as thinking styles, introversion vs. extroversion, preferred hobby styles (e.g., logical, creative, or physical), independence vs. teamwork, and other questions that match the characteristics of the houses. We have also adapted questions from the *Pottermore* sorting quiz (https://www.wizardingworld.com/sorting-hat), which served as the primary inspiration for the personality quiz. Based on the results, firstly, we both assigned each student to a house individually, and then we shared our results. We ended up with three students in Drakonis, Gryphonia, and Pixorin, and four students in Lunaris.

The research also used observation to get a more accurate picture of the changes in the group. Our goal was to focus on how students' behavior and engagement changed by implementing the house system and providing a point system. Throughout our classroom observation, we used short post-lesson notes. We had limitations, since a few students missed more than half of our lessons. On the other hand, we also had motivators in our classroom: there was one student who always motivated others and asked them to do what they were told. The house chant and house sign were initially integrated as homework; unfortunately, we had to integrate them as an in-class task, which was somewhat more enjoyable for the students. We also used different types of tasks during our research. We integrated creative tasks, such as creating a campaign against animal abuse, creating fictional beasts, and completing the *Wordle* of the day, and also used other online sources, such as *Wordwall* and *Quizlet* tasks.

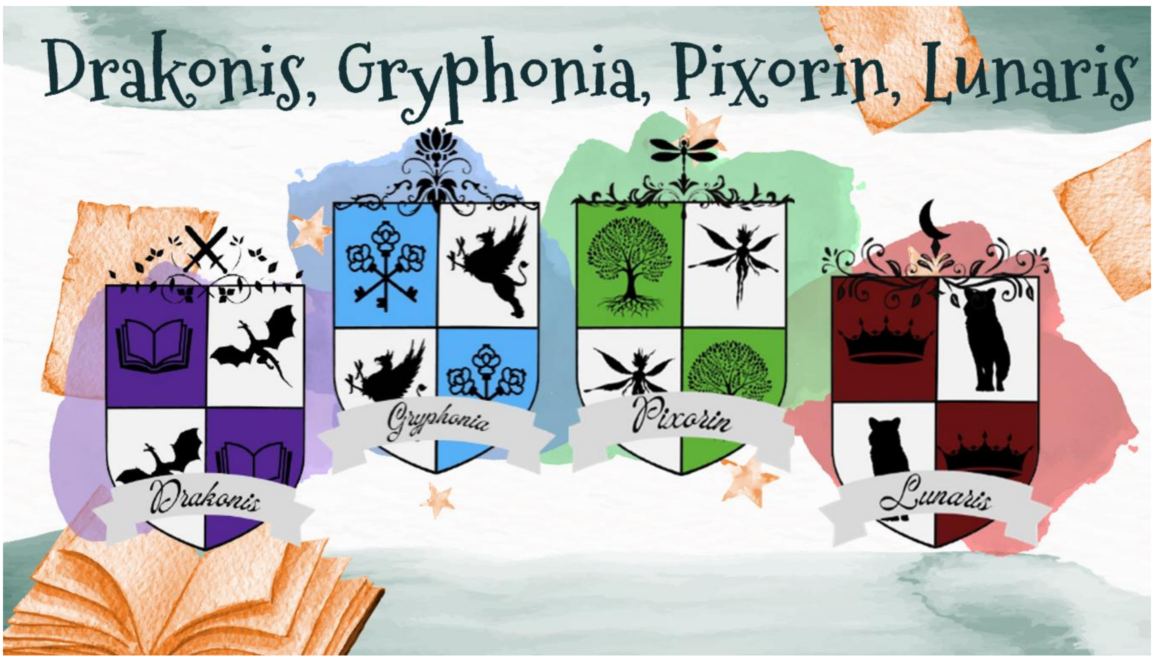
In the feedback questionnaire, we inquired about students' experiences and thoughts regarding the events that occurred during our program, and their feedback on their participation in the house system concept. The feedback questionnaire consisted of several open-ended questions focusing on the general idea of the system, the students' motivational level, and their experiences, and also whether they would like to see more of the system in their class or develop it into a whole-school system. Some students expressed their feelings of unfairness because they thought some of their classmates were "cheating" on the sorting quiz, and also because of the unequal number of people in their house. They were assured that the sorting quiz was handled appropriately, and students were sorted fairly, and also that they could still win even if they had fewer people in their house. A good example is Pixorin house, which in the beginning only had one member because their housemates were sick, but since Gryphonia ended up in the same position, and that one person did not wish to participate anymore, Pixorin still made it to the podium.

As a final step in the research, we conducted an interview with the mentor teacher after the end of the house system. The purpose of the interview was to get a more accurate picture of the lessons and the effectiveness of the house system, as the mentor teacher, as an external observer, could observe the lessons from a different perspective. Based on her interview, we were able to get information about practical challenges we might face, we got an overview of her insight about the competition and collaboration among students, and what impact the house system had on these. We were also able to get a professional perspective on the input of the students' motivational change.

Procedures

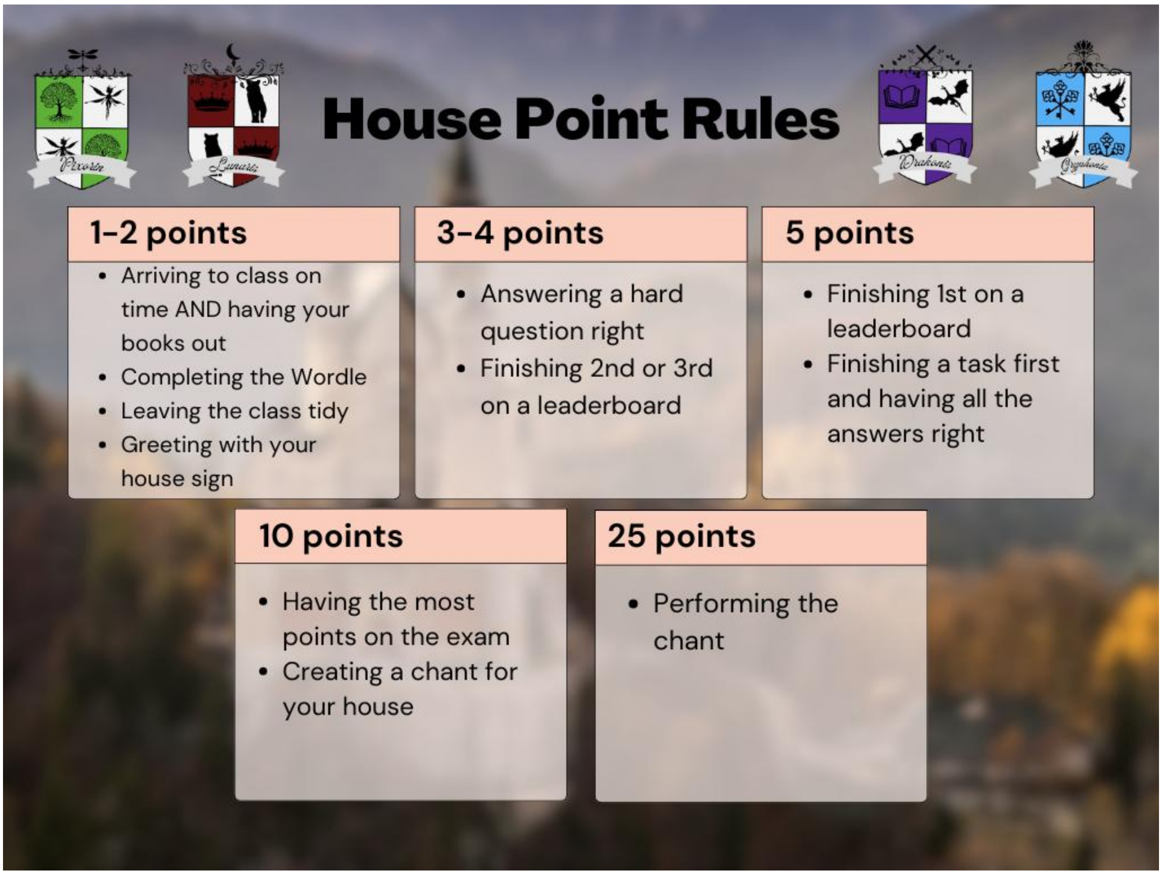
To be ready for our research, we started our preparation by first asking our mentor teacher if we could do this research. Our mentor teacher was very excited and helpful during our work. To make sure the house system reaches its full potential, we created our own houses and crests. Each house had its own traits, and we carefully picked out each color, animal, trait, and symbol to match each other (Figure 1). For example, the Lunaris was given the title: House of Leadership, since the fellows in this house have every trait to guide and help their classmates in anything they might need. The members of Gryphonia are the ones who can keep the competition friendly among the houses; they can make sure everyone feels included. Therefore, this house is the House of Unity. Pixorin members can bring joy into the lives of other houses and also bring some mischief into everyday life. This house is the House of Mischief. As the House of Creation, members of Drakonis can motivate and help their classmates.

Figure 1.
The house crests were developed for the project using Canva



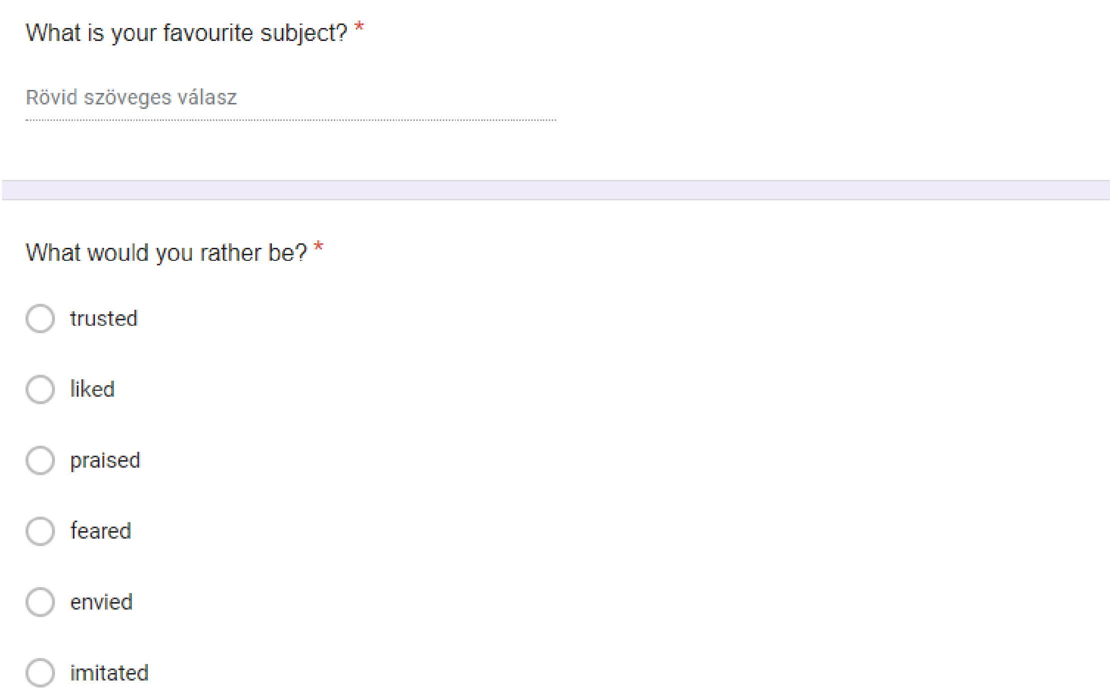
Next, we created our point system so we could motivate the students to participate actively in the lessons (Figure 2). We gave one or two points for arriving on time and being ready to start the lesson, and also for completing and showing the day's *Wordle* answer to us before the lesson starts. Three or four points were given if they answered a hard question correctly and if they finished second or third on the leaderboard for a given online task. They were able to receive five points if they finished first on the leaderboard, and also if someone finished a task first and correctly. Ten points were given for having the most points on an exam and creating a house chant, and presenting it to us in text. Lastly, they were able to receive 25 points if they performed the house chant.

Figure 2.
An overview of the house point system implemented in the project



Next, we also created our sorting quiz to sort the students into their houses (Figure 3). We used questions based on their personality, thinking styles, and other questions related to the characteristics of the houses.

Figure 3.
Examples of sorting questions



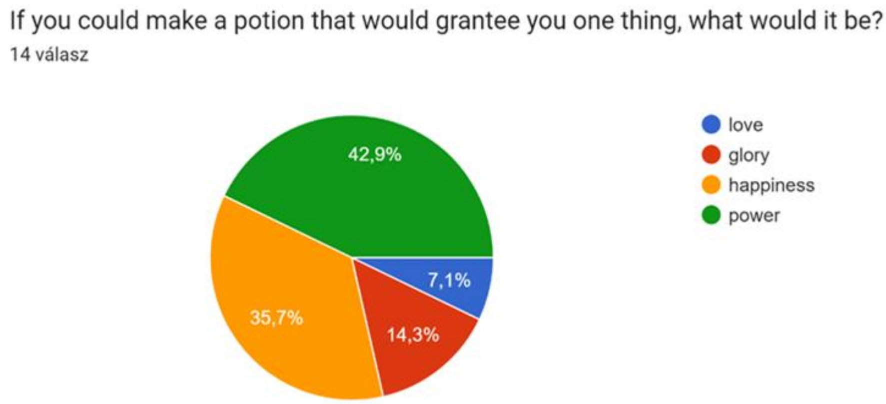
Results

Effect of recognition and rewards on student motivation

The aim of this study was to explore how the introduction of a Harry Potter-inspired house system affects students' school experience. In our study, we adopted a mixed-method approach in order to evaluate the system. First, we used classroom observation to gain a real-time insight into student engagement. Secondly, we used two types of questionnaires: the first one was used to sort students into the four houses (Drakonis, Gryphonia, Pixorin, and Lunaris), while the second one was used to collect feedback on the students' experience and on their opinion on the house system. Finally, we conducted an interview with the mentor teacher, which gave us an insight into her professional view of the system's impact.

As a first step of our research, we asked the students to fill out an online questionnaire on *Google Forms*. We asked the students questions based on their personality, preferences, and interests (Figure 4), and some personal questions that included the topics of favourite animal, subject, hobbies, and about themselves as well. We used multiple-choice questions and one open-ended item.

Figure 4
Multiple Choice Question about Students' Preferences



Similarly, to the guilds of Gressick and Langston (2017), we tried to sort the students into houses based on their common interests and similar personalities. After evaluating the answers, we ended up with three people in Drakonis, three people in Gryphonia, three people in Pixorin, and four people in Lunaris.

During our classroom observation, we paid attention to and took notes about students' engagement with each other and in different tasks. Students seemed interested in how the house system worked, and they also asked questions about the sorting, the point system, and the houses. During the sorting, they rooted for each other and were excited about the results. Even though we tried to find the most fitting house for each student, there was still some disappointment after the sorting. These students later told us that their disappointment did not lie in the house they were sorted into, but in their housemates, they were sorted with. Unfortunately, we could not solve the rivalry and bad relationship between the students with the help of our system, and even with a small number of students, there were some cliques in one of the houses. Thankfully, most of the houses were able to put their disagreement aside and they worked well together.

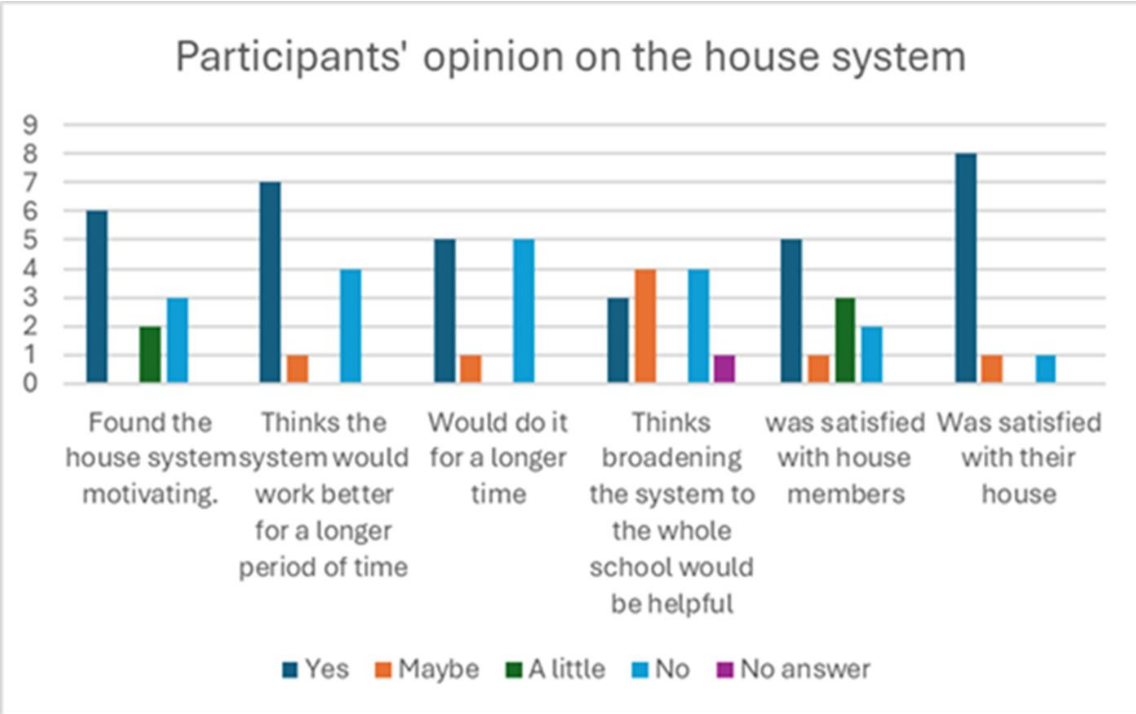
Most of the students were active during the tasks, while three of the male students were stubborn, and one of them did not want to participate at all. The students seemed to be most engaged with tasks where they could be competitive with each other and where they could earn a lot of house points. Students seemed to finish tasks faster and more correctly when they got points for being the first to finish.

Overall, taking into account the shortness of the project, the students kept the motivation rate on the same scale for most of the time.

Impact of competitive collaboration on intrinsic motivation

Most of the findings matched our initial expectations. 63% of students (n=7) found the house system motivating, and thought that it would work better in the long run. Luckily 54% (n=6) were at least somewhat satisfied with their house members, while the vast majority (81%, n=9) were satisfied with their house; however, there was one student who stated that she wanted to 'undercut' her team because of her teammates (Figure 5). The results are a good indicator of students' openness to the house system, and they also give us insight on how much it depends on the members of the houses, as students who did not get on well with their house members gave the most negative answers.

Figure 5
Students' opinions on the house system



We also asked them in the form of a questionnaire to tell us what they liked (Figure 6) or disliked (Figure 7) about the house system. It was interesting to see how some of the results contradicted each other. For example, while three students stated that they liked working with other people, two students answered that they didn't like teamwork. We saw the same in the case of sorting: while some students mentioned that they liked the sorting quiz, others did not like it, one student even mentioned that they thought it was "unfair".

We had a house, Lunaris, in which two out of four members did not like the other members of the team, one said they liked the other members, and one only liked some of the members. Contrary to the results of Gressick and Langston (2017), the positive perception of peers was not present in this case.

Figure 6
Participants' Preferences Regarding the House System

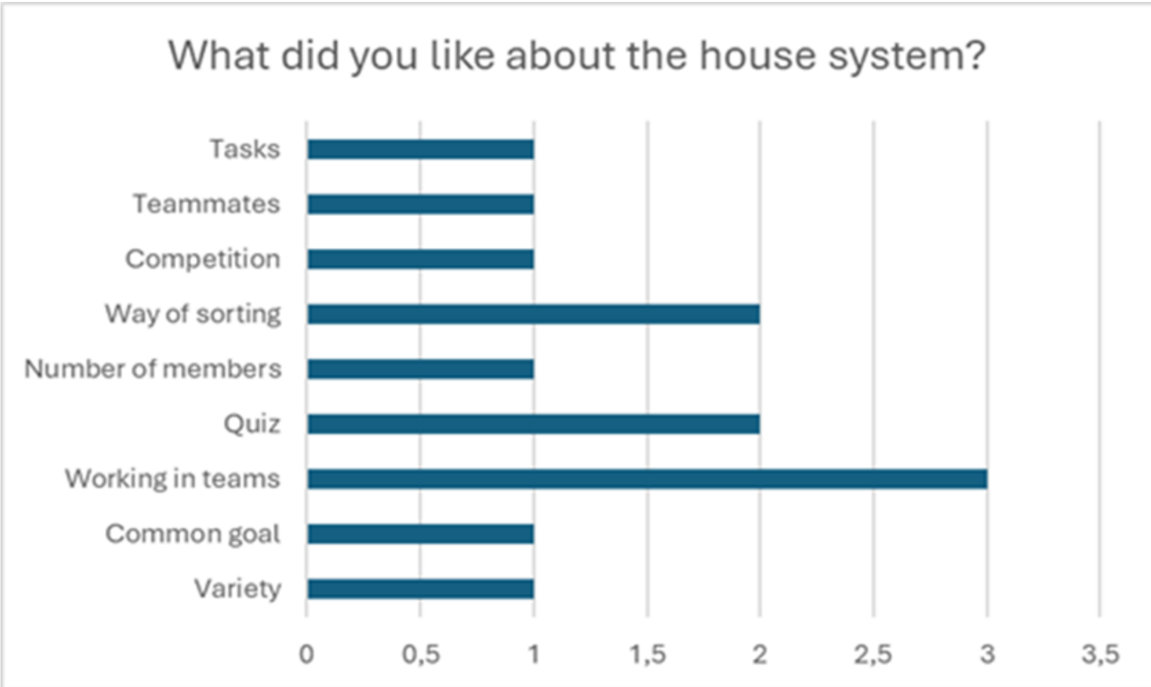
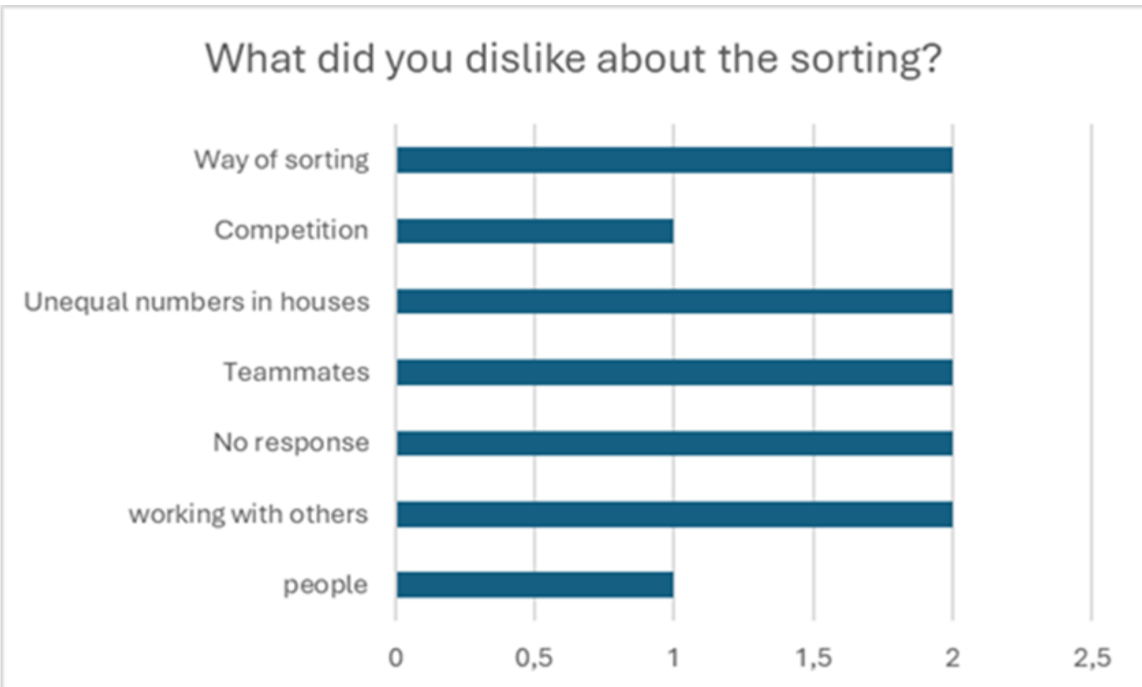


Figure 7
Participants' Criticisms Regarding the House System



During an interview, we asked our mentor teacher about her experiences and thoughts regarding the events that occurred before and during our practice, their feedback on the student's participation in the house system concept.

Firstly, we asked them about the dynamics of the students before the introduction of the house system, including the atmosphere in the classroom, then we wanted to know about how the students relate to each other. The aspects mentioned by our mentor teacher (the general motivation of students towards learning English and the mental and emotional gap between boys and girls) matched our observations of group dynamics, prior to the teaching practice. They also mentioned the Lunaris house, which did not work out well, due to the past of certain students. Although they put aside most of their differences, our mentor teacher observed that the boys and the girls worked as two sub-groups within the house.

The mentor teacher said that there had been some verbal bullying in the group, however, she preferred to describe it as "*pulling each other's leg*". This form of bullying, however, was not present during the teaching practice, while the cliques and rivalries stayed the same. This suggests that the house system had a positive impact on group dynamics to some extent: in order to work together effectively, students changed their ways of communication.

Finally, we also asked her about our main focus, how the students' motivation changed during the use of the house system. According to our mentor, they "*came up with ideas that they sort of worked out together",* resulting in a different form of motivation. She also mentioned that the students' willingness to cooperate differed from prior to the teaching practice. This shows that the house system can lead to changes in group dynamics, even in a short time.

When asked about the future implementation of the house system, the mentor teacher answered that she would "absolutely" use it in the future. She had a positive reaction to the points system and said that it was an effective way of assessment. However, she noted that extending the system to the whole school would involve a lot of work (e.g., converting the points system to other subjects' requirements). This is in line with the findings of Aura et al. (2021), who said that proper ratification entails effort from the part of the teachers.

Overall, we can say that competitive collaboration had a positive effect on the students' intrinsic motivation. We got positive feedback both from the mentor teacher and from the students. Even in Lunaris house, the students managed to put aside some of their disagreements when the houses had to work together.

Key changes needed for the long-term implementation of house systems

Finally, we had a closer look at the following six questions:

1. Do you think the house system helped motivate you or your class?
2. Do you think the house system would've worked better, if it were done for a longer period of time?
3. If there were the possibility to continue the house system, would you like to participate in it?
4. If there were the possibility to broaden the house system to the whole school, would you think it would be helpful for anything?
5. Were you satisfied with the house you were sorted into? Were you satisfied with the members of your house?

The results indicate that the number of those who would want to participate in the house system during a longer period of time and of those who would not was equal, 63% of students (n=7) would not broaden the system to the whole school or was not sure about it, but it is also clear that students do not think it could be implemented as much as in the case of Hogwarts or the RCA. Despite these answers 54% of the students (n=6) found the system motivating, and 63% of those who responded thought that it would work during a longer period of time (n=7), however, 45% of the students (n=5) would actually try it for a longer period of time, and one was not sure about it. As mentioned above, there were some students who were dissatisfied with their house members. This is also reflected in the results of the questionnaire, as 18% (n=2) answered that they were not satisfied with their house members, and some were only somewhat satisfied with them (36%, n=4), one even stating that they even wanted to "undercut" their team.

In the questionnaire, as an answer to Q7, one student stated that it meant too much stress for them, and another stated that it was too much out of their comfort zone. This feedback is similar to the findings of Majuri et al. (2018), which says that gamification does not have the same effect on every student. According to the students' feedback, the house system made the lessons less boring and more exciting. This shows well the students' need for new and interesting teaching methods.

Just as we have seen in previous examples (the RCA system; Aura et al., 2021, 2022), apart from Lunaris House, our system had a positive effect on the classroom's atmosphere and the students' community.

Pedagogical implications

Our research shows that house systems do have a future in education, however, these systems need to be well-structured and detailed, and these findings are underlined with previous studies and already existing systems (Gressick & Langston, 2017; Ron Clark Academy, 2022; Syed, 2018). Designing a system even for a few students requires a lot of energy from the teacher's part, and students need to be open to this new and barely used system.

Our findings show that students are open to new approaches, specifically to the house system, and are willing to try them. This is underlined by the fact that students asked questions about the new system (e.g., about the houses, the points, etc.), and that they rooted and were happy for their peers during the sorting ceremony. At the same time, high school rivalry and cliques will affect the house system mostly in its early stages. Students were (naturally) disappointed when they got sorted into houses with people they did not like.

Students' contradicting answers to the feedback questionnaire prove that each student has their preferences, and therefore it is hard to create a system that every student will equally like. We would like to highlight that teachers should pay attention to classroom diversification even within the house system to ensure that all students feel comfortable during the lessons.

Conclusion and further research

In our research, we explored the possible integration of house systems into public education and its impact on students' intrinsic motivation. We focused on three primary questions: firstly, we wanted to know what changes would be needed to implement the system in the long term, secondly, we looked at the motivating factors of competition and collaboration fostered by the house system, and finally, we examined how the recognition and rewards system contributes to the students' motivation.

Our results indicated that students are interested in this new approach and they were generally engaged in the lessons and the activities (RQ1). However, some students may be forced to step out of their comfort zone and some may see it as a barrier towards studying (RQ2). As we have seen, students had a positive reaction to the house system, however they were not sure about its use in the long run (RQ3). We also learnt that the mentor teacher was open to this approach, and was supportive towards the use of the system. They saw the use of the house system as a positive experience and noted that the students seemed more motivated than usual.

This study, however, has its limitations. We conducted our study for a brief period of two weeks, which was not enough to make a lasting or profound impact on our students. Furthermore, our study only looked at thirteen students, many of whom were missing during lessons. The results therefore cannot be generalized and further research is needed.

In the future, we aim to investigate the long-term effects of the house system on students' academic performance and social dynamics. Our goal is to implement the system within a larger group over an extended period, enabling a deeper understanding of emerging rivalries, cliques and the strategies to manage them. We also seek to develop the house system into a framework that not only encourages individual growth but also fosters effective collaboration both within and across houses. To support this, we plan to examine the interactions between the students and the houses from the perspective of social development and academic outcomes. Furthermore, we are designing a revised feedback and sorting quiz intended to better measure students' acceptance of the house system and to improve the sorting process.

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Zsófia Ambach – Teacher of English and French Language and Culture
zsofiambach19@gmail.com

Ramóna Kitti Szrés – Teacher of English L.&C. and Hungarian Language and Literature
szreskitti@gmail.com

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Shrinking, growing or overburdened?

Territorial patterns in child demographics and institutional burden in Hungary's public education system after 2021

András Béres
Faculty of Sciences, University of Pécs

ABSTRACT

This study explores the spatial patterns of change in Hungarian public education between 2021 and 2024 using settlement-level data on child numbers, the proportion of disadvantaged children (HH/HHH), and child–teacher ratios. Using k-means clustering, five settlement types were identified: *Overburdened Growth Areas*, *Declining but Stabilizing Areas*, *Disadvantaged Declining Areas*, *Moderately Declining Balanced Areas*, and *Balanced Growth Areas*. The findings revealed a deepening divide between dynamic urban/suburban zones and disadvantaged rural peripheries. Rapidly growing urban settlements face rising child–teacher ratios (e.g., up to 24:1 in some areas), indicating capacity constraints, while disadvantaged children have become increasingly concentrated in rural areas (up to 94% in certain settlements). Notably, by 2024, more than 1,200 of 3,155 settlements had no public educational institutions, raising concerns about territorial equity. The results underscore the need for spatially differentiated policy responses and present a typology that can guide the monitoring of fine-grained territorial dynamics in educational systems undergoing demographic and institutional changes.

Keywords: spatial inequality, public education, disadvantaged children, child–teacher ratio, Hungary, cluster analysis

Introduction

Educational Inequalities in Spatial Perspective

Since 2021, the Hungarian public education system has undergone a series of transformations that have intensified the long-standing spatial disparities. These changes were shaped by the remaining effects of the COVID-19 pandemic, continued demographic decline, and a growing shortage of qualified teachers, developments that have disproportionately affected rural and disadvantaged regions (Lannert & Németh, 2023; Varga, 2023). Against this backdrop, understanding where and how the system is expanding, shrinking, or becoming overburdened is critical for informing policies and planning.

Hungary experienced a decade of restructuring prior to 2021. The nationalization of schools shifted control from local governments to centralized authorities, significantly reducing municipalities' autonomy in responding to local educational needs. Funding mechanisms became more uniform but less sensitive to contextual inequalities. Simultaneously, selective school choices, the growing role of church-run institutions, and uneven infrastructural development have contributed to rising territorial disparities in access and quality. Teacher attrition, an aging infrastructure, and the concentration of socioeconomically disadvantaged children further challenge the resilience of the system, particularly in smaller settlements (Berényi, 2025; Pusztai et al., 2019).

While spatial inequalities in education have been widely studied in the international literature, including in Central and Eastern European contexts, few studies have provided a detailed settlement-level analysis of how these patterns have evolved in Hungary since 2021. Most studies have focused on national-level trends or institutional characteristics, leaving a gap in our understanding of micro-regional dynamics and the differentiated impacts of demographic and institutional changes across space (Bareith & Csizmadia, 2025; Dövényi & Németh, 2018; Pénzes et al., 2018).

Spatial Dimensions of Educational Inequality in International Scholarship

A growing body of international research has highlighted the importance of geography in shaping access to quality education. Scholars have shown that educational opportunities are unevenly distributed across urban and rural areas, often reflecting broader socioeconomic stratification patterns (Alam & Parvin, 2023; Drescher et al., 2022; Goetz & Rupasingha, 2004; Green et al., 2017; Krueger & Lindahl, 2001). In many countries, school closures and teacher shortages disproportionately affect peripheral or economically deprived regions, exacerbating territorial disadvantaged cycles. These dynamics have been particularly pronounced in post-industrial and post-socialist contexts, where uneven development has produced sharp contrasts in educational infrastructure and outcomes (Di Cataldo & Romani, 2024; Hannum et al., 2021; Hanushek et al., 2004; Kızıltaş & Gönülal, 2025; Kroismayr, 2019; Muñozo et al., 2020).

Cluster-based typologies have emerged as powerful tools for identifying spatial patterns of educational change. Studies employing such methods have revealed how local educational systems respond differently to national reforms, demographic pressures, and policy interventions, often in ways that mirror the existing social inequalities. These typologies are particularly useful in contexts such as Hungary, where long-term disparities persist, despite overall improvements in national schooling indicators. Research by Hegedűs (2016) using the LeaRn index, a composite measure of formal, informal, and community-based learning resources, shows that student performance correlates strongly with territorial learning environments. Disadvantaged regions consistently scored lower, suggesting that structural inequalities extend well beyond the classroom.

Educational Restructuring and Territorial Disparities in Hungary

In Hungary, the spatial polarization of educational opportunities has intensified since the 2000s. Following the nationalization of public education, local governments lost control over school maintenance, leading to a centralized model of educational governance.

Although this reform aimed to ensure uniform standards, it also weakened the local capacity to address place-specific challenges (Kozma, 2015; Sáska, 2013).

Velkey (2019) argues that this centralization process released local elites from their responsibilities in shaping equitable education systems while enabling the expansion of church-run institutions, particularly in shrinking or disadvantaged areas. This has led to the reconfiguration of institutional landscapes and access, contributing to growing disparities in service availability and child composition.

The post-pandemic years have brought about further disruptions, including accelerating teacher attrition and intensifying the regional demographic decline. The persistence of settlements without any public education institutions (over 1,200 cases in this study) underlines the extent of structural fragmentation in rural Hungary.

Moreover, territorial disparities in teacher distribution—especially among special education professionals—have a direct impact on inclusion and student support. Hegedűs (2023) found that in several northeastern districts, no special education teachers were employed at all, despite rising numbers of children with special needs. Such shortages are compounded by the concentration of teacher-training institutions in urban centers, which limits the return of qualified professionals to peripheral areas. This systemic pattern of uneven teacher allocation reinforces regional disadvantages and limits capacity for functional inclusion.

As Jászi (2013) pointed out, most mainstream teachers are unprepared to accommodate children with special educational needs, especially in areas where special educators are absent. While integration rates may appear high on paper, a lack of appropriate pedagogical support often results in symbolic rather than effective inclusion. Alpár (2020) further argued that teachers are not merely passive participants in this process; they can also actively contribute to the exclusion of other students when they lack the skills or attitudes required for inclusive pedagogy.

The uneven spatial distribution of teacher-training institutions (Hegedűs, 2015) also plays a crucial role: graduates tend to remain near their training centers rather than returning to their home regions, leaving peripheral areas chronically underserved. This loss of intellectual capital deepens territorial disadvantage, particularly in northeastern Hungary.

Taken together, these findings underscore that spatial inequalities in Hungary are not simply the result of uneven demand or demographic shifts but reflect structural patterns of exclusion, under-resourcing, and institutional disengagement. The current study builds on previous works (Alpár, 2020; Forray R. & Híves, 2011; Hegedűs, 2020; Híves, 2006, 2015; Híves & Forray, 2009) to analyze how regional learning environments, teacher presence, and disadvantaged status indicators interact to perpetuate or mitigate educational inequalities in post-2021 Hungary. By integrating the spatial, social, and institutional dimensions, this analysis contributes to a more comprehensive understanding of Hungary's evolving educational geography.

Indicators of Disadvantage and Institutional Burden

Understanding Disadvantaged Children

In Hungary, children are classified as "disadvantaged" (HH – hátrányos helyzetű) or "severely disadvantaged" (HHH – halmozottan hátrányos helyzetű) based on their family's socioeconomic conditions, as defined in the Act XXXI of 1997 on the Protection of Children. This classification includes factors such as low parental education, poverty, and adverse living conditions. Children who meet these criteria qualify for additional support within education and welfare systems.

The legal definition and institutional management of disadvantages have significantly changed over the past few decades. Although originally defined in the 1993 Act on Public Education, the legal framework was revised in 2013, transferring the classification to the Child Protection Act. This shift emphasized that addressing educational disadvantage is not solely the responsibility of schools but a broader welfare obligation, spanning early childhood through young adulthood (ages 0–24).

Currently, eligibility for regular child protection allowance (rendszeres gyermekvédelmi kedvezmény, RGYK) is a prerequisite for HH or HHH status, underscoring the focus on income-based criteria. In addition to low household income, HH status requires one of the three risk factors: low parental education, prolonged unemployment, or inadequate housing conditions. HHH status requires at least two of these conditions, or applies automatically to children in foster care or those receiving after-care while enrolled in education.

This legal structure prioritizes economic deprivation as the primary trigger for support. However, it has been criticized for not adequately addressing non-material forms of deprivation, such as cultural marginalization or social isolation, unless they coincide with low income. The assessment process is administered by local authorities (notaries), and although it is intended to reflect local knowledge, its practical implementation may vary.

By codifying the disadvantages within the child protection system, Hungary aims to ensure a more integrated and long-term approach to equity, linking education, welfare, and developmental support. However, they also highlight broader issues, such as social exclusion and segregation, where disadvantaged children may be concentrated in certain schools or regions. For example, in some rural areas, nearly all children (up to 95%) may be classified as disadvantaged, which can limit their access to quality education and opportunities.

Table 1.
Legal Criteria for Disadvantaged (HH) and Severely Disadvantaged (HHH) Status in Hungary

Status	Criterion	Description	Legal Reference
Prerequisite (HH & HHH)	Regular Child Protection Allowance (RGYK)	Income- and asset-based eligibility for child protection subsidy.	Act XXXI of 1997, §§ 19, 20, 67/A
HH	Low Parental Education	Parents or guardians have completed no more than 8 years of primary school.	§ 67/A (1)
	Low Employment Activity	Parents or guardians are long-term unemployed or recipients of social assistance.	
	Inadequate Housing	The child lives in segregated, substandard, or unsafe housing conditions.	
HHH	At least Two HH Criteria	Two or more of the HH criteria (above) apply simultaneously.	§ 67/A (2)
	Foster Care Placement	The child is under long-term state care (foster care).	
	After-care Youth in Education	The individual is over 18, receiving after-care, and enrolled in education.	

Measuring Institutional Burden

By examining these three indicators together—child numbers, disadvantaged child proportions, and child–teacher ratios—we can map out how Hungary's education system is changing across different towns and villages. This approach helps us understand:

- Where the system is growing or shrinking, urban areas are seeing more children, whereas rural areas are losing children.
- Where disadvantaged children are concentrated: Many rural schools have a high percentage of disadvantaged children, which can deepen inequality.
- Where schools are under pressure, high child–teacher ratios show where teachers are overburdened, affecting the quality of education.

These indicators reveal a growing divide between thriving urban areas and struggling rural regions, helping policymakers to identify where support is most needed.

Research Objectives and Questions

This study addresses this gap by investigating how Hungarian settlements have experienced educational change between 2021 and 2024 along three dimensions: (1) shifts in child population size, (2) changes in the share of officially disadvantaged children (HH/HHH), and (3) variation in child–teacher ratios as a proxy for institutional burden. Using a cluster-based approach, this study identified distinct types of settlements that illustrate divergent trajectories, such as growth under strain, stable decline, or balanced development. This study focused on three research questions:

1. How have the patterns of child enrollment changed since 2021?
2. Where did the proportion of disadvantaged children increase or decrease? What does this suggest regarding segregation and opportunities?
3. Which settlements have the child–teacher ratio increased most significantly, indicating a growing institutional strain?

Using k-means clustering, this study classifies all Hungarian settlements with at least one public education institution into distinct types based on these three variables. The goal is to uncover territorial patterns such as:

- Where is the educational system shrinking or expanding?
- Where are the disadvantaged children becoming more concentrated?
- What is the institutional burden that increases most significantly?

Through this typology, this study provides an empirical basis for differentiated policy responses and highlights the geographic dimensions of emerging educational inequalities in the post-pandemic era.

Data and Methods

Data Sources

This study relies on statistical data aggregated at the settlement level, based on institutional site-level records (intézményi telephelyek) from the Hungarian public education database (Oktatási Hivatal, n.d.), maintained by the Educational Authority. The dataset includes information for all Hungarian settlements from 2021 to 2024, covering institutional enrollment numbers, proportion of disadvantaged children, and staff capacity. Only settlements with at least one active public education institution in 2021 are included in the clustering process (Figure 1).

The dataset encompasses the entire spectrum of public educational institutions in Hungary, with the variables disaggregated by institution type. These include kindergartens

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(óvoda), primary schools (általános iskola), general secondary schools (gimnázium), vocational grammar schools (szakgimnázium), technicums (technikum), vocational training schools (szakképző iskola), special vocational schools (szakiskola), and skill development institutions (készségfejlesztő iskola).

It is important to note that the database used in this study exclusively covers public education institutions (köznevelési intézmények) as registered by the Educational Authority. Data on vocational training centers (szakképzési centrumok)—which fall under a separate governance system and are managed by the Ministry for Economic Development—are not included in the dataset. Therefore, the analysis does not reflect enrollment or staffing figures in the vocational training sector.

All data were aggregated annually and standardized to allow inter-settlement comparisons. Data cleaning and validation were performed to account for missing[1] or inconsistent entries[2], particularly in settlements with newly established or closed institutions[3].

Importantly, teacher headcounts were also aggregated across all institutional levels within each settlement, regardless of school type. This approach reflects the study's primary aim: to investigate systemic patterns in public education comprehensively, without disaggregating by level or institutional function.

Indicators and Variable Construction

To ensure comparability across settlements and minimize the influence of single-year anomalies, changes in all three indicators were calculated as the compound average annual changes over the period 2021–2024. This approach captures consistent growth or decline trajectories, rather than volatile year-on-year fluctuations. The formula applied to each variable was as follows:

$$Average\ annual\ change = \left(\frac{Value_{2024}}{Value_{2021}}\right)^{\frac{1}{3}} - 1$$

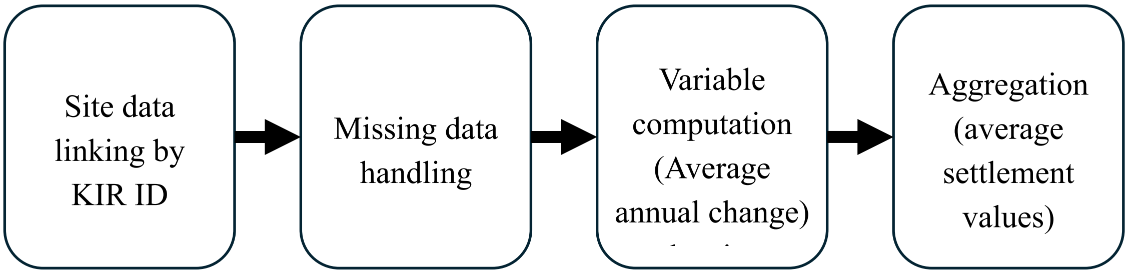
This method allows for a standardized interpretation of relative change rates and is commonly used in demographic, financial, and educational trend analyses. All derived rates were subsequently standardized (z-scores) before clustering.

Three key indicators were derived to capture the primary dimensions of educational transformation.

[1] No public data on the number of teachers was available in 2021 for five school sites located in the following settlements: Székesfehérvár, Budapest District XIV, Szeged, Kecskemét, and Debrecen.
[2] In 2021, KIR data were published at the level of school sites, whereas by 2024, the data are available by grade level within each site.
[3] In 2021, there were 9,046 school sites (feladatellátási hely), which decreased to 8,590 by 2024. Of these, 3,609 provided primary education (ISCED 1–2) in 2021, a number that *declined* to 3,521 by 2024.

- Change in child population (Δ Children): Difference in the total number of children enrolled in public education institutions between 2021 and 2024 per settlement.
- Change in the proportion of disadvantaged children (Δ HH/HHH %): Based on the official Hungarian categories for disadvantaged status, this indicator reflects shifts in the social composition of the child body.
- Change in child–teacher ratio (Δ STR): Calculated by dividing the total number of enrolled children by the number of full-time equivalent teachers for each year, then computing the change over the three-year period. This serves as a proxy for the institutional burden.

Figure 1.
Data processing of the study



Clustering Methodology and Visualization

K-means clustering was used to identify distinct groups of settlements, based on similar patterns across the three standardized variables. The optimal number of clusters was determined using the elbow method and silhouette analysis, with five clusters offering the best balance between interpretability and internal consistency (see the Appendix A).

To assess the statistical robustness of the cluster solution, one-way ANOVA was conducted to compare the average values of the three core indicators across the five identified clusters (Table 1).

Table 1.
Results of One-Way ANOVA Testing for Differences Between Clusters Across Key Educational Change Indicators (2021–2024)

Indicator	**F-statistic**	**Sig. (p)**	**Interpretation**
Children–teacher ratio change	614.33	< .001	Very strong differences across clusters
Disadvantaged child ratio change	3002.82	< .001	Extremely strong cluster separation
Children population change	19.94	< .001	Statistically significant, though weaker

The results confirm that all three indicators vary significantly between clusters, with especially strong differentiation observed for changes in the HH/HHH child proportion and child–teacher ratios. The relatively low F-value for child population change suggests that demographic shifts alone account for less of the variance than institutional burdens or social composition.

To further assess the internal consistency and reliability of the clustering solution, two validation procedures were implemented using Python (Scikit-learn). First, the Silhouette coefficient was calculated for the full dataset, which yielded a value of 0.370. Although not exceptionally high, this result indicates a moderate level of cohesion and separation between clusters, which is acceptable in the context of complex real-world educational data. Second, the stability of the cluster structure was tested through a bootstrap-based resampling approach: the k-means algorithm was rerun on a random 80% subsample of the data, and the resulting cluster assignments were compared to the original full-sample classification using the Adjusted Rand Index (ARI). This procedure implemented using the adjusted_rand_score() function from sklearn.metrics, yielded an ARI of 0.946, indicating a very high structural stability. Based on independent statistical methods, the five-group solution was strong and meaningful. This provides a solid basis for future spatial and policy analysis.

Cluster labels were assigned post-hoc based on the direction and magnitude of change in each indicator, resulting in categories such as overburdened growth, disadvantaged decline, and balanced growth. In addition, settlements with no recorded public education institutions were excluded from clustering but were mapped separately to highlight institutional absence. Spatial visualization was performed using ArcGIS (Esri Inc, 2024), and the analysis was conducted using SPSS (IBM, 2023) and PyCharm (JetBrains, 2025).

Results

Territorial Comparison of Institutional Human Resources and Enrollment (2021–2024)

To capture territorial differences in institutional capacity and student distribution within Hungary's public education system, this section analyzes both the median and total values of three key indicators: the number of teaching staff, the number of educational support staff, and total student enrollment (Data in Appendix B). The comparison spans Hungary's seven NUTS-2 regions and Budapest over the period from 2021 to 2024. These trends, presented in Figures 2–4, reveal persistent regional inequalities in school size, staffing levels, and demographic pressures.

Figure 2 presents data on teaching staff. While median values remained relatively stable over the four-year period, clear regional disparities are evident. Budapest consistently reported the highest medians, with 13 to 14 teachers per educational unit, reflecting the prevalence of large, well-resourced urban schools. Central Hungary, the Southern Great Plain, and Central Transdanubia showed mid-range medians of 9 to 11 teachers, corresponding to moderately sized institutions. In contrast, Northern Hungary and Southern Transdanubia reported the lowest medians (7 to 8), suggesting a more fragmented institutional landscape and potential staffing constraints. These disparities are reinforced by total figures: while Budapest maintained a teaching force of more than 23,000 teachers annually, Southern Transdanubia and Western Transdanubia reported totals below 13,000, pointing to substantial capacity gaps.

Figure 3 shows the regional distribution of educational support staff. Once again, Budapest and Central Hungary had the highest median values, ranging from five to six staff members per regionally aggregated educational unit. This indicates more comprehensive institutional support infrastructures. Meanwhile, most other regions — particularly in Transdanubia and Northern Hungary — operated with medians of only two to three support staff, potentially limiting their ability to provide inclusive, individualized, or remedial educational services. Total figures follow the same pattern: in 2021, Budapest employed more than 7,500 support staff, whereas Southern and Western Transdanubia remained below 3,300.

Student enrollment patterns, presented in Figure 4, further illustrate territorial concentration. Median enrollment was highest in Budapest and Central Hungary, where schools typically enrolled more than 110 students, reflecting the urban character and institutional centralization of these regions. By contrast, Southern Transdanubia, Northern Hungary, and Western Transdanubia showed considerably lower medians — between 70 and 80 students — suggesting either declining child populations or the maintenance of smaller school units. Total enrollment figures again highlight Budapest's dominant position, with over 230,000 children enrolled each year. In contrast, Southern Transdanubia never exceeded 106,000, with other regions exhibiting similarly modest figures.

Overall, the data suggest notable regional differences in institutional capacity and demographic pressure. Urbanized regions—most prominently Budapest and Central Hungary—tend to concentrate educational staff and enrollment, while other areas operate with comparatively smaller institutional units and fewer available resources. These disparities, though not unexpected, help contextualize the cluster analysis that follows by offering a broader view of the systemic background in which educational change is unfolding across regions.

Figure 2.
Teaching Staff by Region (2021–2024)
Left: Median number of teaching staff per region.
Right: Total number of teaching staff per region.

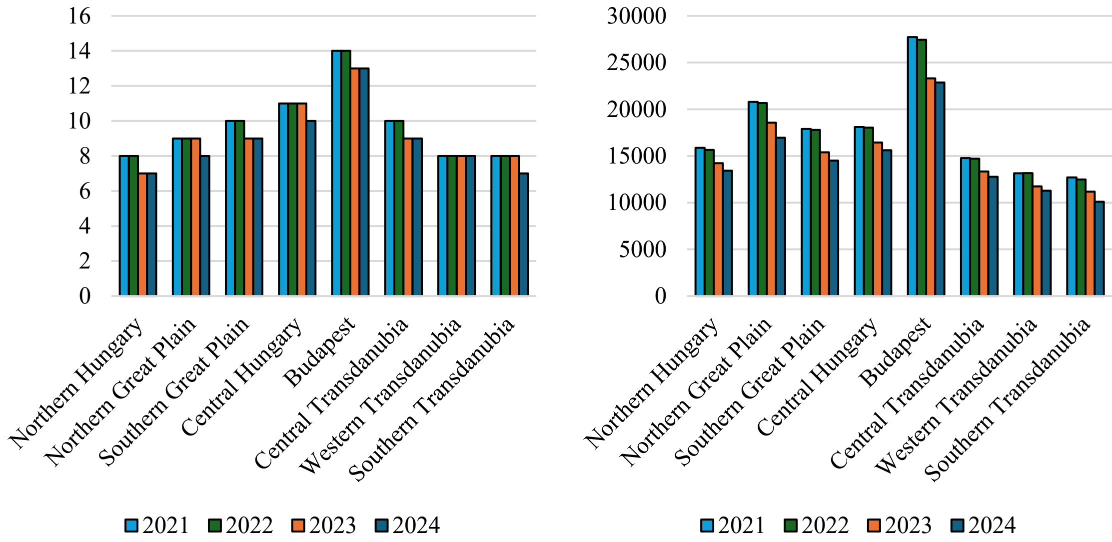


Figure 3.
Educational Support Staff by Region (2021–2024)
Left: Median number of educational support staff per region.
Right: Total number of educational support staff per region.

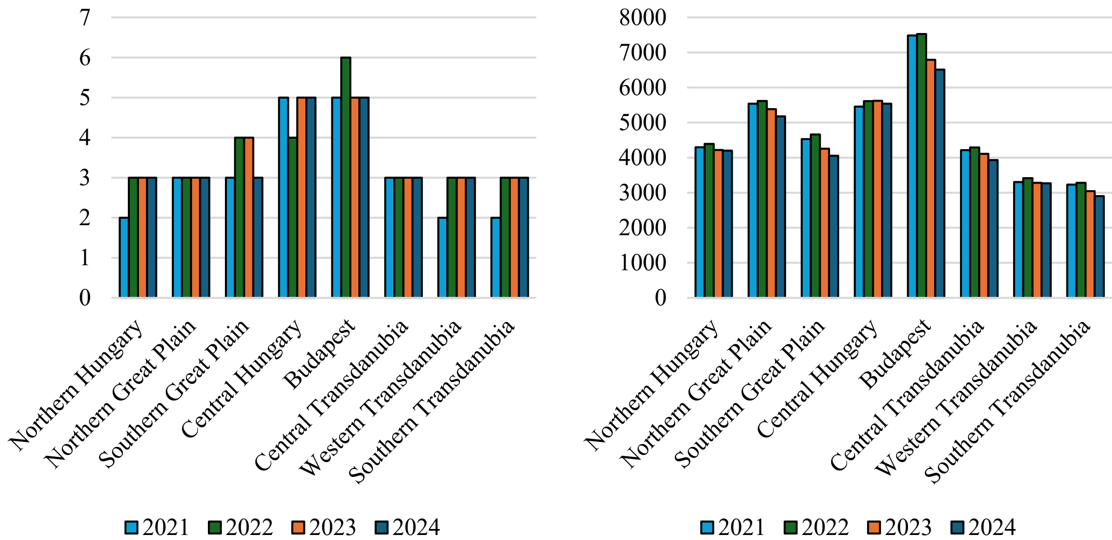
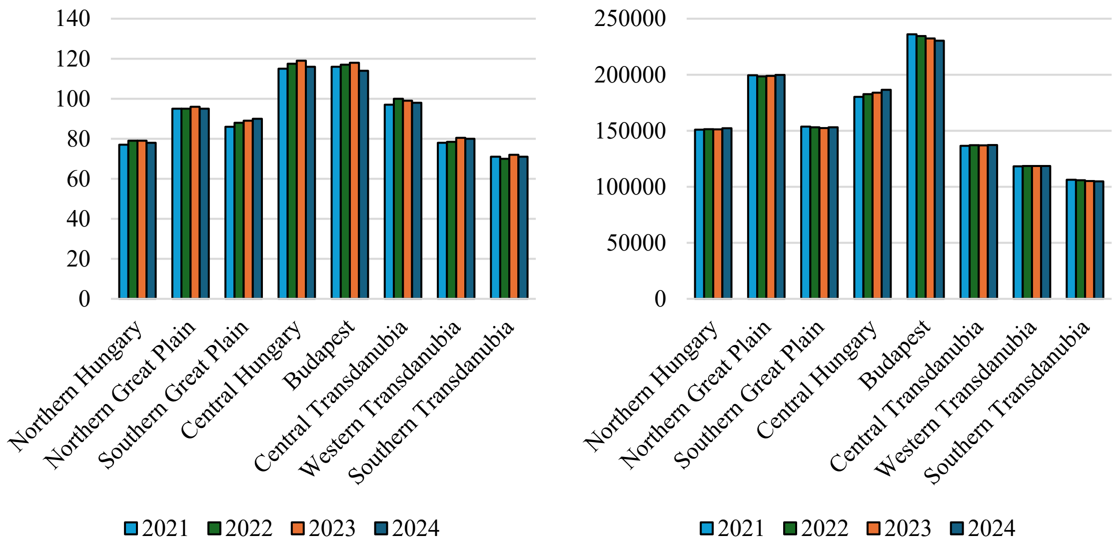


Figure 4.
Children Enrollment by Region (2021–2024)
Left: Median number of enrolled children per region.
Right: Total number of enrolled children per region.



Spatial Analysis of Key Indicators

This section offers an in-depth spatial analysis of the three core indicators underlying the cluster typology: changes in child population, the proportion of disadvantaged children (HH/HHH), and the child–teacher ratio. Choropleth maps were generated to illustrate the spatial distribution and intensity of each phenomenon at the settlement level for the period 2021–2024.

Change in Children Population (2021–2024)

The second map displays the annual compound changes in the number of children. Most Hungarian settlements have experienced modest growth or decline. The majority fall within the 100–1,311 child increase range, suggesting a relatively limited but stable educational demand. However, several patterns have also emerged:

- Major urban centers (e.g., Budapest agglomeration, Debrecen, Győr) and their peri-urban zones saw the most significant growth, with some settlements gaining over 12,000 children (e.g., the exceptional case of Budapest [230,344]).
- In contrast, numerous rural areas, especially in Western Transdanubia and Southern Baranya, experienced minimal growth, or stagnation (6–100 range).
- White (missing) areas correspond to settlements without any registered public education institutions, most likely because of population decline or institutional closure.

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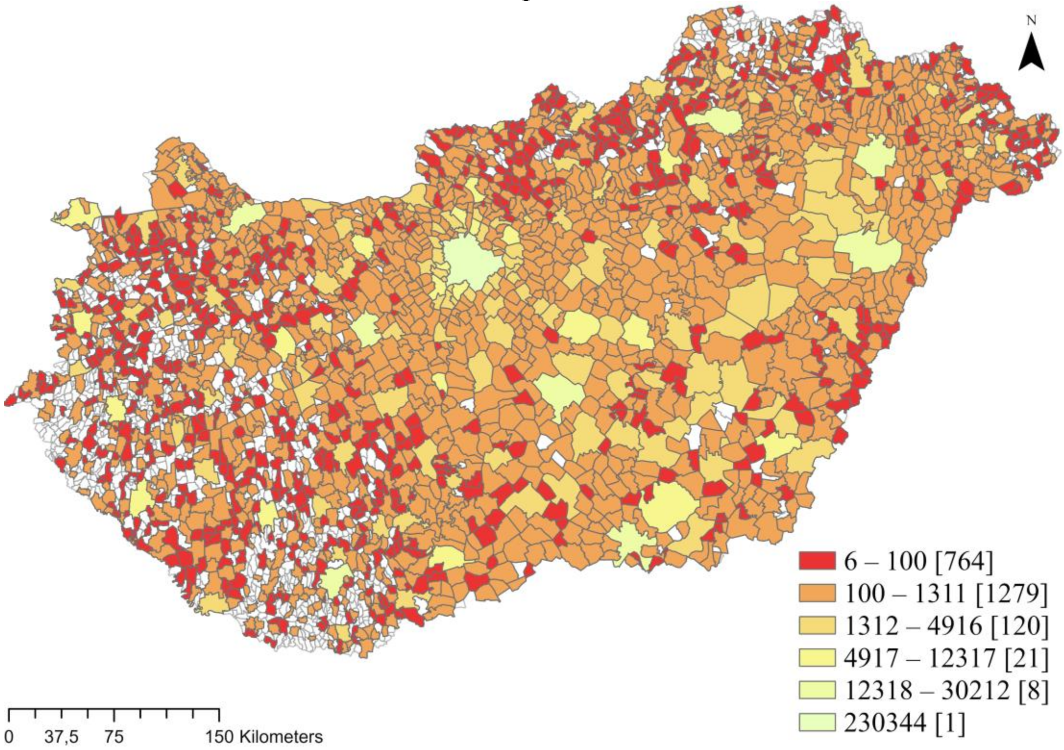
Figure 4.
Number of children in public education in 2024



Source: Author's compilation based on Oktatási Hivatal (n.d.)

Figure 4 shows the compound annual changes in the number of children enrolled in public education between 2021 and 2024. Nationally, most settlements have experienced either modest growth or decline, with the majority of localities registering annual increases in the 0.1%–1.3% range. This indicates a relatively stable but uneven educational demand across regions.

Clear spatial patterns emerged from the data. Major urban centers and their suburban belts—such as Budapest, Debrecen, and Győr—exhibited the most pronounced child growth. In particular, Budapest itself recorded a gain of over 12,000 children, highlighting its continued gravitational pull-on educational migration and institutional expansion. Peri-urban settlements around the capital city also contributed significantly to this trend.

At the micro level, settlements such as Rinyabesenyő, Vámosatya, and Tarhos have reported the highest relative growth rates, exceeding 40% annually. For example, Rinyabesenyő increased its child population from four to thirteen, representing a 48.1% average annual growth rate. Although these cases demonstrate remarkable percentage increases, they are heavily influenced by the small base population and are thus sensitive to even minor absolute changes. Similar patterns were observed in Mártély and Pálosvörösmart, both showing a growth above 37%, albeit with fewer than 100 children.

Conversely, numerous rural settlements in Western Transdanubia, Southern Baranya, and some low-density regions of Northern Hungary recorded stagnation or decline. These include areas where the child population contracted by 10–30% over the period, often coinciding with a broader demographic decline and the closure or downgrading of educational institutions.

White spaces on the map represent settlements where no public education institutions were recorded in 2024, reflecting either a lack of school-age population or institutional disappearance. These cases were concentrated in remote and depopulated regions.

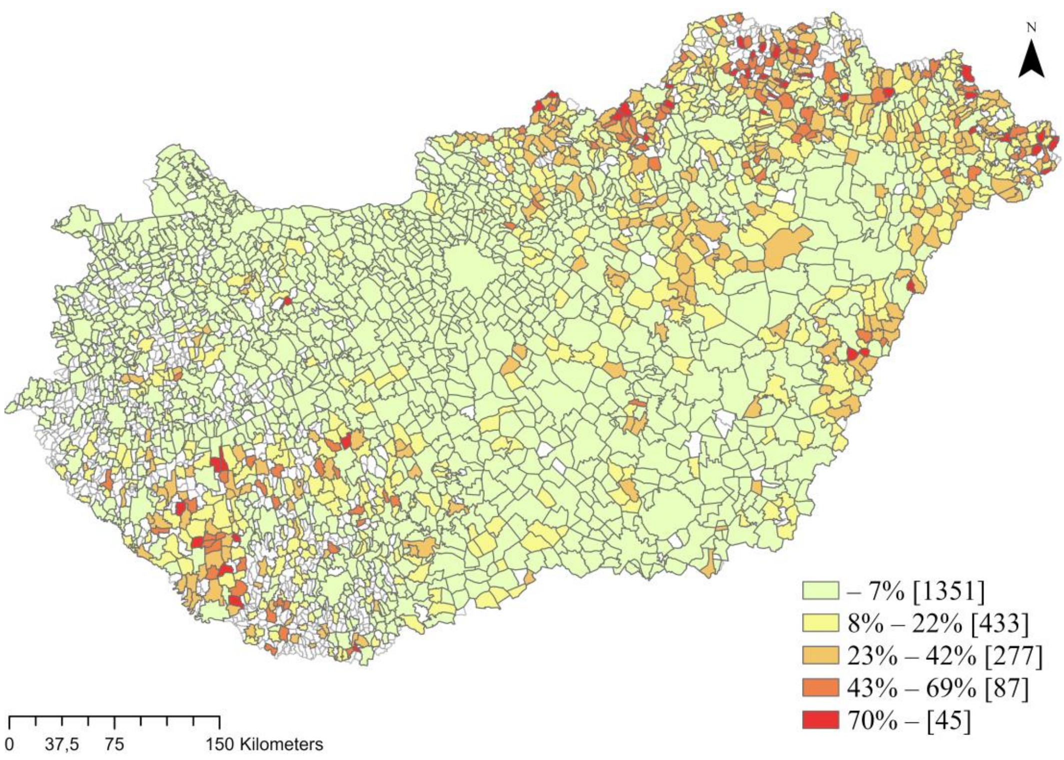
Overall, these patterns underscore the accelerating spatial concentration of school-age populations in growth centers, while peripheral and rural areas increasingly face structural educational shrinkage. This divergence highlights the need for territorially adaptive educational infrastructure planning, and demographic resilience strategies.

Proportion of Disadvantaged Children (2024)

The third map (Figure 5) shows the proportion of disadvantaged children (HH/HHH) in 2024.

- A clear North–South and East–West divide emerges.
  - Northeastern counties (Borsod-Abaúj-Zemplén, Szabolcs-Szatmár-Bereg, Heves) and parts of Southern Transdanubia show high HH concentrations.
  - These regions have settlements where over 70% of the children are disadvantaged, signaling entrenched marginalization.
- In contrast, the Central Transdanubia and Budapest regions show low HH ratios (below 7%), reinforcing patterns of spatial selectivity.

Figure 5.
Proportion of disadvantaged children by settlement (2024)



Source: Author’s compilation based on Oktatási Hivatal (n.d.)

Figure 5 shows the spatial distribution of disadvantaged children (categorized as HH/HHH) by settlement in 2024. A striking East–West and North–South dichotomy was apparent. Northeastern counties, including Borsod-Abaúj-Zemplén, Szabolcs-Szatmár-Bereg, and parts of Heves, as well as several localities in Southern Transdanubia, show markedly high concentrations of disadvantaged children. These patterns reflect deeply rooted regional inequalities and educational limitations.

In extreme cases, such as Fáj (Borsod-Abaúj-Zemplén), disadvantaged children accounted for 94% of all enrolled pupils in 2024. Similar proportions were observed in Boldogkőújfalu, Magosliget, and Bakonyoszlop, with disadvantage rates above 92%. While these settlements have a relatively small child population (typically around 50–70 children), their near-total HH prevalence signals concentrated educational marginalization. These contexts often face compounded disadvantages, including limited school choices, weaker institutional resources, and socioeconomic segregation.

By contrast, Central Transdanubia and the Budapest metropolitan areas exhibited low proportions of disadvantaged children. For instance, in several larger settlements with over 100 pupils, such as Telki or Nagykovácsi, the share of HH children was well below 5%. These data points reinforce the role of spatial selectivity and sorting in the Hungarian education system, shaped by catchment policies, school closures in peripheral areas, and residential mobility toward more advantaged localities.

Together, these examples underscore how geographic disparities in disadvantage are not only demographic reflections of poverty, but also products of systemic processes within the education system, necessitating territorially sensitive policy interventions.

Change in Children–Teacher Ratio (2021–2024)

The fourth map (Figure 6) presents the change in child–teacher ratios, overlaid with dot sizes indicating the rate of increase:

- The highest increases (24.6–52.0) cluster around expanding urban and suburban areas, especially in the northwestern quadrant and greater Budapest. These are likely areas under strain where institutional growth lags behind population growth.
- Dot overlays indicate settlements where the rate of increase is most intense, some of which may not yet have alarming absolute ratios, but are trending steeply upward.
- Peripheral settlements with low ratios but significant demographic changes could be early warning zones for future overloads.

This map underlines the asymmetric development of educational infrastructure, where growth is not evenly met with staffing capacity. In 2024, for instance, the average number of children per teacher surpassed 20:1 in 131 Hungarian settlements, according to aggregated site-level data.

From a policy and planning perspective, interpreting child–teacher ratio trends also require reference to normative benchmarks. International recommendations (e.g., OECD[4] averages) often suggest an optimal child–teacher ratio of 12:1 to 15:1 in primary education and slightly higher in secondary contexts, depending on class size standards, inclusion policies, and subject specialization (Dubrowski & MacRae, 2006; Kelleher & Weir, 2016; Mayerle et al., 2022; White & Tweeten, 1973).

In the Hungarian context, settlement-level values significantly exceeding these thresholds, especially those approaching or surpassing 20:1, indicate critical levels of institutional strain, particularly in inclusive settings where children with behavioral or learning difficulties are present.

Given the spatial variation observed in the map, some high-growth settlements would require a 15–30% increase in teaching staff to restore balanced capacity. For instance, a settlement with a 24:1 ratio and 720 children would require at least eighteen additional teachers to return to an acceptable range (e.g., 15:1).

Conversely, settlements with declining child numbers but rising ratios suggest that teaching capacity eroded faster than demographic decline, possibly due to attrition, retirement, or unfilled vacancies.

Two settlements stand out where the increase in the child–teacher ratio was not only substantial in relative terms, but also coupled with a high number of enrolled children, indicating significant institutional strain. In Ecser, the ratio rose from 11.06 to 25.0 between 2021 and 2024, with 1,150 children enrolled in the final year of the study period. Restoring the recommended 15:1 ratio in this context would require the inclusion of at least thirty-one full-time equivalent teachers. Similarly, in Nagykovácsi, the child–teacher ratio increased from 10.7 to 15.9, while the child body reached 2,006 individuals, implying a shortfall of approximately eight teachers.

These examples illustrate that, when steep ratio increases occur alongside large child populations, the resulting workload intensification poses a genuine risk to institutional sustainability. Such cases merit prioritized intervention in the context of territorially differentiated teacher workforce planning.

Conversely, several settlements show dramatic percentage increases in child–teacher ratios, yet these occur in low-population contexts, thereby limiting the systemic impact. In Rinyabesenyő, for instance, the ratio increased by 48.1%, but only thirteen children remained. In such settings, minor fluctuations in teacher allocation, such as a shift from full- to part-time employment, can disproportionately affect this metric. Vámosatya saw a 44.2% increase, with only twenty-one children, likely due to changes in staffing status. Tarhos, with ninety-one children, approached a mid-sized scale, although the estimated

[4] The Organization for Economic Co-operation and Development (OECD) does not prescribe a singular "optimal" child-teacher ratio. Instead, it provides data on average ratios and class sizes across its member countries. On average, OECD countries report approximately 14 children per teacher in public education (OECD, 2024).

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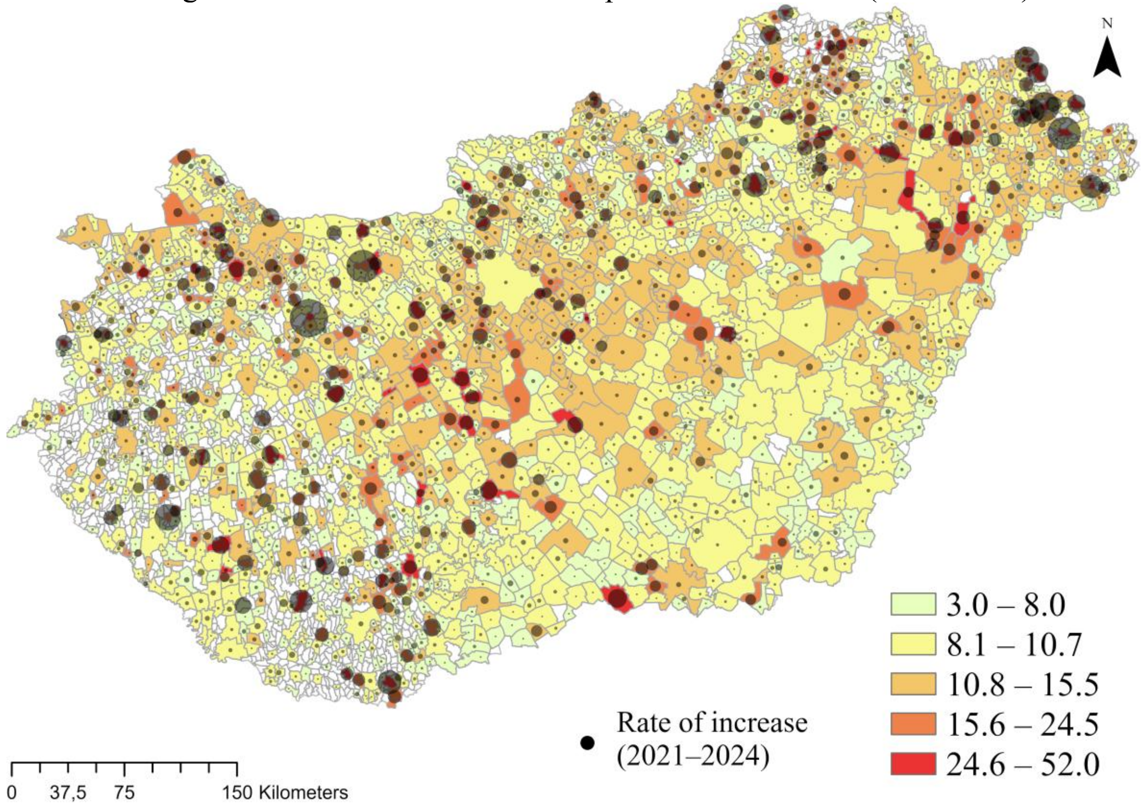
shortage remained within thirteen teachers. Mártély and Pálosvörösmart likewise experienced sharp ratio increases despite low child numbers.

These cases underscore the fact that ratio-based metrics alone can be misleading. In smaller institutions, a single teacher's reassignment or departure may significantly distort the ratio, without reflecting broader structural deficiencies. Hence, integrating child population size into planning frameworks is essential to accurately diagnose areas of institutional vulnerability and to avoid misdirected policy responses.

Figure 6.
Change in child–teacher ratio and its spatial concentration (2021–2024)



Source: Author's compilation based on Oktatási Hivatal (n.d.)
Note: The child–teacher ratio indicates the number of enrolled children per full-time equivalent teacher. Higher values reflect a greater institutional burden on the educators.

Cluster Profiles Based on Educational Change

To synthesize the spatial patterns described in the previous sections, a cluster analysis was conducted to identify broader settlement types that exhibit similar trajectories across the three core indicators. This approach allows for the integration of demographic, social, and institutional dimensions into a unified typology, thereby facilitating the interpretation of complex territorial dynamics.

The cluster analysis resulted in five distinct types of settlements based on the average annual changes in (1) child population, (2) proportion of disadvantaged children (HH/HHH), and (3) child–teacher ratio. These clusters reflect different combinations of demographic pressures, social composition, and institutional capacity between 2021 and 2024.

Cluster 1 – Overburdened Growth Areas (n = 1,215)

Characterized by a notable increase in child numbers and growing child–teacher ratios, the proportion of disadvantaged children decreased slightly. These are typically dynamic settlements, with expanding educational demands and limited pedagogical capacity. Major cities, such as Debrecen and Miskolc, fall into this category, each experiencing substantial child populations (over 23,000) and modest increases in institutional burden.

Cluster 2 – Declining but Stabilizing Areas (n = 373)

These settlements experienced a mild decrease in child numbers and HH rates, with a slight increase in the institutional burden. They may stabilize after previous losses, but demographic pressure remains weak. Examples include Halásztelek and Bonyhád, mid-sized towns that show marginal child growth but slight institutional pressure.

Cluster 3 – Disadvantaged, Declining Areas (n = 148)

Marked by a rising proportion of disadvantaged children, a shrinking child population, and a mild increase in teacher workload. These areas are typically rural or semi-peripheral areas that experience a cumulative disadvantage. Piliscsaba, for instance, recorded a stable child–teacher ratio but experienced a rise in the share of HH children despite a moderate population.

Cluster 4 – Moderately Declining, Balanced Areas (n = 21)

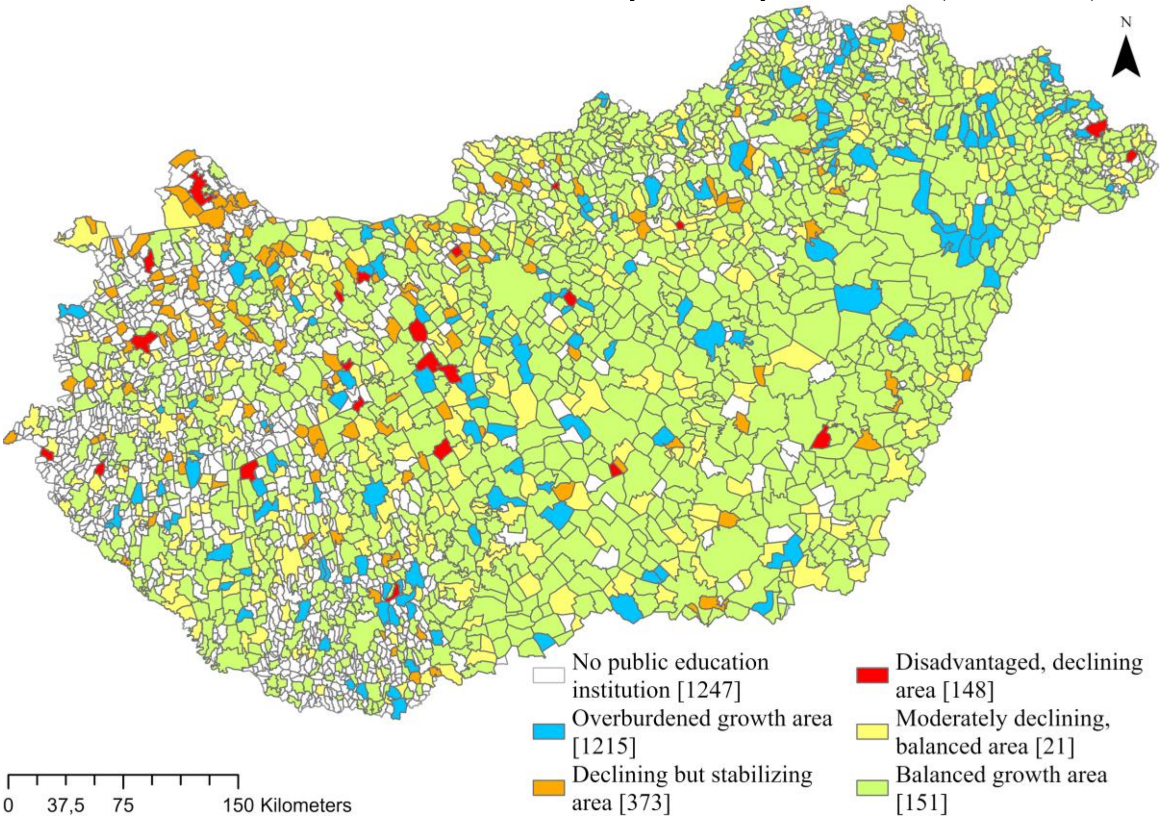
Show minor decreases in child population and mild increases in HH rates, but with stable child–teacher ratios. These settlements were neither expanding nor under significant strain. Examples include Szigetszentmiklós and Dabas, both sizeable towns (with over 3,000 children) that maintain relatively stable educational structures, despite marginal demographic and social shifts.

Cluster 5 – Balanced Growth Areas (n = 151)

This is represented by a slight growth in child numbers, declining HH rates, and stable institutional load. These are often peri-urban or medium-sized settlements with relatively well-functioning educational systems. For instance, Mosonmagyaróvár and Sárvár experienced modest growth or stability in child numbers and declining proportions of disadvantaged children while maintaining a balanced child–teacher ratio.

Additionally, 1,247 settlements were identified as having no public education institutions by 2024. These were excluded from clustering but analyzed separately because of their relevance in understanding institutional absence and access disparities.

Figure 7.
Cluster-based classification of educational dynamics by settlements (2021–2024)



Source: Author's compilation based on Oktatási Hivatal (n.d.)
Note: Clusters were derived using k-means analysis based on three standardized indicators: (1) annualized change in child population, (2) change in the proportion of disadvantaged children (HH/HHH), and (3) change in the child–teacher ratio between 2021 and 2024.

Conclusion

This study examined the spatial patterns of change in Hungarian public education between 2021 and 2024 by analyzing settlement-level trends in the child population, the proportion of disadvantaged children (HH/HHH), and institutional burden measured through child–teacher ratios. By applying a cluster-based approach, five distinct types of settlement were identified, each reflecting divergent trajectories in demographic pressure, social composition, and infrastructural capacity. The following key findings emerged:

- A growing divide between overburdened growth areas, often in urban or peri-urban regions, and disadvantaged declining areas is concentrated in rural peripheries.
- A notable rise in child–teacher ratios in high-growth settlements highlights the potential bottlenecks in educational infrastructure and workforce availability.
- The increasing concentration of disadvantaged children in shrinking settlements reinforces territorial educational inequality.
- The persistent absence of public education institutions in more than 1,200 settlements raises concerns regarding spatial equity and long-term access.

These findings suggest that Hungary's public education system is undergoing not only quantitative transformation, but also territorial reconfiguration. Without differentiated policy responses, such as capacity expansion in growth zones and equity-oriented interventions in disadvantaged areas, these trends may deepen existing inequalities. Although legal frameworks allow for financial compensation in disadvantaged areas—such as hardship allowances for educators working in "beneficiary municipalities" (Government Decree No. 105/2015 (April 23) on the Classification of Beneficiary Settlements and the Criteria for Classification, 2025) and additional pay based on local conditions (Act CXC of 2011 on National Public Education, 2012; Act LII of 2023 on the New Career Path of Teachers, 2025)—there remains considerable legal and administrative uncertainty regarding the consistent application of these benefits, especially in the most affected regions.

This study also demonstrated the analytical value of integrating demographic, social, and institutional indicators into a single spatial typology. This approach offers a replicable framework for monitoring educational transformations on a fine-grained territorial scale. In light of recent debates on the future of the school network, the pressures identified here resonate with broader concerns regarding educational policy. As Andl (2023) underscores, the rising energy costs and chronic teacher shortages are reigniting discussions on the need to restructure the system. Small schools, in particular, remain exposed to existential uncertainty—an issue also emphasized by Lannert (2021) and acknowledged by policymakers questioning the viability of maintaining numerous low-enrollment institutions (Pintér, 2022).

Limitations and Future Research

Although the analysis captures broad spatial dynamics, it does not account for school-level pedagogical quality, institutional autonomy, or parental school choice patterns. Moreover, the use of HH/HHH status as a proxy for disadvantage, although institutionally relevant, has limitations in reflecting nuanced socioeconomic realities. This study's focus on socioeconomic disadvantages, as indicated by the HH/HHH status, does not encapsulate the full spectrum of factors that contribute to educational disparities. Future research could incorporate a more intersectional approach, examining how factors such as ethnicity, gender, and disability intersect with socioeconomic status to influence educational opportunities and outcomes. Moreover, the analysis did not consider the professional qualifications of teachers; in particular, certain subjects—such as science teachers at the ISCED 2–4 levels—are notably absent from schools in several settlements. Future research should also consider longitudinal follow-up beyond 2024, explore the qualitative aspects of institutional adaptation, and examine the correlations between child outcomes and mobility trajectories.

Acknowledgments

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Appendix A

List of all settlements by clusters

No public education institution

Abasár, Abaújalpár, Abaújlak, Abaújszolnok, Abaújvár, Abod, Ábrahámhegy, Acsád, Acsalag, Adásztevel, Adorjánháza, Adorjás, Ág, Ágfalva, Agyagosszergény, Aka, Alibánfa, Almásháza, Almáskeresztúr, Alsóbogát, Alsódobsza, Alsógagy, Alsómocsolád, Alsónyék, Alsópetény, Alsórajk, Alsóregmec, Alsószenterzsébet, Alsószölnök, Alsótelekes, Alsótold, Andornaktálya, Andrásfa, Apácatorna, Apátistvánfalva, Apátvarasd, Aranyosgadány, Arka, Árpás, Aszófő, Áta, Babarcszőlős, Babosdöbréte, Babót, Bácsszentgyörgy, Bácsszőlős, Badacsonytördemic, Baglad, Bágyogszovát, Baj, Bakháza, Bakóca, Bakonya, Bakonybánk, Bakonygyirót, Bakonyjákó, Bakonykoppány, Bakonykúti, Bakonypéterd, Bakonypölöske, Bakonyság, Bakonyszücs, Bakonytamási, Baktüttös, Balatonakali, Balatonakarattya, Balatonederics, Balatongyörök, Balatonhenye, Balatonmagyaród, Balatonmáriafürdő, Balatonőszöd, Balatonrendes, Balatonszepezd, Balatonszőlős, Balatonudvari, Balatonújlak, Balinka, Balogunyom, Bálványos, Bana, Bánd, Bánfa, Bánk, Bár, 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Felsőjánosfa, Felsőmarác, Felsőmocsolád, Felsőörs, Felsőpáhok, Felsőregmec, Felsőszenterzsébet, Felsőtold, Fenyőfő, Fertőboz, Fertőendréd, Fertőhomok, Fertőszentmiklós, Fertőszéplak, Fiad, Filkeháza, Fityeház, Folyás, Fonó, Főnyed, Füle, Fülöpháza, Fülpösdaróc, Füzérkajata, Füzérkomlós, Füzérradvány, Fűzvölgy, Gáborjánháza, Gadács, Gadány, Gagyapáti, Gagybátor, Galvács, Ganna, Gánt, Garáb, Garabonc, Garbolc, Garé, Gasztony, Gátér, Gecse, Gelsesziget, Gerde, Gerényes, Gersekarát, Gétye, Gilvánfa, Gombosszeg, Gór, Gordisa, Gosztola, Gömörszőlős, Gönyű, Görcsönydoboka, Gősfa, Grábóc, Gyalóka, Gyanógeregye, Gyenesdiás, Gyód, Gyóró, Gyöngyfa, Gyöngyösfalu, Gyöngyöshalász, Gyöngyösmellék, Győrladamér, Győröcske, Győrsövényház, Győrújfalu, Győrzámoly, Gyugy, Gyulakeszi, Gyügye, Gyűrűs, Hagyárosbörönd, Hajmás, Halastó, Halászi, Halogy, Harasztifalu, Háromhuta, Hárskút, Hásságy, Hegyesd, Hegyeshalom, Hegyfalu, Hegyháthodász, Hegyhátmaróc, Hegyhátsál, Hegyhátszentjakab, Hegyhátszentmárton, 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Kaszó, Katádfa, Katafa, Kátoly, Kávás, Kazsok, Kehidakustány, Kéked, Kékesd, Kékkút, Keléd, Kelevíz, Kemendollár, Kemeneshőgyész, Kemeneskápolna, Kemenespálfa, Kemenessömjén, Kemenesszentmárton, Kemenesszentpéter, Keménfa, Kemestaródfa, Kemse, Kenéz, Kercaszomor, Kercseliget, Kerecseny, Kerekharaszt, Kereki, Keresztéte, Kerkabarabás, Kerkafalva, Kerkakutas, Kerkáskápolna, Kerkaszentkirály, Kerkateskánd, Kérsemjén, Keszeg, Keszőhidegkút, Keszü, Kétbodony, Kétvölgy, Kilimán, Királyszentistván, Kisapáti, Kisasszond, Kisasszonyfa, Kisbabot, Kisbágyon, Kisbárkány, Kisberény, Kisberzseny, Kisbeszterce, Kisbodak, Kisbucsa, Kisbudmér, Kiscsehi, Kiscsősz, Kisdér, Kisdobsza, Kisdombegyház, Kisdorog, Kisecset, Kisfalud, Kisfüzes, Kisgörbő, Kisgyalán, Kishajmás, Kisherend, Kishódos, Kishuta, Kisigmánd, Kisjakabfalva, Kiskassa, Kiskinizs, Kiskutas, Kislippó, Kismányok, Kisnamény, Kisnémedi, Kisnyárád, Kisoroszi, Kispáli, Kispirit, Kisrákos, Kisrécse, Kisrozvágy, Kissikátor, Kissomlyó, Kistamási, 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Pálosvörösmart, Paloznak, Pamlény, Pamuk, Pankasz, Pányok, Pápadereske, Pápoc, Páprád, Parádsasvár, Pásztori, Pat, Patalom, Patapoklosi, Patca, Patosfa, Pécsbagota, Pécsdevecser, Pécsely, Pécsudvard, Pénzesgyőr, Perecse, Pereked, Perenye, Peresznye, Pereszteg, Perőcsény, Peterd, Péterhida, Pethőhenye, Petőmihályfa, Petrikeresztúr, Petrivente, Pettend, Pilisborosjenő, Piliscsév, Pilisjászfalu, Pilisszántó, Pilisszentiván, Pilisszentlászló, Pinkamindszent, Pinnye, Piskó, Pócsa, Pogány, Polány, Pornóapáti, Porpác, Porrogszentkirály, Porrogszentpál, Pórszombat, Porva, Pósfa, Potony, Potyond, Pölöske, Pölöskefő, Pördefölde, Pötréte, Pula, Pusztaapáti, Pusztaberki, Pusztacsalád, Pusztacsó, Pusztaederics, Pusztafalu, Pusztamiske, Pusztaottlaka, Pusztaradvány, Pusztaszemes, Pusztaszentlászló, Püski, Püspökszilágy, Rábacsanak, Rábagyarmat, Rábakecöl, Rábapordány, Rábasebes, Rábaszentandrás, Rábaszentmihály, Rábaszentmiklós, Rábatöttös, Rábcakapi, Rádfalva, Rádóckölked, Radostyán, Ráksi, Ramocsa, Rápolt, Raposka, Rátót, Regéc, Regenye, Remeteszőlős, Répáshuta, Répceszemere, Répceszentgyörgy, Répcevis, Resznek, Révfülöp, Rigács, Rigyác, Rinyakovácsi, Rinyaújlak, Rinyaújnép, Románd, Röjtökmuzsaj, Rönök, Sajóecseg, Sajógalgóc, Sajókápolna, Sajómercse, Sajópálfala, Sajópüspöki, Sajósenye, Sajtoskál, Salföld, Salköveskút, Sámod, Sand, Sántos, Sárazsadány, Sárfimizdó, Sárkeszi, Sárok, Sarród, Sáska, Sé, Semjén, Semjénháza, Sénye, Sérsekszőlős, Sikátor, Siklósbodony, Sima, Simaság, Sióagárd, Siójut, Sitke, Sobor, Sóly, Som, Somlójenő, Somlóvecse, Somogyacsa, Somogyaracs, Somogyaszaló, Somogybabod, Somogybükkösd, Somogycsicsó, Somogydöröcske, Somogyegres, Somogyhatvan, Somogymeggyes, Somogysimonyi, Somogytúr, Somogyviszló, Somogyzsitfa, Sopronhorpács, Sopronkövesd, Sopronnémeti, Sorkikápolna, Sormás, Sorokpolány, Sósvertike, Söpte, Söréd, Sukoró, Sumony, Szabadi, Szada, Szágy, Szajk, Szakácsi, Szakadát, Szaknyér, Szakony, Szakonyfalu, Szalafő, Szalapa, Szalatnak, Szálka, Szalmatercs, Szamosangyalos, Szamoskér, Szamostatárfalva, Szamosújlak, Szanda, Szántód, Szápár, Szaporca, Szárász, Szárazd, Szárföld, Szarvasgede, Szarvaskend, Szarvaskő, Szászfa, Szátok, Szatta, Szebény, Szécsénke, Szécsisziget, Szegerdő, Szegi, Székelyszabar, Szellő, Szemely, Szemenye, Szentbékkálla, Szentborbás, Szentdomonkos, Szentegát, Szentgáloskér, Szentgyörgyvár, Szentgyörgyvölgy, Szentimrefalva, Szentistvánbaksa, Szentjakabfa, Szentkatalin, Szentkozmadombja, Szentliszló, Szentmargitfalva, Szentpéterfölde, Szenyér, Szerecseny, Szergény, Szijártóháza, Szilágy, Szilvágy, Szilvás, Szilvásszentmárton, Szinpetri, Szokolya, Szomor, Szorosad, Szőc, Szőce, Szőke, Szőkéd, Szőkedencs, Szőlősardó, Szörény, Szuha, Szuhafő, Szulimán, Szűr, Tagyon, Tahitótfalu, Tákos, Tanakajd, Tard, Tarjánpuszta, Tarnaszentmária, Tárnokréti, Tarrós, Tekenye, Tékes, Teklafalu, Telekes, Telekgerendás, Teleki, Tengeri, Tengőd, Teresztenye, Terpes, Tés, Tésa, Tésenfa, Téseny, Teskánd, Tikos, Tilaj, Tiszacsécse, Tiszatardos, Tiszavalk, Tiszavid, Tivadar, Tófalu, Tófű, Tokorcs, Tolmács, Tompaládony, Tormafölde, Tormásliget, Tornabarakony, Tornakápolna, Tornaszentandrás, Tornaszentjakab, Tornyiszentmiklós, Torvaj, Tótszentgyörgy, Tótszentmárton, Tótújfalu, Tök, Tömörd, Trizs, Túrony, Túrricse, Udvar, Udvari, Újbarok, Újhartyán, Újkér, Újlőrincfalva, Újsolt, Újszalonta, Újtelek, Újvárfalva, Und, Úny, Uppony, Uraiújfalu, Úrkút, Uszka, Uzsa, Üllő, Váckisújfalu, Vadosfa, Vág, Vágáshuta, Valkonya, Vállus, Vámoscsalád, Vámosszabadi, Vanyola, Várad, Varászló, Várbalog, Varbóc, Várda, Várfölde, Varga, Várgesztes, Várkesző, Várong, Vasalja, Vásárosbéc, Vásárosfalu, Vásárosmiske, Vasasszonyfa, Vasboldogasszony, Vasegerszeg, Vashosszúfalu, Vaskeresztes, Vaspör, Vassurány, Vászoly, Vasszentmihály, Vasszilvágy, Vát, Vázsnok, Vejti, Vékény, Vekerd, Velem, Velemér, Velény, Vének, Vértessomló, Vértestolna, Veszkény, Veszprémfajsz, Veszprémgalsa, Vid, Vigántpetend, Villánykövesd, Vilyvitány, Vinár, Vindornyafok, Vindornyalak, Vindornyaszőlős, Visegrád, Visnye, Visz, Viszák, Viszló, Vonyarcvashegy, Vöckönd, Völcsej, Vönöck, Vöröstó, Vörs, Zádor, Zagyvaszántó, Zajk, Zala, Zalaboldogfa, Zalaháshágy, Zalaigrice, Zalaköveskút, Zalameggyes, Zalamerenye, Zalasárszeg, Zalaszegvár, Zalaszentjakab, Zalaszentlászló, Zalaszentlőrinc, Zalaszentmárton, Zalaszentmihály, Zalaszombatfa, Zaláta, Zalatárnok, Zalaújlak, Zalavár, Zalavég, Zalkod, Zánka, Zaránk, Zebecke, Zebegény, Zengővárkony, Zics, Zimány, Zók, Zsana, Zsarolyán, Zsebeháza, Zsédeny, Zselickisfalud, Zselickislak, Zselicszentpál, Zsennye, Zsujta

Cluster #1

Abaújkér, Adony, Almamellék, Apátfalva, Ásotthalom, Bakonyoszlop, Baktakék, Balatoncsicsó, Balatonkenese, Balatonlelle, Balkány, Bánokszentgyörgy, Baracs, Batyk, Bázakerettye, Beregdaróc, Beremend, Berhida, Besenyszög, Bocskaikert, Bóly, Bonyhád, Bordány, Bőcs, Böhönye, Bugyi, Buj, Ceglédbercel, Csapi, Csenyéte, Demecser, Diósd, Dióskál, Diósviszló, Dombrád, Dunapataj, Dunatetétlen, Dunavecse, Écs, Ecser, Edelény, Egyek, Egyházasdengeleg, Erdősmecske, Erdőtarcsa, Fáj, Felpéc, Felsőtárkány, Földes, Fulókércs, Gemzse, Gerjen, Girincs, Göncruszka, Gulács, Gyöngyössolymos, Gyüre, Hahót, Hajdúdorog, Hajdúhadház, Hajdúsámson, Halásztelek, Harkány, Hernádnémeti, Hosszúhetény, Ipolytarnóc, Jákó, Jászalsószentgyörgy, Kelemér, Kemecse, Kerekegyháza, Keszthely, Királd, Kistarcsa, Kömlőd, Környe, Kőszeg, Kurityán, Lakitelek, Laskod, Lengyeltóti, Lónya, Madaras, Maglód, Mágocs, Máriapócs, Mecseknádasd, Mezőladány, Mihálygerge, Mosdós, Nádudvar, Nágocs, Nagyberki, Nagyhalász, Nagyharsány, Nagykörű, Nagymányok, Naszály, Neszmély, Noszvaj, Nyáregyháza, Nyíradony, Nyírbogdány, Onga, Papos, Parasznya, Pátyod, Pécsvárad, Perkupa, Péteri, Petőfibánya, Pusztamonostor, Rábacsécsény, Rácalmás, Rinyabesenyő, Sajólád, Sajónémeti, Sajószöged, Sály, Selyeb, Seregélyes, Soltvadkert, Somberek, Somogyvár, Szabás, Szamosbecs, Szászvár, Szemere, Szentlőrinc, Szigetcsép, Szikszó, Szirák, Tabdi, Tamási, Téglás, Tét, Tiszadob, Tiszalök, Tiszaszalka, Tiszaszentmárton, Tordas, Tornanádaska, Tótkomlós, Úri, Üröm, Vámosatya, Vámospércs, Váraszó, Vásárosdombó, Verpelét, Vértesacsa, Veszprémvarsány, Zalagyömörő, Zalakaros, Zsombó

Cluster #2

Abda, Alsópáhok, Alsóújlak, Ártánd, Ásványráró, Atkár, Bakonybél, Balatonendréd, Balatonfűzfő, Balatonkeresztúr, Balatonszabadi, Baracska, Bélmegyer, Bér, Bükkzsérc, Cirák, Csénye, Cserháthaláp, Csobánka, Csomád, Csömör, Csősz, Dáka, Darvas, Demjén, Derekegyház, Deszk, Dunaalmás, Egerszólát, Egyházasfalu, Egyházaskesző, Egyházasrádóc, Enese, Felsőpetény, Felsőszölnök, Ferencszállás, Fertőd, Fertőrákos, Gibárt, Golop, Gyepükaján, Győrasszonyfa, Győrújbarát, Gyúró, Hantos, Hédervár, Hegykő, Hejőkürt, Héreg, Herend, Himesháza, Himod, Homokbödöge, Kapoly, Kaskantyú, Kecskéd, Kemenesmihályfa, Kenyeri, Kesztölc, Kimle, Kisapostag, Kisbajcs, Kiscsécs, Kóspallag, Kuncsorba, Kunszállás, Külsővat, Lébény, Lengyel, Litér, Magyaratád, Magyaregregy, Maklár, Mályi, Mátyásdomb, Mecsér, Mesterszállás, Mezőlak, Mihályi, Mogyorósbánya, Molnári, Mosonszolnok, Nagygyimót, Nagyréde, Nagysimonyi, Nagytálya, Nagytevel, Nak, Nekézseny, Nemesbőd, Nógrád, Nőtincs, Nyúl, Óhíd, Olasz, Oszlár, Öskü, Pér, Perbál, Petőháza, Piliscsaba, Pilisszentkereszt, Rajka, Ravazd, Répcelak, Rétalap, Romonya, Sáregres, Sárhida, Sátorhely, Solymár, Szakáld, Szákszend, Szár, Szegilong, Szeleste, Szentantalfa, Szente, Szentpéterfa, Szil, Szilsárkány, Szirmabesenyő, Takácsi, Taliándörögd, Telki, Telkibánya, Tihany, Tiszadorogma, Tiszaug, Tokod, Tolnanémedi, Töltéstava, Töttös, Újiráz, Újlengyel, Újrónafő, Újszentiván, Újudvar, Vértesboglár, Vérteskethely, Vilonya, Zalacsány, Zalacséb, Zalaszentgyörgy, Zamárdi, Zámoly, Závod

Cluster #3

Alap, Bajánsenye, Bakonysárkány, Balatonfőkajár, Becsvölgye, Csaholc, Csárdaszállás, Dad, Fonyód, Fülöpjakab, Gárdony, Lovasberény, Ludas, Mende, Mosonmagyaróvár, Nógrádkövesd, Pétfürdő, Pusztaszabolcs, Sárvár, Tarpa, Tinnye, Váralja, Vitnyéd

Cluster #4

Ács, Acsa, Ácsteszér, Adács, Akasztó, Algyő, Alsóörs, Ambrózfalva, Apostag, Bábonymegyer, Bagod, Bajna, Bak, Bakonyszentkirály, Bakonyszombathely, Balatonberény, Balatonföldvár, Bánhorváti, Bánréve, Bársonyos, Bedő, Bekecs, Békéssámson, Bekölce, Beleg, Bénye, Bérbaltavár, Berkesd, Berkesz, Bernecebaráti, Berzék, Berzence, Besenyőd, Biharkeresztes, Bócsa, Bodajk, Bodrogolaszi, Boldog, Borota, Bősárkány, Bükkszenterzsébet, Cibakháza, Cigánd, Cikó, Csanádapáca, Császártöltés, Csátalja, Csegöld, Cserépfalu, Cserkeszőlő, Csikéria, Csögle, Csömödér, Csurgó, Dág, Dávod, Decs, Dejtár, Dencsháza, Detk, Dóc, Domaháza, Domaszék, Dombegyház, Dorog, Döbrököz, Döge, Dömsöd, Dunaharaszti, Dunaszentbenedek, Dusnok, Egerbocs, Elek, Előszállás, Enying, Erdőtelek, Érsekvadkert, Erzsébet, Ete, Etyek, Fábiánsebestyén, Feldebrő, Felsőnána, Felsőnyék, Felsőrajk, Fony, Földeák, Füzér, Galgamácsa, Gamás, Garadna, Géderlak, Gencsapáti, Gérce, Gerendás, Geszteréd, Gyöngyöstarján, Halimba, Hangács, Harc, Harkakötöny, Hévíz, Hidvégardó, Hollóháza, Hort, Iharos, Iklad, Ipolyvece, Istenmezeje, Iszkaszentgyörgy, Izmény, Jánkmajtis, Jánossomorja, Jászdózsa, Jenő, Juta, Kadarkút, Kálmáncsa, Káloz, Kápolna, Kápolnásnyék, Kaposvár, Karácsond, Karcsa, Kemence, Kemenesmagasi, Kenézlő, Kerta, Kétpó, Kéty, Kisbárapáti, Kishartyán, Kiskorpád, Kisköre, Kistormás, Kisújszállás, Kisvarsány, Kisszekeres, Kocs, Kokad, Kóny, Kölked, Kőszárhegy, Kunszentmiklós, Ladánybene, Lajosmizse, Látrány, Lázi, Legyesbénye, Lövőpetri, Magosliget, Magy, Magyarszerdahely, Majs, Marcaltő, Mátraderecske, Mátranovák, Medgyesbodzás, Medgyesegyháza, Medina, Mélykút, Mérk, Mesztegnyő, Mezőfalva, Mezőhegyes, Mezősas, Mezőszilas, Mezőtárkány, Miháld, Mikófalva, Mindszent, Miske, Monorierdő, Nagydorog, Nagykorpád, Nagyút, Nagyvenyim, Napkor, Nemesbikk, Nemesdéd, Nemesgörzsöny, Németkér, Nézsa, Nikla, Noszlop, Nova, Nyársapát, Nyergesújfalu, Nyirád, Nyíribrony, Nyírkáta, Nyírkércs, Nyírlövő, Nyírparasznya, Nyírpilis, Ópályi, Ópusztaszer, Ömböly, Őriszentpéter, Ősi, Öttömös, Ötvöskónyi, Pápateszér, Papkeszi, Pázmánd, Pázmándfalu, Pecöl, Penyige, Perkáta, Petőfiszállás, Pilismarót, Pincehely, Pitvaros, Pócsmegyer, Pogányszentpéter, Pókaszepetk, Pörböly, Pusztahencse, Püspökmolnári, Rábahídvég, Ráckeve, Ragály, Rakamaz, Rédics, Regöly, Révleányvár, Rohod, Rózsafa, Rózsaszentmárton, Ruzsa, Sajóörös, Sajópetri, Sarkad, Sárszentmihály, Sávoly, Siklósnagyfalu, Somlószőlős, Somodor, Somogygeszti, Somogyhárságy, Somogysámson, Somogysárd, Somogyszil, Somogyudvarhely, Somogyvámos, Sonkád, Sopron, Sorkifalud, Sótony, Sümegcsehi, Szabadhídvég, Szabolcsbáka, Szajla, Szakály, Szakcs, Szakmár, Szárliget, Szatymaz, Százhalombatta, Szegvár, Szelevény, Szendrő, Szenna, Szentbalázs, Szentdénes, Szentgotthárd, Szeremle, Szigetmonostor, Szigetújfalu, Szilaspogony, Szorgalmatos, Szúcs, Szulok, Szűcsi, Tabajd, Taktaharkány, Taktaszada, Táp, Tapolca, Tardona, Tárkány, Tarnaméra, Tarnaszentmiklós, Tárnok, Tenk, Tiszabábolna, Tiszabecs, Tiszaderzs, Tiszasas, Tiszavárkony, Tóalmás, Told, Tomor, Tószeg, Törtel, Tüskevár, Újtikos, Vácrátót, Vadna, Vajszló, Vámosmikola, Várdomb, Városföld, Varsád, Vasad, Verseg, Villány, Vízvár, Vizslás, Vokány, Zajta, Zalabaksa, Zalabér, Zalakomár, Zalaszentbalázs, Zalaszentgrót, Zalaszentiván, Ziliz, Zsadány, Zsámbok, Zsira, Zsurk

Cluster #5

Aba, Abádszalók, Abaliget, Abaújszántó, Abony, Ádánd, Ágasegyháza, Aggtelek, Ajak, Ajka, Alacska, Alattyán, Albertirsa, Alcsútdoboz, Aldebrő, Almásfüzitő, Almáskamarás, Álmosd, Alsóberecki, Alsónána, Alsónémedi, Alsónemesapáti, Alsószentiván, Alsószentmárton, Alsószuha, Alsóvadász, Alsózsolca, Anarcs, Andocs, Annavölgy, Apagy, Apaj, Aparhant, Apc, Áporka, Aranyosapáti, Arló, Arnót, Ároktő, Árpádhalom, Aszaló, Ászár, Aszód, Átány, Attala, Babarc, Babócsa, Bábolna, Bácsalmás, Bácsbokod, Bácsborsód, Badacsonytomaj, Bag, Bagamér, Baja, Bajót, Bakonszeg, Bakonycsernye, Bakonynána, Bakonyszentiván, Bakonyszentlászló, Baks, Baksa, Baktalórántháza, Balajt, Balassagyarmat, Balástya, Balaton, Balatonalmádi, Balatonboglár, Balatonfenyves, Balatonfüred, Balatonszárszó, Balatonszemes, Balatonszentgyörgy, Balatonvilágos, Ballószög, Balmazújváros, Balotaszállás, Balsa, Barabás, Báránd, Baranyajenő, Barcs, Bárdudvarnok, Bárna, Báta, Bátaapáti, Bátaszék, Baté, Bátmonostor, Bátonyterenye, Bátorliget, Battonya, Bátya, Becsehely, Becske, Békés, Békéscsaba, Békésszentandrás, Bélapátfalva, Beled, Bercel, Beregsurány, Berekböszörmény, Berekfürdő, Berente, Berettyóújfalu, Besenyőtelek, Besnyő, Beszterec, Biatorbágy, Bicsérd, Bicske, Biharnagybajom, Bihartorda, Biharugra, Bikács, Bikal, Boba, Bocfölde, Boconád, Bodrog, Bodroghalom, Bodrogkeresztúr, Bodrogkisfalud, Bódvaszilas, Bogács, Bogád, Bogádmindszent, Bogyiszló, Bojt, Boldogkőújfalu, Boldogkőváralja, Boldva, Bolhó, Borjád, Borsfa, Borsodbóta, Borsodivánka, Borsodnádasd, Borsodszentgyörgy, Borsodszirák, Borsosberény, Botpalád, Bő, Bököny, Bölcske, Bőny, Bucsa, Búcsúszentlászló, Budajenő, Budakalász, Budakeszi, Budaörs, Budapest, Bugac, Buják, Buzsák, Bük, Bükkábrány, Bükkaranyos, Bükkösd, Büssü, Cece, Cégénydányád, Cegléd, Celldömölk, Cered, Csabacsűd, Csabdi, Csabrendek, Csákánydoroszló, Csákvár, Csanádalberti, Csanádpalota, Csány, Csányoszró, Csanytelek, Csaroda, Császár, Csávoly, Csécse, Csehimindszent, Csemő, Csengele, Csenger, Csengersima, Csengerújfalu, Csengőd, Csépa, Csepreg, Cserhátsurány, Csernely, Cserszegtomaj, Csesztreg, Csesztve, Csetény, Csévharaszt, Csikóstőttős, Csipkerek, Csitár, Csobád, Csobaj, Csókakő, Csokonyavisonta, Csokvaomány, Csolnok, Csólyospálos, Csongrád, Csonkahegyhát, Csór, Csorna, Csorvás, Csót, Csökmő, Csököly, Csörög, Csörötnek, Dabas, Dabronc, Dalmand, Dánszentmiklós, Dány, Darány, Daruszentmiklós, Debrecen, Dédestapolcsány, Dég, Délegyháza, Derecske, Dévaványa, Devecser, Diósberény, Diósjenő, Doboz, Dombóvár, Domony, Domoszló, Dormánd, Dorogháza, Drávafok, Drávaszabolcs, Drávasztára, Drégelypalánk, Dudar, Dunaegyháza, Dunafalva, Dunaföldvár, Dunakeszi, Dunaszekcső, Dunaszentgyörgy, Dunasziget, Dunaújváros, Dunavarsány, Ebes, Ecséd, Ecseg, Eger, Egerág, Egerbakta, Egercsehi, Egerfarmos, Egerszalók, Egyházasgerge, Egyházasharaszti, Egyházashollós, Egyházaskozár, Emőd, Encs, Encsencs, Endrefalva, Eperjeske, Ercsi, Érd, Erdőbénye, Erdőhorváti, Erdőkertes, Erdőkürt, Erk, Érpatak, Érsekcsanád, Érsekhalma, Értény, Esztár, Eszteregnye, Esztergom, Etes, Fábiánháza, Fácánkert, Fadd, Fajsz, Fancsal, Farkaslyuk, Farmos, Fegyvernek, Fehérgyarmat, Fehérvárcsurgó, Felcsút, Felgyő, Felsődobsza, Felsőkelecsény, Felsőlajos, Felsőnyárád, Felsőpakony, Felsőszentiván, Felsőszentmárton, Felsőtelekes, Felsővadász, Felsőzsolca, Fényeslitke, Foktő, Forráskút, Forró, Fót, Furta, Fülesd, Fülöp, Fülöpszállás, Fürged, Füzesabony, Füzesgyarmat, Gáborján, Gacsály, Gadna, Gádoros, Gagyvendégi, Galambok, Galgaguta, Galgagyörk, Galgahévíz, Gálosfa, Gara, Gávavencsellő, Géberjén, Gégény, Gelej, Gelénes, Gellénháza, Gelse, Geresdlak, Geszt, Gesztely, Gic, Gige, Gógánfa, Gomba, Göd, Gödöllő, Gödre, Gölle, Gönc, Görbeháza, Görcsöny, Görgeteg, Gutorfölde, Gyál, Gyarmat, Gyékényes, Gyermely, Gyomaendrőd, Gyömöre, Gyömrő, Gyöngyös, Gyöngyösoroszi, Gyöngyöspata, Gyönk, Győr, Györe, Györgytarló, Györköny, Győrság, Győrszemere, Győrtelek, Győrvár, Gyula, Gyulaháza, Gyulaj, Hács, Hajdúbagos, Hajdúböszörmény, Hajdúnánás, Hajdúszoboszló, Hajdúszovát, Hajmáskér, Hajós, Halmaj, Halmajugra, Hangony, Harka, Háromfa, Harsány, Harta, Hatvan, Hedrehely, Héhalom, Hejőbába, Hejőkeresztúr, Hejőpapi, Hejőszalonta, Helvécia, Hencida, Hercegszántó, Heréd, Herencsény, Hernád, Hernádkak, Hernádszentandrás, Hernádvécse, Hetes, Hetvehely, Heves, Hevesaranyos, Hévízgyörk, Hidas, Hidasnémeti, Hobol, Hodász, Hódmezővásárhely, Hollókő, Homokszentgyörgy, Homrogd, Hortobágy, Hosszúpályi, Hosszúpereszteg, Hőgyész, Hugyag, Hunya, Ibrány, Igal, Igrici, Iharosberény, Ikervár, Ikrény, Ilk, Imrehegy, Ináncs, Inárcs, Inke, Ipolyszög, Iregszemcse, Isaszeg, Istvándi, Ivád, Iván, Iváncsa, Izsák, Izsófalva, Ják, Jakabszállás, Jákfalva, Jánd, Jánoshalma, Jánosháza, Jánoshida, Járdánháza, Jármi, Jásd, Jászapáti, Jászárokszállás, Jászberény, Jászboldogháza, Jászfelsőszentgyörgy, Jászfényszaru, Jászjákóhalma, Jászkarajenő, Jászkisér, Jászladány, Jászszentandrás, Jászszentlászló, Jásztelek, Jobbágyi, Kaba, Kajárpéc, Kajdacs, Kakucs, Kál, Káld, Kálló, Kállósemjén, Kálmánháza, Kalocsa, Kamut, Kántorjánosi, Kánya, Kaposfő, Kaposmérő, Kaposszekcső, Káptalanfa, Kapuvár, Karád, Karancsalja, Karancskeszi, Karancslapujtő, Karancsság, Karcag, Karmacs, Karos, Kartal, Kaszaper, Katymár, Káva, Kazár, Kazincbarcika, Kázsmárk, Kecel, Kecskemét, Kék, Kékcse, Kelebia, Kéleshalom, Kémes, Kenderes, Kengyel, Kerecsend, Kerékteleki, Kerepes, Kertészsziget, Kesznyéten, Kétegyháza, Kéthely, Kétsoprony, Kétújfalu, Kevermes, Kincsesbánya, Királyegyháza, Királyhegyes, Kisar, Kisbajom, Kisbér, Kisgyőr, Kisharsány, Kiskőrös, Kiskunfélegyháza, Kiskunhalas, Kiskunlacháza, Kiskunmajsa, Kisláng, Kisléta, Kislőd, Kismarja, Kismaros, Kisnána, Kispalád, Kistelek, Kistokaj, Kisvárda, Kisvaszar, Kisvejke, Kiszombor, Kisszállás, Kocsér, Kocsola, Kocsord, Kóka, Komádi, Komárom, Komló, Komoró, Kompolt, Kondó, Kondoros, Konyár, Koroncó, Kosd, Kótaj, Kovácsvágás, Kozármisleny, Kölcse, Kölesd, Kömlő, Kömörő, Kömpöc, Körmend, Köröm, Körösladány, Körösnagyharsány, Köröstarcsa, Kőröstetétlen, Körösújfalu, Körösszakál, Körösszegapáti, Kötcse, Kötegyán, Kőtelek, Kővágószőlős, Krasznokvajda, Kulcs, Kunadacs, Kunágota, Kunbaja, Kunfehértó, Kunhegyes, Kunmadaras, Kunpeszér, Kunszentmárton, Kurd, Kutas, Kübekháza, Lábatlan, Lábod, Lad, Lajoskomárom, Lak, Lakócsa, Lánycsók, Leányfalu, Leányvár, Legénd, Léh, Lenti, Lepsény, Lesenceistvánd, Lesencetomaj, Létavértes, Letenye, Letkés, Levelek, Liget, Lippó, Litke, Lovászi, Lovászpatona, Lőkösháza, Lőrinci, Lövő, Lucfalva, Ludányhalászi, Mád, Madocsa, Magyarbánhegyes, Magyarbóly, Magyarcsanád, Magyargéc, Magyarhertelend, Magyarhomorog, Magyarkeszi, Magyarlak, Magyarmecske, Magyarnándor, Magyarszék, Majosháza, Makád, Makkoshotyka, Makó, Mándok, Mány, Marcali, Máriakálnok, Máriakéménd, Markaz, Maroslele, Martfű, Martonvásár, Mátészalka, Mátételke, Mátramindszent, Mátraszele, Mátraszőlős, Mátraterenye, Mátraverebély, Matty, Máza, Megyaszó, Méhkerék, Méhtelek, Méra, Mernye, Mezőberény, Mezőcsát, Mezőcsokonya, Mezőgyán, Mezőkeresztes, Mezőkomárom, Mezőkovácsháza, Mezőkövesd, Mezőnagymihály, Mezőnyárád, Mezőpeterd, Mezőszemere, Mezőszentgyörgy, Mezőtúr, Mezőzombor, Mike, Mikepércs, Mikóháza, Milota, Mindszentgodisa, Miskolc, Mocsa, Mogyoród, Mohács, Mohora, Monok, Monor, Monostorapáti, Monostorpályi, Mór, Mórágy, Mórahalom, Mozsgó, Mucsi, Múcsony, Murakeresztúr, Muraszemenye, Murony, Nábrád, Nádasdladány, Nagyalásony, Nagyar, Nagyatád, Nagybajom, Nagybánhegyes, Nagybaracska, Nagybarca, Nagybárkány, Nagyberény, Nagybörzsöny, Nagycsécs, Nagycserkesz, Nagydém, Nagydobos, Nagydobsza, Nagyecsed, Nagyér, Nagyesztergár, Nagyfüged, Nagyhegyes, Nagyigmánd, Nagyiván, Nagykálló, Nagykamarás, Nagykanizsa, Nagykapornak, Nagykarácsony, Nagykáta, Nagykereki, Nagykónyi, Nagykovácsi, Nagykőrös, Nagylengyel, Nagylóc, Nagylók, Nagylózs, Nagymágocs, Nagymaros, Nagyoroszi, Nagypall, Nagypeterd, Nagyrábé, Nagyrécse, Nagyrév, Nagyrozvágy, Nagysáp, Nagyszékely, Nagyszekeres, Nagyszénás, Nagyszentjános, Nagyszokoly, Nagyvarsány, Nagyvázsony, Nemesapáti, Nemesgulács, Nemesnádudvar, Nemesvámos, Nemesvid, Nemesszalók, Nemti, Nógrádmarcal, Nógrádmegyer, Nógrádsáp, Nógrádsipek, Nógrádszakál, Novajidrány, Nyárlőrinc, Nyékládháza, Nyírábrány, Nyíracsád, Nyírbátor, Nyírbéltek, Nyírbogát, Nyírcsaholy, Nyírcsászári, Nyírderzs, Nyíregyháza, Nyírgelse, Nyírgyulaj, Nyírjákó, Nyírkarász, Nyírlugos, Nyírmada, Nyírmártonfalva, Nyírmeggyes, Nyírmihálydi, Nyírpazony, Nyírtass, Nyírtelek, Nyírtét, Nyírtura, Nyírvasvári, Nyőgér, Ócsa, Ófehértó, Okány, Olaszfa, Olaszliszka, Olcsva, Ónod, Ordas, Orfű, Orgovány, Ormosbánya, Orosháza, Oroszlány, Orosztony, Ostffyasszonyfa, Ostoros, Oszkó, Osztopán, Ózd, Ozora, Őcsény, Öcsöd, Ököritófülpös, Őr, Őrbottyán, Öregcsertő, Öreglak, Őrhalom, Örkény, Örményes, Őrtilos, Pácin, Pacsa, Páhi, Páka, Pákozd, Paks, Pálfa, Pálháza, Pálmajor, Pálmonostora, Palotabozsok, Palotás, Pánd, Pannonhalma, Panyola, Pap, Pápa, Pápakovácsi, Pápasalamon, Parád, Pári, Paszab, Pásztó, Patak, Pátka, Pátroha, Patvarc, Páty, Pécel, Pécs, Pellérd, Pély, Penc, Penészlek, Pere, Pétervására, Petneháza, Piliny, Pilis, Pilisvörösvár, Piricse, Pirtó, Pocsaj, Pócspetri, Polgár, Polgárdi, Pomáz, Porcsalma, Poroszló, Porrog, Prügy, Pusztadobos, Pusztaföldvár, Pusztakovácsi, Pusztamagyaród, Pusztamérges, Pusztaszer, Pusztavacs, Pusztavám, Pusztazámor, Putnok, Püspökhatvan, Püspökladány, Rábapatona, Rábapaty, Rábatamási, Ráckeresztúr, Rád, Rakaca, Rakacaszend, Rákóczibánya, Rákóczifalva, Rákócziújfalu, Ramocsaháza, Rásonysápberencs, Rátka, Recsk, Réde, Rém, Rétközberencs, Rétság, Rezi, Ricse, Rimóc, Rinyaszentkirály, Romhány, Rozsály, Röszke, Rudabánya, Rudolftelep, Rum, Ságújfalu, Ságvár, Sajóbábony, Sajóhídvég, Sajóivánka, Sajókaza, Sajókeresztúr, Sajólászlófalva, Sajószentpéter, Sajóvámos, Sajóvelezd, Salgótarján, Salomvár, Sámsonháza, Sándorfalva, Sáp, Sáránd, Sárbogárd, Sárisáp, Sarkadkeresztúr, Sárkeresztes, Sárkeresztúr, Sármellék, Sárosd, Sárospatak, Sárpilis, Sárrétudvari, Sárszentágota, Sárszentlőrinc, Sarud, Sásd, Sáta, Sátoraljaújhely, Segesd, Sellye, Sényő, Serényfalva, Siklós, Simonfa, Simontornya, Siófok, Sirok, Sokorópátka, Solt, Soltszentimre, Somlóvásárhely, Somogyapáti, Somogyfajsz, Somogyjád, Somogyszentpál, Somogyszob, Somoskőújfalu, Soponya, Sóshartyán, Sóskút, Sóstófalva, Söjtör, Súr, Surd, Sükösd, Sülysáp, Sümeg, Sümegprága, Süttő, Szabadbattyán, Szabadegyháza, Szabadkígyós, Szabadszállás, Szabadszentkirály, Szabolcs, Szabolcsveresmart, Szajol, Szakoly, Szalánta, Szalaszend, Szalkszentmárton, Szalonna, Szamossályi, Szamosszeg, Szank, Szany, Szarvas, Szászberek, Szatmárcseke, Szava, Szécsény, Szécsényfelfalu, Szederkény, Szedres, Szeged, Szeghalom, Székely, Székesfehérvár, Székkutas, Szekszárd, Szendehely, Szendrőlád, Szenta, Szentendre, Szentes, Szentgál, Szentistván, Szentkirály, Szentkirályszabadja, Szentlászló, Szentlőrinckáta, Szentmártonkáta, Szentpéterszeg, Szentpéterúr, Szepetnek, Szerencs, Szerep, Szigetbecse, Szigethalom, Szigetszentmárton, Szigetszentmiklós, Szigetvár, Szigliget, Szihalom, Szilvásvárad, Szin, Szob, Szólád, Szolnok, Szombathely, Szomód, Szomolya, Sződ, Sződliget, Szögliget, Szőlősgyörök, Szuhakálló, Szuhogy, Szurdokpüspöki, Szügy, Tab, Táborfalva, Tác, Taksony, Taktabáj, Taktakenéz, Tállya, Tápióbicske, Tápiógyörgye, Tápióság, Tápiószecső, Tápiószele, Tápiószentmárton, Tápiószőlős, Táplánszentkereszt, Tapsony, Tápszentmiklós, Tar, Tarany, Tarcal, Tardos, Tarhos, Tarján, Tarnabod, Tarnalelesz, Tarnaörs, Tarnazsadány, Táska, Tass, Taszár, Tát, Tata, Tatabánya, Tataháza, Tatárszentgyörgy, Tázlár, Tengelic, Tényő, Tépe, Terem, Terény, Tereske, Tetétlen, Tevel, Tibolddaróc, Tiborszállás, Timár, Tiszaadony, Tiszaalpár, Tiszabercel, Tiszabezdéd, Tiszabő, Tiszabura, Tiszacsege, Tiszacsermely, Tiszadada, Tiszaeszlár, Tiszaföldvár, Tiszafüred, Tiszagyenda, Tiszagyulaháza, Tiszaigar, Tiszainoka, Tiszajenő, Tiszakanyár, Tiszakarád, Tiszakécske, Tiszakerecseny, Tiszakeszi, Tiszakóród, Tiszakürt, Tiszaladány, Tiszalúc, Tiszamogyorós, Tiszanagyfalu, Tiszanána, Tiszaörs, Tiszapalkonya, Tiszapüspöki, Tiszarád, Tiszaroff, Tiszasüly, Tiszaszentimre, Tiszasziget, Tiszaszőlős, Tiszatarján, Tiszatelek, Tiszatenyő, Tiszaújváros, Tiszavasvári, Tisztaberek, Tófej, Tokaj, Tokodaltáró, Tolcsva, Tolna, Tomajmonostora, Tompa, Tormás, Tornyosnémeti, Tornyospálca, Torony, Tótszerdahely, Tótvázsony, Tököl, Tömörkény, Törökbálint, Törökkoppány, Törökszentmiklós, Tunyogmatolcs, Tura, Túristvándi, Túrkeve, Tuzsér, Türje, Tyukod, Ugod, Újcsanálos, Újdombrád, Újfehértó, Újireg, Újkenéz, Újkígyós, Újléta, Újpetre, Újszász, Újszentmargita, Újszilvás, Ukk, Ura, Úrhida, Uszód, Üllés, Vác, Vácduka, Vácegres, Váchartyán, Vácszentlászló, Vaja, Vajdácska, Vajta, Vál, Valkó, Vállaj, Vámosgyörk, Vámosoroszi, Vámosújfalu, Váncsod, Vanyarc, Varbó, Városlőd, Várpalota, Varsány, Várvölgy, Vásárosnamény, Vaskút, Vasmegyer, Vasvár, Vaszar, Vasszécseny, Vatta, Vécs, Vecsés, Végegyháza, Velence, Vémend, Vép, Vereb, Veresegyház, Verőce, Versend, Vértesszőlős, Vése, Veszprém, Vésztő, Vezseny, Vilmány, Visonta, Viss, Visznek, Vizsoly, Zabar, Zádorfalva, Zagyvarékas, Záhony, Zákány, Zákányfalu, Zákányszék, Zalaapáti, Zalaegerszeg, Zalaerdőd, Zalahaláp, Zalaistvánd, Zalalövő, Zalaszabar, Zalaszántó, Zemplénagárd, Zichyújfalu, Zirc, Zomba, Zubogy, Zsáka, Zsámbék

Appendix B

Number of teaching staff - total	2024	2023	2022	2021
Northern Hungary	13 425	14 228	15 651	15 876
Northern Great Plain	16 951	18 555	20 663	20 796
Southern Great Plain	14 501	15 388	17 785	17 900
Central Hungary	15 623	16 443	18 034	18 096
Budapest	22 857	23 311	27 437	27 725
Central Transdanubia	12 774	13 330	14 711	14 783
Western Transdanubia	11 287	11 736	13 159	13 154
Southern Transdanubia	10 098	11 170	12 483	12 696

Number of educational support staff - total	2024	2023	2022	2021
Northern Hungary	4 202	4 217	4 394	4 295
Northern Great Plain	5 177	5 384	5 617	5 540
Southern Great Plain	4 053	4 253	4 661	4 531
Central Hungary	5 541	5 623	5 612	5 456
Budapest	6 514	6 791	7 528	7 487
Central Transdanubia	3 931	4 107	4 293	4 214
Western Transdanubia	3 266	3 282	3 416	3 305
Southern Transdanubia	2 902	3 043	3 282	3 231

Total children enrollment - total	2024	2023	2022	2021
Northern Hungary	152 320	151 260	151 436	150 985
Northern Great Plain	199 801	199 004	198 469	199 522
Southern Great Plain	153 104	152 338	153 145	153 623
Central Hungary	186 538	184 013	182 640	180 309
Budapest	230 344	232 402	234 470	236 045
Central Transdanubia	137 256	137 035	137 179	136 493
Western Transdanubia	118 560	118 624	118 543	118 331
Southern Transdanubia	104 818	105 181	105 910	106 298

András Béres – PhD student
beres.andras2@pte.hu
ORCID ID: 0009-0008-4320-3998

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Representation of the Roma in Hungarian Textbooks after the Turn of the Millennium

A Literature Review

Bálint Borbándi
Faculty of Humanities and Social Sciences, University of Pécs

ABSTRACT

This study aims to summarize and systemize the findings of scientific studies on the representation of the Roma, the largest and most negatively perceived ethnic minority in Hungary, in Hungarian textbooks. This paper provides a comprehensive, chronologically structured overview that compares the data of individual scholarly publications and highlights the changes in the textbook representation of the Roma population in Hungary over the more than two decades since the turn of the millennium. In summary, despite positive tendencies, improvements in both quantity and quality are needed in Hungarian textbooks to ensure that students in public education gain a nuanced and multi-perspective understanding of the history, culture, and traditions of the Roma. In order to reduce stereotypes and prejudices related to the Roma, it is essential that textbooks used in education convey reliable and scientifically grounded information about the Roma to all students in public education.

Keywords: Literature review; Roma representation; Textbook analysis

Introduction

„Textbooks are collections of canonized knowledge that encompass views that are socially accepted, aligned with the prevailing public spirit, and necessary for a successful career in a given historical era. As such, textbooks do not simply convey knowledge, but also demonstrate values, communicate norms, provide patterns and set standards." (Terestyéni, 2005, p. 1) The passage quoted from the work of Tamás Terestyéni perfectly highlights why it is extremely important to examine the quantity and quality in which ethnicities/minorities are presented in the textbooks of various subjects, especially regarding the Roma, who are particularly negatively perceived by the majority group (Keresztes-Takács et al., 2016). In order to reduce or eliminate the stereotypes and discrimination affecting the Roma, a major shift in the perspective of the majority, and an increase in social awareness are essential, and textbooks, from which all students in public education learn nationwide, provide the perfect opportunity to achieve these changes. Textbooks are the most democratic educational tool, and because everyone uses them at some point, their influence is far-reaching; therefore, deciding how they represent the Roma is a great opportunity and responsibility. They serve the transmission of knowledge and the development of skills. They also fulfil

scientific (by conveying accurate knowledge, values and culture), pedagogical (through influencing students' personalities and shaping students' worldview through their methods of content delivery), and institutional (through communicating the educational content, goals and requirements of the public education system within public schools) functions (Bozsik, 2015). As emphasized by Cserti Csapó, the content found in educational materials is always shaped by the intentions and discourse of high politics, minority policy, education policy, as well as by public discourse, minorities' current identity constructions and the official positions of science. Textbook developers have to navigate between these content-related frameworks and meet the methodological expectations set for textbooks. (Cserti Csapó, 2023a)

Aim of the Analysis and Literature Review

The aim of this analysis is to summarize and systemize the findings of scientific studies concerning the representation of the Roma in Hungarian textbooks. This paper seeks to highlight changes in the representation of the Roma in Hungarian textbooks over the past two decades by comparing data from scientific publications. This study is intended as an exploration of the positive and negative trends in the presentation of knowledge related to the Roma in Hungarian textbooks in the past two decades. Similar review studies were done earlier by Viola Bozsik (2015) and Péter Bogdán (2016). This study offers a novel contribution by filling the gap left since 2016, as no up-to-date work that would summarize the scholarly output of the last ten years has been available.

In the following, studies and scientific publications that have examined the content of textbooks concerning the Roma after the turn of the Millennium will be reviewed in chronological order.

Overview of the Findings of the Reviewed Literature

Content Related to the Roma in High School History and Social Studies Textbooks (Terestyéni, 2004), Content Related to Ethnicity in High School Textbooks (Terestyéni, 2005)

The aim of Tamás Terestyéni's (2002) research was to examine the extent to which themes related to the Roma are covered in Hungarian history and social studies textbooks used in public education, and to assess whether the content in the analysed material is suitable for promoting the development of a politically correct image of the Roma during students' education (Balázs et al., 2014). A total of 83 secondary school history and social studies textbooks (published for grammar schools and vocational schools) were analysed using both quantitative (statistical) and qualitative (textual analysis) methods. Terestyéni found that 25.3% of the sample examined (21 materials) contained content related to Roma studies. Of the 83 educational materials examined, 73 were classified as history textbooks or supplementary materials for history education, while 10 volumes fell under the categories of social studies, civic education or public law aimed, partially or entirely, to provide guidance on the legal and social conditions of contemporary Hungary (i.e., following the regime change in 1990). 9 of the 73 history textbooks did not include themes related to Roma studies due to the historical era covered in them. Of the remaining 64 textbooks, only 14 contained text segments related to the Roma. Of the 10 social studies (civic education, public law) textbooks, 7 contained information related to the Roma community. Based on these findings, it could be concluded that works concerned with contemporary Hungarian society were significantly more likely to include information related to the Roma than textbooks that covered historical periods. Terestyéni found that the number of textbooks addressing the Roma was very low, only 28% of the 74 textbooks, and the extent of the text segments related to the Roma was limited as well. A third of the segments mentioning the Roma consisted of only a single sentence; only in 8 materials were found text segments about the Roma two or three paragraphs long or longer (see Table 1; Terestyéni, 2004, 2005).

Table 1.
The length of Roma-related text segments in textbooks (absolute numbers)

Length	Quantity
1 sentence	7
1 paragraph	6
2-3 paragraphs	6
Longer	2
All textbooks addressing the Roma	21

Note. Created by the author. Source: Terestyéni (2004)

Among the textbooks that contained material related to the Roma, almost all of them included some historical background, and more than half addressed the relationship between the Roma and the Hungarian majority. Relatively significant attention was given to the size of the Roma population, and in half of the textbooks, information on the social conditions of the Roma was presented, and a similar proportion addressed their culture and way of life. Only a few textbooks included geographical information about how the Roma population is distributed within Hungary. The origin and linguistic status of the Roma were addressed only in one or two textbooks (see Table 2; Terestyéni, 2004, 2005).

Table 2.
The thematic composition of Roma-related text sections (the texts could include multiple themes)

Theme	Number of mentions
Size of the Roma population in Hungary	9
Geographical distribution of the Roma in Hungary	3
Origin of the Roma	1
Linguistic status of the Roma	1
History of the Roma within Hungary	19
Social conditions of the Roma	8
Culture[5] and way of life of the Roma	8

[5]Despite being phrased this way in the study, speaking of Roma cultures in the plural would be more accurate as there are several distinct Roma communities, each with their own cultural traditions and practices

Theme	Number of mentions
Relationship between the Roma minority and the majority population	11
All textbooks addressing the Roma	21

Note. Created by the author. Source: Terestyéni (2004)

Overall, it can be concluded that the textbooks examined devoted limited attention to the Roma. Apart from the fact that the majority of the textbooks examined made no mention of the Roma, those that did address the Roma did so briefly, superficially, and incidentally, without substantive elaboration. The history of the Roma was not presented in a consistent and continuous manner, it was rather fragmented and episodic, not integrated organically into the Hungarian majority's history. Positive aspects of Roma history and society (e.g., commendable acts or social contributions) were almost entirely absent from the textbooks, or when mentioned, were given little emphasis and significance. In contrast, negative aspects (both past and temporary) appeared frequently. These included conflicts with the Hungarian Majority, rejection of social norms, criminality, disadvantaged social roles, and a perceived lack of effort and willingness to adapt to the majority society. It can be concluded that negative aspects significantly outnumbered the positive ones. Cultural aspects of the Roma community were scarcely addressed in the materials, and there was no mention of how the Roma contributed to the enrichment and diversification of Hungarian culture. Contemporary conditions and living circumstances of the Roma were rarely discussed, and when mentioned, the descriptions were often stereotypical, superficial and lacking in substance. The analysed materials did little to challenge stereotypical and prejudiced beliefs; on the contrary, through careless phrasing and by including, albeit not necessarily intentionally, disadvantageous associations and conclusions, they may have reinforced rather than weakened prejudiced thinking about the Roma (Terestyéni, 2004, 2005).

Representation of the Roma in Primary and High School Textbooks (Balázs et al., 2014)

Members of MONITOR[6] repeated Tamás Terestyéni's research to see how contents related to Roma studies changed in textbooks since Terestyéni's study. While Terestyéni focused exclusively on secondary school history and civic studies textbooks, the members of MONITOR included ethics textbooks and extended their analysis to primary school textbooks as well. A total of 53 textbooks were analysed (compared to the 83 materials examined in Terestyéni's research), which highlighted the reduction in the range of textbooks regulated by the official textbook list defined for the 2013/2014 academic year by the then newly introduced 2012 National Core Curriculum (hereinafter NCC). The members of MONITOR applied Terestyéni's quantitative and qualitative methodology, and found that 30 out of the 53 (56.6%) textbooks contained text segments related to the Roma population. This result indicates an improving trend compared to Terestyéni's research. Additionally, they found that the sections related to the Roma consisted of at least two to three paragraphs or longer in 22 of the 30 textbooks (see Table 3). Taking a glance at the table perfectly highlights a significant increase in quantity over the decade since Terestyéni's study.

[6]An open workshop and critical platform established by students of art theory at the Hungarian University of Fine Arts

Table 3.
The length of Roma-related text segments in textbooks (absolute numbers)

Length	Quantity	
	Terestyéni (2002)	Balázs et al. (2014)
1 sentence	7	6
1 paragraph	6	2
2-3 paragraphs	6	10
Longer	2	12
All textbooks addressing the Roma	21	30

Note. Created by the author. Source: Balázs et al. (2014)

In addition to the main texts, the members of the MONITOR group also examined textbook appendices related to the Roma, which was a new aspect compared to Terestyéni's study. They found that the analysed textbooks contained 30 optional learning materials, points of interest or reading excerpts; 14 tables, graphs, diagrams or maps; and 13 photographs, images and illustrations.

Out of the textbooks that address the history of the Roma, more than half included some form of reference to the size of the Roma population; however, much fewer contained information on the geographical distribution of the Roma in Hungary. Approximately a third of the textbooks addressed the origin and linguistic status of the Roma; the history of the Roma in Hungary was addressed in a similar quantity, although the sections were rather unevenly distributed across the major historical periods. A little less than half of the textbooks addressed the social conditions of the Roma, and the relationship between the Roma minority and the Majority population. It is important to note that the majority of these segments addressed this in historical contexts; only a few textbooks contained discussions about the issue in a contemporary context (meaning after the regime change of 1990). The majority of thematic content related to the Roma focused on Roma culture; however, this was limited to a few sentences, mainly about Roma music and musicians (see Table 4).
Despite the positive trends and improvements regarding the quantity and accuracy of content related to the Roma, the conclusion remains that the examined educational resources still failed to promote a comprehensive understanding of the history, social conditions and culture of the Roma, and did not contribute meaningfully to the deconstruction of prejudices and stereotypes (Balázs et al., 2014).

Table 4.
Main themes of texts addressing the Roma (absolute numbers)

Theme	Mentions	
	Terestyéni (2002)	Balázs et al. (2014)
Size of the Roma population in Hungary	9	17
Geographical distribution of the Roma in Hungary	3	11
Origin of the Roma	1	10
Linguistic status of the Roma	1	10
History of the Roma within Hungary	19	10
Social conditions of the Roma	8	12
Roma culture and way of life	8	21
Relationship Between the Roma minority and the Majority population	11	11
All textbooks addressing the Roma	21	30

Note. Created by the author. Source: Balázs et al. (2014)

Roma Representation in Curricula and Pilot Textbooks. Studies, Analyses and Recommendations (Binder & Pálos, 2016)

The aim of the study by Mátyás Binder and Dóra Pálos (2016) was to examine the representation of the Roma in materials used in public education. The study focused on the experimental, new generation textbooks, workbooks and text collections published by the Hungarian Institute for Educational Research and Development. In contrast to previous research (Balázs et al., 2014; Terestyéni, 2004, 2005), along with history and civic/social studies and ethics textbooks, the study by Binder and Pálos included Hungarian language and literature, and Hungarian cultural and folk studies textbooks as well. A total of 47 educational materials, along with the relevant framework curricula, were analysed based on a pre-defined set of criteria (see Table 5). In addition to examining what can be found in the textbooks (explicit content), the study also analysed how these contents were presented, assessing proportionality and credibility in comparison to other educational materials and the available scholarly knowledge on the Roma. Furthermore, they also examined the hidden meanings (implicit content) in the textbooks.

During the analysis of the findings, three sets of issues were identified. First, the authors focused on methodological and pedagogical issues that may hinder the effective processing and integration of the presented content. The second issue examined was the academic quality of the curricular content, focusing on the extent to which information presented about Roma communities aligned with contemporary scholarly literature. The third problem area was intercultural perspective; along with explicit content, implicit (hidden/unspoken) meanings were also examined.

The authors found that Roma communities were significantly underrepresented in the experimental textbooks and workbooks in terms of source- and activity-based approaches. They observed that according to the indications included in the textbooks, the majority of texts related to the Roma (28 texts or text excerpts) were part of the main curriculum, while the remaining related texts (18 texts or text excerpts) were designated as supplementary materials. This proportion could be seen as a cause for optimism, especially considering that the framework curricula of the time did not include graduation requirements related to Roma communities. There are opportunities to represent the Roma population in historic periods under the theme of nationalities; however, this was not mandated by the regulatory documents responsible for content standards. Including other than the worst and most difficult periods of the Roma history in textbooks would have been essential for a nuanced representation of the Roma. The authors found that some textbook developers may have recognized this issue, as a significantly larger amount of Roma studies-related content was included in textbooks compared to the amount required by the regulations. In their view, the positive increase in quantity was uneven and insufficient in several respects. An important part of the authors' research was to formulate opportunities, recommendations and ideas for development related to the analysed materials based on the experiences gained during the research, which could aid history teachers in their everyday high-quality work when educating students in themes related to the Roma.

Table 5.
The set of criteria used by Mátyás Binder and Dóra Pálos

Set of criteria
1 Quantity/proportionality
2 Quality
2.1 Scholarly quality
2.2 Quality of visual representation
2.3 Other supplementary materials
3 Representation
3.1 Chronological placement of Roma representation
3.2 Integrated content or separate chapter?
3.3 Are there related activities, or only knowledge transmission?
3.4 Mandatory or supplementary/informative material?
4 Relevance (alignment with age-specific cognitive abilities and cross-curricular knowledge)
5. Comprehensibility (cross-subject reinforcement or conflict)

Note. Source: Binder and Pálos (2016, p. 5)

"The Representation of the Roma Culture in Content Regulators and Educational Content, and Possibilities for their Improvement" (Orsós, 2016, p. 10)

In 2015, a comprehensive textbook analysis study led by Anna Orsós was conducted at the Department of Roma Studies and Educational Sociology, Institute of Educational Sciences, Faculty of Humanities and Social Sciences, University of Pécs.[7] The aim of the research was to examine whether the newly developed, new generation, experimental textbooks,

[7] „A roma kultúra reprezentációja a tartalomszabályozók, tartalomhordozók körében, valamint ezek fejlesztési lehetőségei"/„Representation of the Roma in curriculum regulators and educational materials and possible opportunities for development" (TÁMOP-3.1.15-14-2014-0001; Cserti Csapó, 2021, p. 109)

workbooks and text collections represented the Roma, and if so, in what ways. Another goal of the study was to observe whether, during their public education, students were provided knowledge about ethnic minorities from textbooks, particularly focusing on the Roma, and to assess the extent to which the analysed educational materials contributed to the social inclusion and acceptance of the Roma (Orsós, 2016). Consulting theoretical experts and practicing teachers about the goals and outcomes of previous developments related to the theme of the research, along with potential directions for future improvements, was an important part of the research (Orsós, 2015). New generation textbooks, workbooks and text collections published by the Hungarian Institute for Educational Research and Development were analysed, just as materials published by Nemzedékek Tudása Tankönyvkiadó, and Apácai Kiadó (two textbook publishers). The analysed materials were all based on the 2012 NCC and its corresponding framework curricula. A total of 258 materials were examined. Compared to previous studies, the range of subjects included was significantly broader, covering the 5 areas of competence outlined by the NCC: mother tongue and literature (Hungarian grammar and literature), humanity and society (history and ethics), humanity and the environment (sciences and environmental studies), the Earth and nature(geography), arts (music, visual culture). The analysis was conducted using a pre-developed research instrument that examined the contents of the textbooks, along with the complementary images and figures, through both quantitative and qualitative approaches. The instrument focused on the primary issue of the research, which was to discover whether the examined textbooks/workbooks/text collections contained content related to the Roma or not (Orsós, 2016). The research also included the recording and analysis of interviews conducted with experts (Orsós, 2015). The researchers found that out of the 258 materials, only 67 (26%) contained knowledge related to Roma studies. In cases where the examined textbook/workbook/text collection did not include any information related to the Roma, the authors assessed the possibility of including such content in the given material and made recommendations in all such cases, based on the results. The groups involved in the research deemed the inclusion of Roma-related content possible in 141 (72% of all materials examined) out of the 195 cases where no Roma-related text or image was included. Regarding the themes that appear in the materials, it was found that elements of the Roma culture were the most common theme (appearing in 49% of the materials), followed by information about the Social condition of the Roma. The third most frequent group of themes included demographic data, including geographical distribution and educational indicators of the Roma population. The history, linguistic status or other Roma-related themes were less frequently discussed. In the 67 textbooks that contained Roma studies content, 49 images related to the ethnic group of interest of this paper were found. Out of the 49 images, 27 (more than half) were illustrative but also corresponded with the given educational content. In approximately 20% of cases, however, the images served only illustrative purposes and were not related to the content at all. It was also found that the textbooks containing Roma-related content often included information or images that were either without functionality or prone to stereotyping. An important part of the research was to explore how frequently different, more and less politically correct terms that refer to the Roma appeared in the texts, and to assess if the contexts in which the terms appeared had positive, negative or neutral connotations. *„After examining the frequency of the terms "cigány (gipsy)" and "roma", it can be concluded that "cigány" appeared significantly more frequently (95%)."* (Orsós, 2016, p. 19) It was found that the terminology used to refer to the Roma was not consistent: The authors of the textbooks used the terms „cigány" and roma" often interchangeably as synonyms. The researchers emphasized that the terminology used in textbooks needs to be standardized and made consistent (Orsós, 2016). Regarding the contexts in which these terms were used, the following was concluded: "*In the* *majority of cases the lexeme "cigány" was used in neutral contexts; in the remaining cases, it appeared in a positive context, just as much as in a negative one. The term "roma" was used either in a neutral or a negative context, with almost no positive connotation, considering that it appeared in a positive context only in one case throughout all materials examined."* (Orsós, 2016, p. 20)

As concluded by the researchers, based on the very limited accurate Roma studies content found in only a small percentage of the textbooks of the time, the image that could be formed about the Roma was very narrow and far from reassuring (Orsós, 2015, 2016). In the following, the results of the research groups involved will be reviewed following the 5 main areas of competence outlined by the NCC.

Mother Tongue and Literature

The researchers found (Orsós, 2015) that Roma studies content was extremely underrepresented in the 1-3 grade Hungarian grammar and literature textbooks. The textbooks for grades 1 and 3 did not include any information about the Roma, and only three grade 2 textbooks contained such content.

Materials for grades 5-8 only partially met the goals and task requirements set by the NCC and the corresponding framework curricula. The grade 5 and 8 Hungarian grammar textbooks contained some well-intentioned efforts to include linguistic representations for the Roma, however, the number of these efforts was negligible.

In secondary school (grades 9-12) Hungarian literature textbooks, Roma representation was scarcely present in the texts. In terms of visual content, references to the Roma were also limited, serving only illustrative and decorative purposes. In the Hungarian grammar textbooks published for grades 9-12, Roma studies content was absent or appeared only to a negligible extent. Out of the 14 educational materials examined, only two mentioned the Roma communities, in both cases in contexts either with no functionality or prone to stereotyping (Orsós, 2015).

Humanity and Society

The researchers found (Orsós, 2015) that history textbooks for grades 5-8 were overly focused on politics and prominent individuals, while giving little attention to social history. It can be stated that the history subject is based predominantly on written sources, which results in Roma history being largely excluded from secondary school (grades 9-12) history education. Since the Roma communities had no literate individuals of their own for many centuries, their unique and distinctive history essentially remained obscure, and without their system of values and cultural agency, the Roma did not become integrated into the Hungarian historical collective consciousness (Orsós, 2015). Our knowledge of the internal history of the Roma, in the traditional sense, is relatively limited. The knowledge we have extends mostly to what others wrote about the Roma, however, being represented only by others has the danger and difficulty of only the extremes (aggressors or victims) being portrayed. For students from the majority, these history textbooks may have implied the message that Roma people had no important or significant role in Hungarian history or did not contribute to nation-building (i.e., in forming the state); instead, they are portrayed as outsiders in society, primarily associated with conflicts. The examined materials did not include any universal history content related to the Roma (Orsós, 2015).

Roma culture was scarcely represented in the content of lower primary school (grades 1-4) ethics textbooks. In upper primary school (grades 5-8) textbooks, sections addressing the Roma more extensively appeared only in the grade 6 curriculum, with no prior coverage in the grade 5 or continuation in the grade 7 or 8 curricula (Orsós, 2015).

Humanity and the Environment

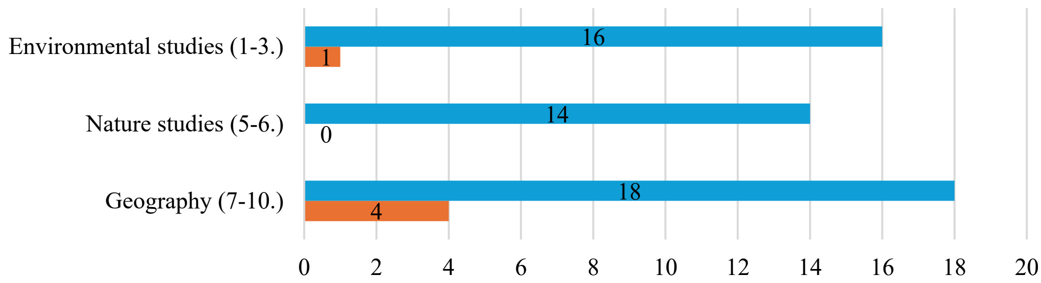
The sciences and environmental studies framework curricula did not include any mandatory requirements related to the Roma. Out of the 16 environmental studies materials (grades 1-3) examined, Roma-related content was present only in one case, in the form of an image. Environmental studies materials for grades 5-8 did not include any content related to the Roma in any form (Andl & Cserti Csapó, 2017; Orsós, 2015). The researchers found that the educational materials contained very little information about Roma communities, and related content was absent even in places where such content could have been evidently included. According to the group of researchers, relevant Roma studies content could have been appropriately integrated in 28 of the 30 textbooks examined (Andl & Cserti Csapó, 2017).

The Earth and Nature

In the case of the research group examining geography educational materials, the research process consisted of two phases. The first phase included the analysis of materials, followed by the exploration of the potential for development in the examined materials, and the formulation of recommendations for necessary changes (Cserti Csapó, 2021). The initial analysis of the textbooks resulted in very negative findings. Only a limited number of the examined materials (4 out of the 18 publications) included relevant content; however, these were, without exception, either inaccurate or limited to underdeveloped and superficial information, thereby posing the risk of reinforcing thinking based on stereotypes. Out of all the materials examined, only 28% contained Roma-related information, therefore, it can be concluded that geography textbooks underperformed in this regard, especially considering the fact that only in 22% of the cases was knowledge related to geography included (Cserti Csapó, 2016). Geography textbooks for grades 7 and 8 failed to meet the objectives and requirements set by the NCC, the corresponding framework curricula and the targeted areas of competence for development. The majority of secondary school textbooks published for grades 9 and 10 did not contain information in sufficient detail. The researchers found that the examined educational materials contained very little information about Roma communities, and related content was absent even in places where such content could have been evidently included (Andl & Cserti Csapó, 2017).

Compared to the sample from the whole research where the lexeme “cigány (gypsy)” was used more frequently (95%) than the term “roma”, geography educational materials, in contrast, used the more politically correct term, „roma”, in 50% of the cases. 80% of the references related to the Roma were classified as objective and neutral, the risk of reinforcing stereotypes was present in only one instance. The second phase of the research involved the review of the textbooks revised according to the given recommendations. The received revised materials contained significant improvements and positive changes. The number of sections containing information related to ethnicities, and the Roma in particular, has seen a growth. In terms of quality, students received more nuanced, informative and contextually framed knowledge. In the second phase, alongside the still prevalent objective mentions (85%), more positive thoughts and statements reinforcing the values of the Roma (15%) have appeared (Andl & Cserti Csapó, 2017; Cserti Csapó, 2021).

Figure 1.
Showing the ratio of information related to Roma environmental studies, nature studies and geography textbooks



	Geography (7-10.)	Nature studies (5-6.)	Environmental studies (1-3.)
All textbooks	18	14	16
Textbooks addressing the Roma	4	0	1

Note. Created by the author. Sources: Andl and Cserti Csapó (2017); Cserti Csapó (2016, 2021); Orsós (2015)

Arts

There was no trace of representation of the Roma culture in music textbooks, not even in contexts that are widely recognized to be related to Roma musical heritage, such as the verbunkos (a Hungarian folk dance) or information related to certain instruments and Hungarian folk songs. A positive finding was the fact that the music textbooks did not contain any direct references to the Roma in negative contexts.

The structure of visual culture (art) textbooks often did not allow for the inclusion of Roma-related content, as, according to the researchers, it would have had a counterproductive effect.

Ethnic Minority Ethnography Textbooks (Tibor Cserti Csapó, 2023a, 2023b, 2023c, 2023d)

A total of 16 ethnic minority ethnography textbooks (published between 2000-2021) were analysed, 14 of which were textbooks, and two were workbooks. Some of these materials have since been withdrawn from circulation due to problematic content or approach, and there are some that are still being used today (Cserti Csapó, 2023b). The researchers found that the textbooks rather reflected the authors' naive perspectives, closer to popular science, and contained scientifically unsubstantiated and questionable ideas and claims (Cserti Csapó, 2023a). It can be concluded that the development of ethnic minority ethnography textbooks faces numerous challenges, and their content often falls short of expectations (Cserti Csapó, 2023c). The textbooks often echoed superficial stereotypes deeply embedded in public consciousness. 6 main issues were identified:

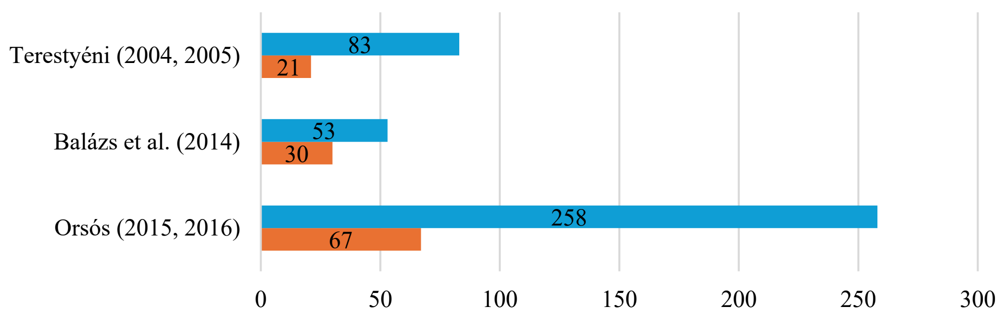
„1) Emphasis on the static nature of Roma occupations
2) Inadequate professional presentation of the occupations of the Oláh Roma tribes
3) Overemphasis on the fact that the Roma community, which previously had a diverse occupational structure in the Carpathian Basin, has been pushed to the margins of society, confined to menial jobs

4) Foundational works are not used, or at least not properly cited. Where citations are included, the name of György Rostás-Farkas, who, rather than a researcher, entered the domestic ethnographic canon as an author of popular writings, often appears
5) The generalized and essentialist claims raise doubts in critical readers
6) Fragmentary historical texts are used as sources as if the occupations mentioned in said texts were common in the respective periods" (Cserti Csapó, 2023d, pp. 187-196).

Conclusion

The findings from the Roma studies-related analysis of educational materials painted a rather concerning picture around a decade ago. Research has clearly highlighted that the Roma-related content in textbooks, workbooks and text collections were in need of further revision and supplementation in various regards. Beyond the results found so far (see Figure 2), further quantitative and qualitative improvements were necessary in textbooks to ensure that students in public education could engage with the culture, history and customs of Roma communities in a multi-perspective and nuanced manner. 10 years have passed since the research conducted by the group of researchers at the Department of Roma Studies and Educational Sociology, Institute of Educational Sciences, Faculty of Humanities and Social Sciences, University of Pécs. In order to learn what positive and/or negative changes have taken place since then in the materials widely used in public education, conducting research of similar scope would be necessary. In my view, the Roma-related content in the textbooks for individual subjects can significantly contribute to (or hinder) the development of inclusive or prejudiced attitudes towards the Roma people. In order to break stereotypes about the Roma, simply increasing the quantity of Roma-related content is not enough; the content has to contain accurate and scientifically validated information. Previous research has highlighted both quantitative and qualitative issues. In my opinion, besides improving textbooks, properly training teachers working in public education to teach such socially sensitive themes is essential and would be the responsibility of teacher training programmes of universities and in-service teacher training courses.

Figure 2.
Showing the ratio of the materials containing Roma studies-related content based on the various studies



	Orsós (2015, 2016)	Balázs et al. (2014)	Terestyéni (2004, 2005)
All textbooks	258	53	83
Textbooks addressing the Roma	67	30	21

Note. Created by the author. Sources: Balázs et al. (2014); Orsós (2015, 2016); Terestyéni (2004, 2005)

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Bálint Borbándi – PhD Student
borbandi.balint98@gmail.com
ORCID ID: 0009-0002-0931-907X

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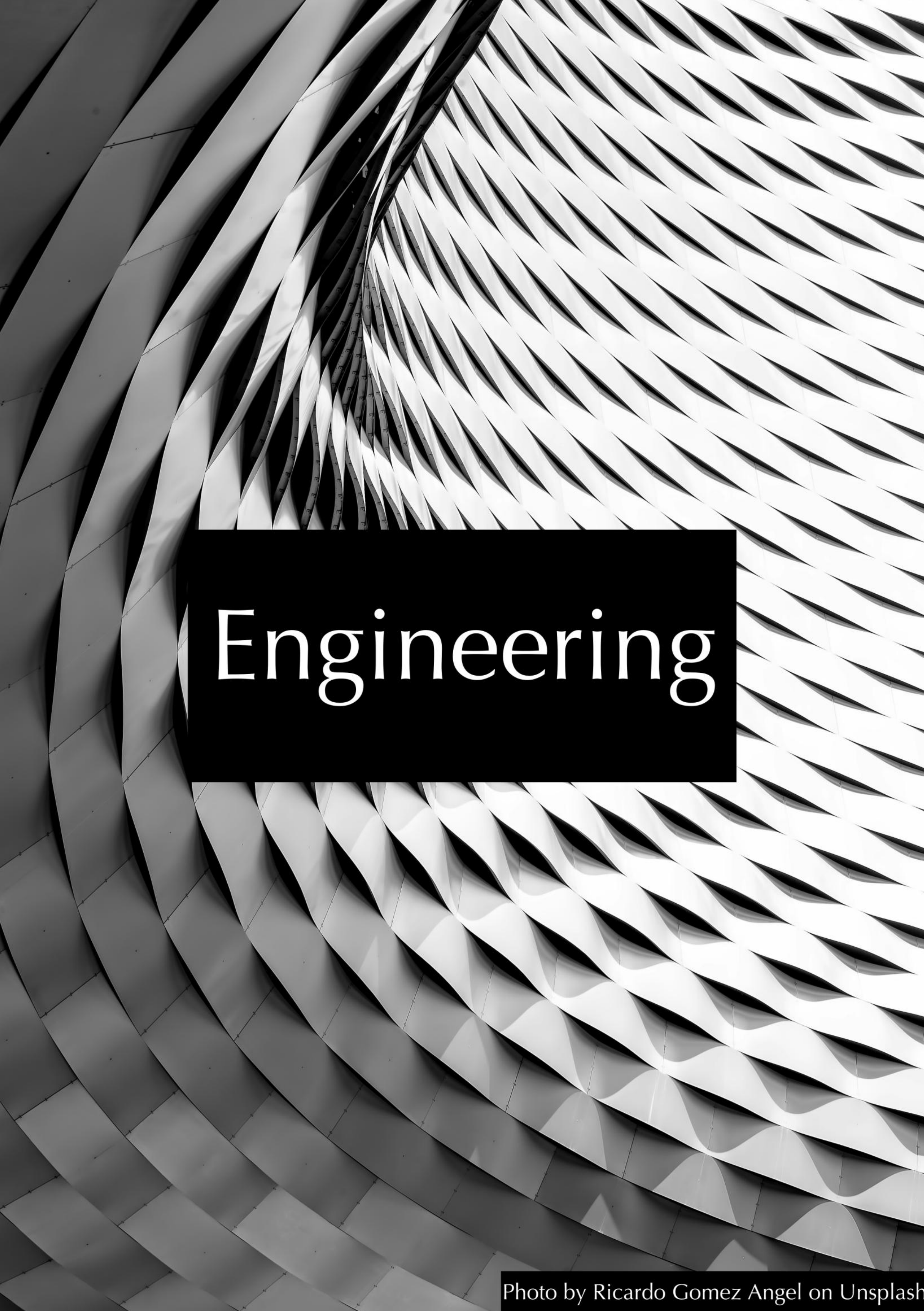

Engineering

Photo by Ricardo Gomez Angel on Unsplash

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Where to Next, Architecture?

The Role of Artificial Intelligence in Contemporary Hungarian Architectural Practice

Norbert Dudás
Faculty of Engineering and Information Technology, University of Pécs

ABSTRACT

Artificial intelligence (AI) has become one of the most rapidly evolving technologies in recent years, increasingly influencing creative industries such as architecture. This paper explores the integration of AI into architectural design, focusing on its opportunities, challenges, and the extent to which it has been adopted in professional practice and architectural education in Hungary. The research utilizes a quantitative approach through a questionnaire survey to examine the attitudes of architecture students and professionals towards AI, as well as the awareness and use of such technologies in architectural workflows. Furthermore, the study presents a comparative analysis of three design software tools—Archicad 28, the Veras AI plugin for SketchUp, and TwinMotion—highlighting the technical features and potential applications of AI-assisted design. The central aim is to understand the impact of AI on architectural processes, with particular attention to automation, visualization, and the relationship between technology and creativity.

Keywords: architecture, architectural visualization, artificial intelligence, AI, future

Introduction and Justification of Topic Selection

Artificial Intelligence (AI) has become one of the most rapidly developing technological fields over the past decade, revolutionizing not only the scientific community but also everyday life and the world of work. Today, AI applications appear in nearly every industry, including healthcare, automotive, finance, as well as creative sectors such as architecture and design (Cudzik & Radziszewski, 2018). The advantages of AI include speed, efficiency, and support in solving complex problems, offering opportunities for innovation and increased productivity (Stanislas, 2022).

Artificial Intelligence refers to machines possessing human-like capabilities such as reasoning, learning, planning, and creativity. It enables technology to perceive its environment, process what it senses, solve problems, and plan its actions to achieve specific goals. A computer not only receives data—whether preprocessed or gathered through sensors like cameras—but also processes and reacts to it. These systems are capable of modifying their behavior to some extent by analyzing the outcomes of previous actions and working autonomously.

Architecture is a particularly exciting domain for AI applications, as it relies simultaneously on creative imagination and analytical thinking. Architects increasingly use AI-based tools that provide significant assistance not only in visualization and cost estimation but also in developing innovative design solutions (Tsigkari, 2021). However, the rise of this technology also raises important questions regarding ethics, workforce transformation, and the future of the architectural profession.

The expansion of AI brings not only opportunities but also challenges. A common concern is that AI may automate tasks traditionally requiring human labor. This raises the question of whether technology can fully replace human creativity and intuition—fundamental elements of architecture.

The aim of my research is to examine the extent to which AI's potential is being harnessed within the architectural profession in Hungary, and what attitudes this technology evokes. Do professionals view AI with apprehension or openness? How does this attitude differ across generations? To what degree is AI usage widespread, and what practical experiences do domestic professionals report? I hypothesize that younger generations are more receptive to AI, having grown up in environments where digital tools and technologies are integral to daily life. For them, AI is not a threatening unknown but an innovative tool that can facilitate and enhance their work.

The quantitative research underpinning this thesis collected data from over 250 respondents, including architecture students and active professionals. This broad sampling provided an opportunity to obtain a comprehensive view of the profession's future and to draw well-founded conclusions regarding attitudes and experiences related to AI applications.

In the second part of the thesis, I analyze two software programs that are particularly popular in architectural design and feature AI-based functionalities: the latest version (28) of Archicad and the most recent release of SketchUp. The goal of this analysis is to gain deeper insight into the operation of AI-supported features and to investigate how these technologies assist architects in their daily workflows, especially in visualization.

Particular emphasis is placed on evaluating the effectiveness of these tools in creating visual renderings and their capacity to approximate results traditionally achieved by human effort. To this end, I compare the AI capabilities of these programs with TwinMotion, a conventionally used software that requires more manual editing. The analysis considers workflow speed, command complexity, as well as the aesthetic and technical quality of the resulting visualizations.

My hypothesis is that although AI-based solutions have undergone significant development, they are not yet capable of fully replacing the creative and professional work of architects. For example, while AI excels at performing certain repetitive tasks quickly or generating visualizations based on parameters, the assembly and fine-tuning of commands may still be more time-consuming than producing manually edited renderings by an experienced architect.

Results of the Quantitative Research

During the literature review, it became evident that there are very few studies available in Hungarian that address the relationship between artificial intelligence and architecture. Therefore, this study primarily relies on English-language literature for its theoretical foundation.

The aim of my research is to provide relevant data on how Hungarian architecture students and professionals perceive the application of artificial intelligence, as well as to assess the impact of this technology on architectural workflows and the future of the profession.

The research was conducted using online questionnaires, which were distributed via social media and digital platforms such as Facebook, Messenger, Teams, and email. The questionnaire consisted of 15 questions, primarily in multiple-choice format, with opportunities for respondents to provide individual answers as well. A total of 252 participants completed the survey, all of whom are currently or have previously attended universities in Hungary. Among respondents, 49.6% identified as female, 49.6% as male, and only 0.8% did not disclose their gender. The majority of responses came from individuals aged between 18 and 27 years. The average age of participants was 24.76 years.

In the continuation of the research, one of the questions aimed to identify which higher education institutions the respondents attended. To ensure broad coverage, I endeavored to involve as many diverse institutions as possible in order to obtain the most objective results. I personally emailed the Academic Departments of the universities and contacted the Student Governments of all universities via messages to request their assistance in facilitating the research. Despite these efforts, the willingness to participate remained low among architecture students. The number of respondents was relatively small compared to the overall student population enrolled in these programs, which can be partly attributed to passivity and partly to the lack of time allocated for completing such questionnaires. This experience highlights the potential need for introducing further incentives or employing alternative approaches to improve the effectiveness of similar studies.

Based on the responses, the largest proportion of participants—over 42.1%—were students from the University of Pécs, followed by 25.4% from the Budapest University of Technology and Economics, 13.9% from Óbuda University, 8.3% from the University of Debrecen, and 7.5% from Széchényi István University. The remaining respondents attend or attended various other institutions offering architecture programs.

The overwhelming majority of respondents, 81.0% (200 individuals), are currently actively enrolled in architectural education. This indicates that the research results primarily reflect the experiences and perspectives of current students.

In response to the question of whether the participants have ever used artificial intelligence-based tools for any activity, 186 respondents answered affirmatively, while 59 indicated that they had not used AI. This clearly reflects that AI tools are playing an increasingly significant role in the academic, professional, and even personal lives of the respondents.

One of the most frequently mentioned tools was ChatGPT, primarily used for rapid text generation, idea brainstorming, and academic support. Its popularity can be attributed to its ease of use and versatile applications. Equally prominent was the use of Photoshop's AI-powered features, which respondents mostly tried for image editing and visualization purposes. Functions such as intelligent object selection or automatic background removal significantly accelerate creative workflows. The tool Midjourney was also often mentioned; accessed via the Discord platform, it is used to generate artistic concepts by providing prompts or instructions. This tool was particularly favored by respondents seeking fast and innovative solutions for the visual representation of their designs.

An interesting finding was that although artificial intelligence has been present in our lives for a long time and is continuously evolving, 80.6% of respondents reported not having studied it during their university education, while only 15.9% had. This indicates that although AI tools are increasingly accessible and widespread in professional environments, their integration into university curricula and student knowledge remains quite limited. The high level of unfamiliarity suggests that educational institutions likely need to introduce AI-based materials and courses to better prepare future professionals to effectively utilize these new technologies in their work. As stated in the study by Husain and Nia (2023): In this era of development, it has become essential to promote a new generation of architects who are well-versed in the tools and trends shaping both the present and the future (Husam et al., 2023).

Opinions on artificial intelligence varied widely, reflecting the diverse perceptions of technology. Many respondents emphasized that AI is a useful and time-saving tool that can significantly ease repetitive, tedious, or lengthy workflows. This is especially important in design and analysis processes, where AI can accelerate work and increase accuracy. Numerous participants stressed that mastering the use of AI today can provide a serious advantage, yet they also noted that educational institutions do not devote sufficient attention to introducing and teaching this technology. As a result, the use of AI tools largely depends on individual initiative, requiring self-directed learning and practice.

Among the responses, critical voices also emerged. Some expressed concerns that excessive AI use could lead to societal "dumbing down": "It can be very useful in certain situations, but unfortunately, many people use it instead of thinking, which I believe leads to the dumbing down of society." Others criticized its impact on artistic and creative work, arguing that AI cannot replace human creativity and emotions, which form the foundation of art: "It should be applied to serial, assembly-line, programmable monotonous workflows and tasks, not to creative or human soul-touching work, or art." However, more positive perspectives were also present, especially regarding visualization, where the benefits of AI were highlighted: "It helps make visualizations more realistic and can be used for many other things as well." While many recognize numerous possibilities in AI, opinions suggest that significant development is still needed for it to provide truly comprehensive and effective solutions. Several respondents emphasized that AI tools currently play mostly a supplementary role, and their applications remain limited: "It can be useful but still requires a lot of development."

Participants were asked to rate on a five-point scale how much they fear losing their jobs due to the spread of artificial intelligence. The answers revealed an interesting picture, particularly considering that in face-to-face conversations with friends, classmates, and acquaintances, I often heard pessimistic views. Many believed that in about ten years, AI would completely dominate the market, leading society toward dramatically increased unemployment due to automation. However, respondents also mentioned in the questionnaire that they expect job roles to transform; they generally emphasized that AI would assist in design rather than take over entirely, as, for example, an AI cannot assume responsibility for a given project. The data further indicates that neither those under 30 nor older respondents expressed significant fear of this possibility. Those who argued that creativity diminishes with the use of AI tools often pointed out that these technologies tend to offer formulaic solutions, which may suppress individual and original ideas. Some responses suggest that the fear of a decline in human creativity stems from AI prioritizing faster and more efficient workflows, sometimes at the expense of attention to detail and innovation.

Conversely, those who believe AI does not reduce creativity argued that these tools rather complement and support human creativity. Many emphasized that AI's primary role is to automate time- and energy-consuming processes, thereby freeing up more space for creative thinking and the pursuit of unique solutions.

Uncertain responses indicate that the impact of AI on creativity largely depends on how and in what context it is applied. This group of respondents believes that a precise assessment of AI's influence on creativity is yet to be determined, and future developments will be crucial in shaping this understanding.

Architectural Software with Artificial Intelligence

In the second part of this thesis, I analyze two design software programs that incorporate artificial intelligence-based features and are widely used in everyday architectural workflows. These two programs are Archicad version 28 and the latest release of SketchUp. In the analysis, I demonstrate how AI can be applied within these software, and then compare the resulting renderings with a manually created visualization using TwinMotion, with particular focus on efficiency, time investment, and the quality of the final outcome.

AI Integration in Archicad 28

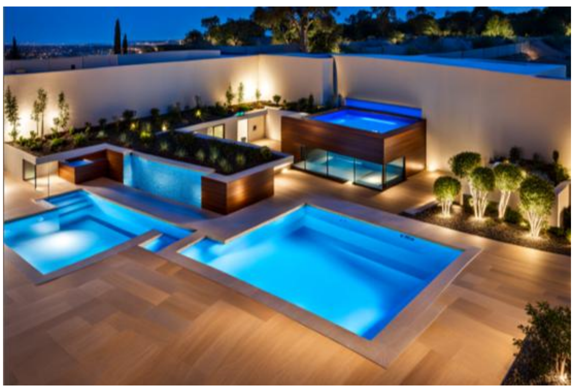
Archicad 28 is a software well-known to almost everyone in Hungarian architecture, even if not all use it on a daily basis. While AI functions required a separate add-on in version 27, they are included by default in version 28. The feature called AI Visualiser can be easily found under the "Window" menu in the "Palettes" option, providing users with simple and quick access.

After entering the appropriate prompts, the user can fine-tune a number of additional settings. For example, they can specify the desired level of creativity in the generated content, adjust the image resolution, set the number of iterations, and control how much the final result deviates from the original prompt guidelines. These options significantly contribute to creating a personalized final output.

Figure 1
Input model

After creating a mass model, this command generated an impressive visual rendering in just 10 minutes. The prompt included the following instructions: "Design a modern, minimalist building with clean geometric forms and smooth surfaces. Emphasize the use of natural materials such as glass, metal, and concrete. Surround the building with lush greenery. Incorporate elegant lighting, including hidden LED strips and warm-toned accent lighting, to enhance the design's sophistication and create a welcoming atmosphere." Although the tool can be used in Hungarian as well, the results tend to be significantly more accurate when the prompt is given in English.

Figure 2
Image generated based on prompts in Archicad 28



Both the outcome and the analysis clearly show that the AI did execute the given prompts; however, it paid less attention to the designed massing and spatial arrangement. While the textures, material usage, and lighting align well with the instructions, the building's proportions and the placement within its environment do not fully reflect the intended concept. It is also important to highlight that, from another perspective, even when using the exact same prompts, the AI is unable to produce an identical result.

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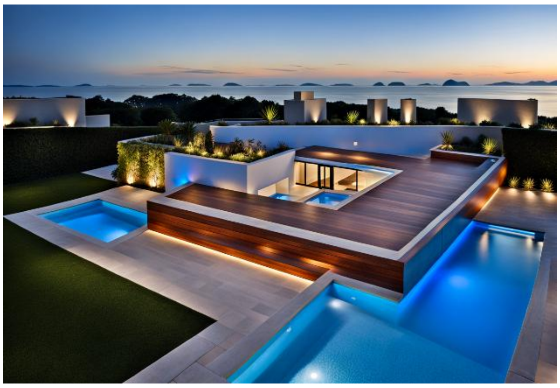
Figure 3
Rendered image generated by the „AI Visualiser" commands from a different angle



AI is not yet fully capable of taking into account architectural design principles such as spatial relationships, massing, and the integration of the building with its environment. This suggests that while AI can quickly generate aesthetic visualizations, deeper design decisions related to functionality and spatial structure still require human expertise.

EvolveLAB Veras AI plugin in SketchUp

Unlike Archicad, SketchUp does not have built-in artificial intelligence features by default. To use AI functions, a separate plugin must be downloaded. In my case, I chose the free EvolveLAB Veras plugin, which became immediately available in the Toolbar after installation. It is easy to use, requiring just one click to display the various options. Since I worked with the free version, I did not have the option to set different styles or themes, such as "Timber Autumn Realistic," "Creative Watercolor," or "Winter Cabin Creative."

In the free version, it was only possible to create visualizations based on text commands. Similar to Archicad, the same functions can be adjusted here as well, such as the level of creativity, image resolution, and the number of iterations. Using the previous commands, the AI generated the following visualization:

Figure 4
AI visualization generated by EvolveLAB Veras using the same commands

It is noticeable that, similarly to the AI in Archicad, this AI also does not take the already designed model into account. It removed the windows, replaced the green roof with a pool, and made other changes that differ from the original design. The program does not preserve the details of the original structure, meaning that the fundamental forms and elements of the designed building are significantly altered. Furthermore, even if we rotate the model and create a visualization from another angle, the AI does not remember the previously set image. As a result, we do not get the same outcome; the visual representation always restarts, and the views are not consistent. This also highlights that although the AI generates images quickly, its ability to fully understand and consistently manage the context of the entire project is still imperfect.

Comparison of TwinMotion and the Two AI-Enabled Programs

A question may arise as to whether creating a visualization with the help of AI is faster. Based on my experience, I concluded that it is not. Although AI generates images quickly, it takes much more time to achieve the desired result because the program often has to restart the image and does not always retain previous settings. Fine-tuning the AI-generated images, repeatedly adjusting parameters, and correcting possible errors can consume a significant amount of time. Moreover, achieving the desired level of precision—such as accurately representing a pre-designed building—still requires considerable manual intervention. Therefore, overall, AI is not necessarily a faster alternative if the quality of the result and the fidelity of the model are the main priorities.

Figure 5
Visualization created with TwinMotion

AI can be an ideal tool for creating various conceptual diagrams, rapid brainstorming, and generating visual foundations. However, for the final project visualization, human intervention remains crucial to ensure that details, modeling, and aesthetic aspects truly meet high-quality standards. In its current state, artificial intelligence functions more as a complementary tool rather than a solution that replaces the entire design process.

Conclusions

Artificial intelligence (AI) and its tools are playing an increasingly significant role in various areas of everyday life, including education, professional practice, and personal use. The survey results clearly show that the majority of respondents—186 people—have already used AI-based tools for various activities, reflecting the widespread adoption and growing use of this technology. Particularly popular are tools such as ChatGPT, AI-supported features in Photoshop, and Midjourney, which offer significant advantages in different sectors like writing, image editing, and artistic design.

Among the benefits of AI-based tools, many respondents highlighted their time-saving nature, ease of use, and the role they play in speeding up work processes. AI tools are highly versatile, enabling the automation of repetitive tasks, accelerating creative processes, and improving design and analysis workflows. However, these tools have not yet become fully widespread in every field, and in the architectural profession, only smaller groups are currently using them. This is reflected by the fact that although many respondents recognize the potential of AI, many in architectural practice still do not use such tools or have not yet found those that could adequately support their work.

Opinions about AI tools are mixed. While many find them useful and time-saving, others expressed concerns about the excessive use of technology. One of the greatest concerns is that AI tools may suppress human creativity and overly mechanize workflows, which some respondents fear could lead to societal intellectual decline. Especially in creative work, it is noted that AI cannot replace human creativity, emotions, and experience, which are essential for artistic activities.

Respondents believe that AI will not necessarily completely replace human labor. The survey results indicate that although automation and AI use will spread, professionals think the human factor—such as responsibility—will remain necessary. AI is expected to play a complementary role, assisting people in their work but not replacing human decision-making and creativity.

The survey also highlights that knowledge of AI is still not widespread in university education. Most respondents—80.6%—did not study AI during their university studies, suggesting a significant lag in education compared to the technology's spread. This high knowledge gap and lack of technical skills signal that educational institutions should play a crucial role in AI education to better prepare future professionals for applying this technology.

Although AI tools are increasingly accessible in architecture and other fields, their use is not yet widespread everywhere, and knowledge and access can be limited. Many respondents rely on their own knowledge, especially in design tasks.

The integrated AI functions of Archicad 28 provide convenient access for users, while SketchUp requires a separate add-on. Both software's AI-based functions can quickly produce visual results, but do not respect the fundamental spatial and functional principles of the designed models. The generated visualizations are more like creative concept sketches than precise representations of architectural plans. AI's inconsistent results—such as ignoring building proportions, details, or environment—show that the technology is not yet capable of integrating complex design considerations. Currently, AI primarily functions as a supplementary tool that helps develop quick concepts and visual ideas. Human expertise remains indispensable for executing complex and detailed projects. Ideas generated by AI tools can serve as inspiration, but finalization still requires significant manual work.

Based on the analysis, the lack of AI education at universities and its limited adoption among architects can be partly explained by the current development stage of the technology and the limited application possibilities of available software. Although many recognize AI's potential, current tool usage does not yet provide significant benefits that would encourage widespread adoption in architectural practice.

Since I began exploring this topic, I have increasingly encountered content on Instagram and other social platforms showcasing AI applications in architecture. Many emphasize that AI significantly eases work and fundamentally transforms design processes. However, based on practical experience, I have not perceived this yet. I believe AI still needs considerable development to truly reach this level. It will likely take more than a decade for these tools to mature sufficiently. Even then, AI will not threaten architects' jobs but rather facilitate the design process by offering various suggestions to support creative decision-making.

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Norbert Dudás – Architectural Engineering BSc
dudas.norbert@pte.hu
ORCID ID: 0009-0004-3892-3115

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Optimizing Multi-Agent Collaboration with Genetic Algorithm in Wire Harness Assembly

Judit Horváth, András Darányi, Tamás Ruppert
Department of System Engineering, University of Pannonia

ABSTRACT

Wire harness assembly is a labor-intensive yet critical process in the automotive industry, requiring efficient and well-coordinated workflows. The assembly is carried out on boards where workers route wires through fixtures. On larger boards, hundreds of wires are assembled, often requiring multiple operators to work together. In this case, their work must be coordinated so that they can collaborate effectively without interfering with each other. This research focuses on optimizing task allocation to minimize total assembly time in multi-agent settings. Optimization considers individual performance differences between workers, as well as spatial factors—assembly tasks are generally faster in central areas and slower at the periphery. Furthermore, it distinguishes between operation types, such as the faster task of switching between wires versus the slower process of laying a wire along the board.

To solve this problem, we developed a genetic algorithm-based task assignment optimization algorithm that is applicable to any agent. The case study was based on a real assembly board with a custom layout, and we also created a visualization simulation and performed a lab demonstration.

Keywords: multi-agent collaboration, genetic algorithm optimization, wire harness assembly, multi-agent traveling salesman problem

Introduction

Wire harnesses play a crucial role in providing electrical connectivity throughout vehicles in the automotive industry. Despite significant advancements in automation technology, wire harness assembly remains a largely manual process. This is primarily due to the flexibility of the wires and the complexity of the assembly tasks (Navas-Reascos et al., 2022), both of which make robotic manipulation difficult.

Consequently, wire harnesses are assembled by human workers, often on large assembly boards. In such setups, collaboration among multiple workers is required. However, a lack of structured coordination can lead to inefficiency, such as long idle time while workers wait for others to finish their tasks. This highlights the need for methods that enable effective human collaboration during wire harness assembly, aiming to improve efficiency and minimize unnecessary idle time.

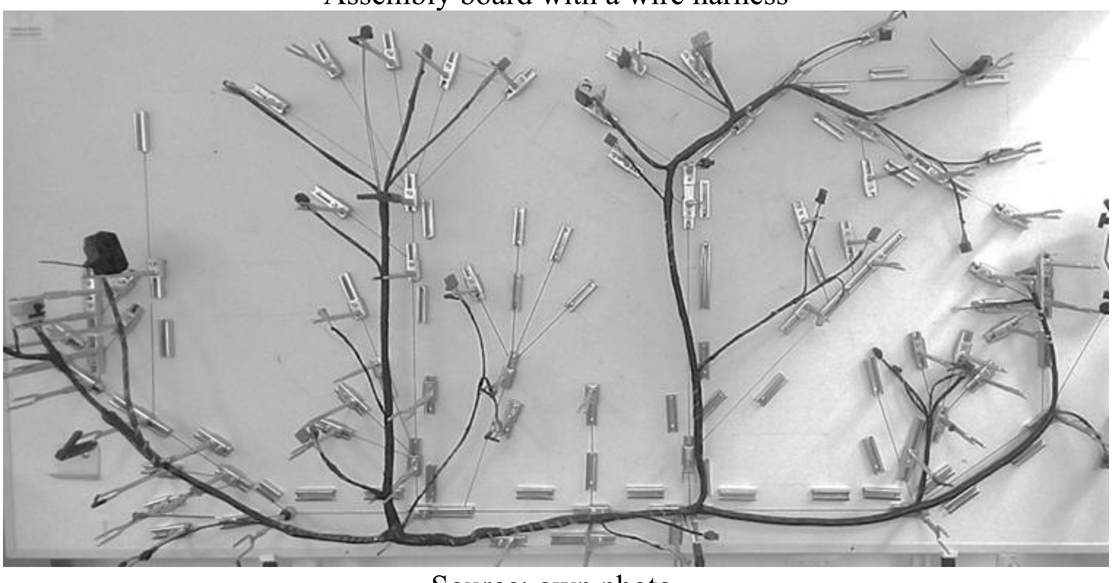
In response to this challenge, this work presents a novel approach based on a genetic algorithm to optimize task assignments among workers. The proposed algorithm generates task schedules that better coordinate and synchronize worker collaboration during wire harness assembly to enhance collaboration and minimize idle time.

Literature Review

Harness Assembly

Wire harnesses (Tromnau et al., 2019) are an organized assembly of wires, and they are used in the automotive industry, where they are essential in connecting the electronic components. Although industry and automation have advanced significantly since cars were introduced, wire harness assembly remains largely manual due to its complexity (Navas-Reascos et al., 2022). In the preparation phase, a CAD layout defines the exact size and position of wires, connectors, and fixing components. During preproduction, wires are cut and crimped – this phase is highly automatable, but in the assembly phase, workers route wires by hand on an assembly board (shown in Figure 1; Ruppert & Abonyi, 2020). After quality testing, the harnesses are installed in the final product.

Figure 1.
Assembly board with a wire harness

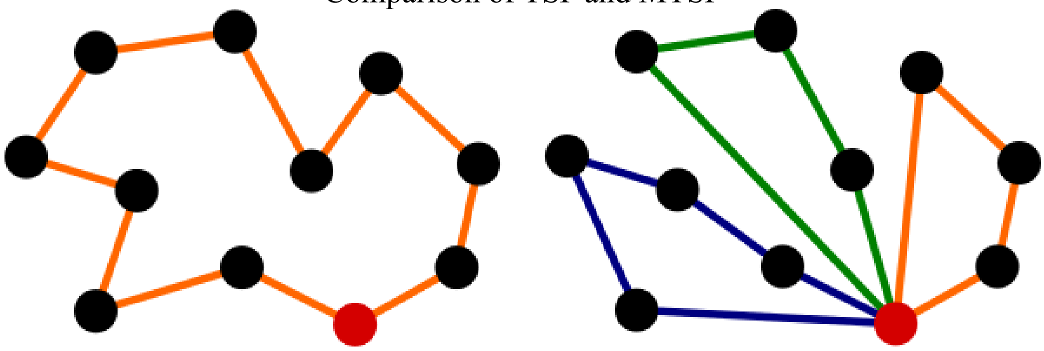


Source: own photo.

Traveling Salesman Problem

The problem to solve is traversing the assembly board by visiting each fixture exactly once via the shortest possible route. This resembles the Traveling Salesman Problem (TSP), where each city must be visited once before returning to the starting point (Jünger et al., 1995). However, there are three key differences: (1) returning to the start is not required, (2) multiple agents are involved, and (3) it is the order of wires – not nodes – that is optimized, aiming to minimize distances between wire endpoints. The second difference frames the problem as a Multi-Agent or Multiple Traveling Salesman Problem (MTSP) (Singh, 2016). In this problem there are more agents than one, and every city needs to be visited exactly by one agent (except the starter city) (Shown in Figure 2, where the starter city is red, and the different agent routes have different colors.). The third difference is an important factor that we must consider when choosing the right algorithm.

Figure 2.
Comparison of TSP and MTSP

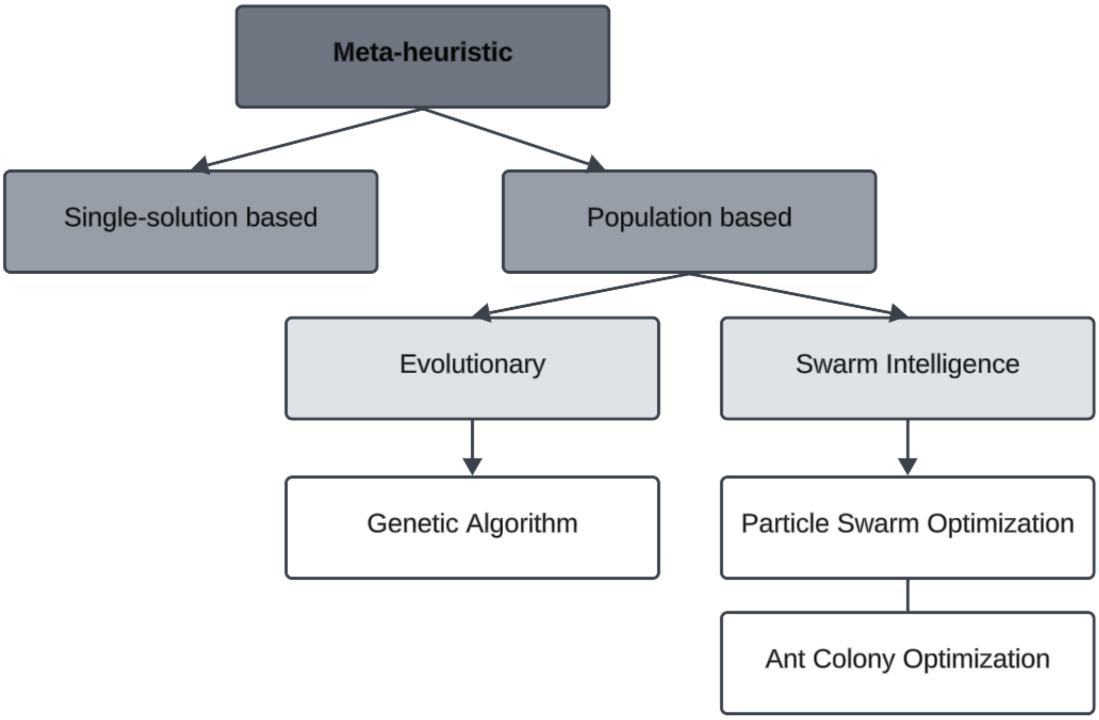


Source: own elaboration.

Possible algorithms fall into two categories: exact and approximate, with the latter including heuristic and meta-heuristic methods (Singh, 2016). Due to the large search space, exact algorithms were excluded early, as they are computationally infeasible. Meta-heuristics extends basic heuristics with higher-level strategies to explore complex spaces effectively (Hosseinabadi et al., 2014) and given the combinatorial nature and expected scale of the problem, a meta-heuristic approach is essential.

The three most commonly used meta-heuristic algorithms for the mTSP are Particle Swarm Optimization (PSO), Genetic Algorithm (GA), and Ant Colony Optimization (ACO; Liu et al., 2009; Singh, 2016; Zhou et al., 2018), as shown in Figure 3. PSO is inspired by the behavior of natural swarms, where individuals adapt their movements based on both personal and collective experience (Wang et al., 2018). ACO models the pheromone-based navigation of ants, favoring shorter paths through stronger pheromone trails (Liu et al., 2009). GA simulates biological evolution, where fitter individuals are more likely to reproduce and pass on advantageous traits (Kumar et al., 2010). Although PSO is often applied to mTSP, it is more suited for continuous problems and was therefore excluded. ACO, while effective for pathfinding, does not align well with our need to optimize both the order and direction of fixed wire routes for multiple agents, so it was also set aside. GA was selected due to its suitability for discrete problems and the relative ease with which solution representations could be implemented.

Figure 3.
Grouping of meta-heuristic algorithms



Source: own elaboration, based on Janga Reddy & Nagesh Kumar (2020)

Genetic Algorithm

GA are population-based search and optimization algorithms based on biological evolution (Kumar et al., 2010). GAs are especially advantageous when evaluating all possible solutions is impractical due to the complexity of the problem, as they allow for the efficient discovery of near-optimal solutions. GAs can be very diverse, but they all have the following steps in common (Kumar et al., 2010; Mathew, 2012):

- find an appropriate genome representation
- generate a population
- evaluate the fitness of the individuals
- select the better ones
- crossover solutions to get new ones
- mutate some of them
- repeat the last four steps until the stop condition is met

The key terms associated with GAs are summarized in Table 1.

Table 1:
Explanation of Genetic Algorithm terms

Term	Explanation
Population	A set of possible solutions
Generation	A set of possible solutions in one iteration
Individual	A single possible solution
Genotype	Encoded possible solution
Phenotype	Decoded possible solution
Genome	The whole encoded possible solution
Gene	One value in the genome
Fitness value	A value shows how good is the possible solution

Source: own elaboration, based on Mathew, 2012

An essential aspect of using GAs effectively is selecting an appropriate genome representation and corresponding operators (crossover, mutation) suited to the problem. Common representations include binary vectors, real or integer vectors, and permutations (Mathew, 2012). The key is to choose an encoding that supports all required operations and allows the phenotype to be reconstructed from the genotype. Once the initial population is generated, individuals are evaluated using a fitness function that quantifies solution quality. Typically, higher fitness values indicate better solutions, although the opposite convention may also be used. Following evaluation, parent selection is performed. There are several ways of doing this, for example truncation (selecting the top individuals) or tournament selection (choosing the best among random subsets; Blickle, 2000). Care must be taken to maintain diversity, as always selecting the best individuals may lead to premature convergence, where the population becomes too homogeneous and the algorithm gets trapped in local optima (Kumar et al., 2010; Mathew, 2012).

Selected parents undergo crossover to produce offspring. Crossover methods depend heavily on the genome type; for example, permutation-based representations require specialized operators (Umbarkar & Sheth, 2015). Mutation is then applied to some offspring to further preserve diversity, again tailored to the representation used. Generations are iterated until a stopping criterion is met – such as a maximum number of generations, runtime limit, minimal improvement over time, or convergence to a target fitness. To prevent loss of the best solutions, elitism may be applied by carrying top individuals into the next generation.

Algorithm performance also depends on parameter tuning – such as population size, mutation rate, or method-specific parameters like migration rate. While random or grid search methods can be used to find suitable values, they may be inefficient, inaccurate and computationally intensive. In such situations, a more efficient approach is offered by Bayesian optimization (Roman et al., 2016), which is a global optimization method for

optimizing explicitly expensive objective functions, and which itself chooses a parameter value in the given interval, considering the results of previous runs.
In summary, GAs are powerful optimization tools inspired by natural evolution. Through iterative selection, crossover, and mutation, they can explore complex search spaces efficiently and converge toward high-quality solutions, even for problems where traditional methods fail.

The Developed Method

Problem Statement

As mentioned in Section *Travelling Salesman Problem,* the problem resembles a TSP but is not the order of the nodes that needs to be optimized, but the **order**, the **direction** and the **handover node** of the wires.

To highlight the importance of these factors, measurements were conducted on the assembly board at the Industry 5.0 laboratory (Ruppert et al., 2022), and example wire routes were defined. The results are shown in Figures 4, 5, and 6.

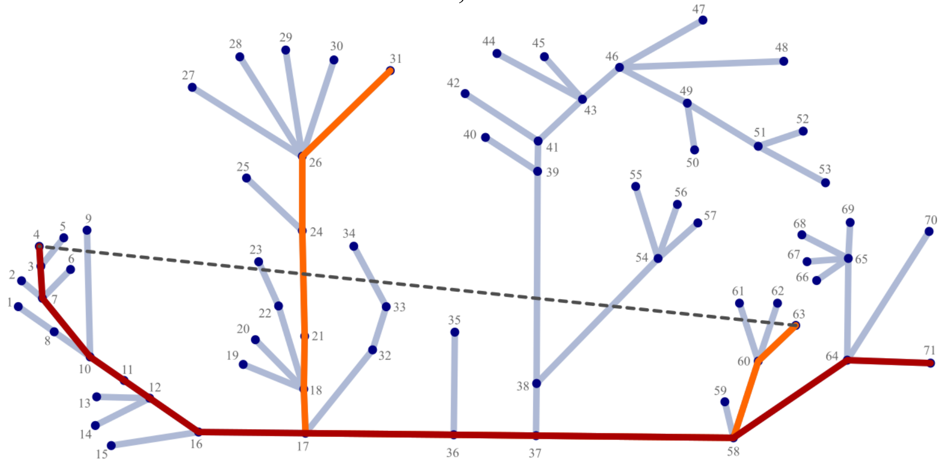
All possible combinations of direction and order for a small set of wires were systematically evaluated, along with variations in handover nodes. This exhaustive approach ensures that (1) the optimal configuration is identified, and (2) the combinatorial complexity of the problem is illustrated. Intermediate cases are also included to demonstrate the effects of different choices.

Direction must be optimized, as an incorrect choice can result in large distances between the endpoints of consecutive wires – forcing agents to walk unnecessarily long paths. Figure 4 illustrates how direction affects this distance. The order is fixed (red wire first, then orange), and arrows indicate routing direction. A dashed black line connects the end of the first wire to the start of the second.

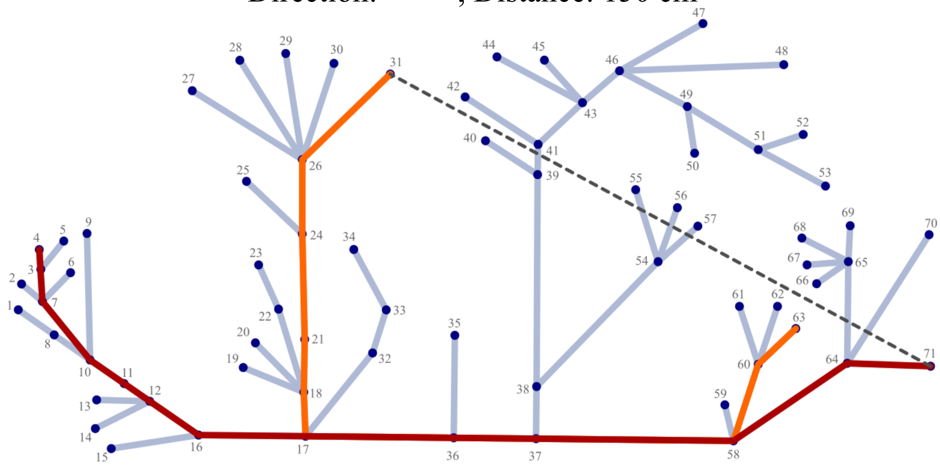
In the worst-case example (Subfigure 4a), routing from node 71 to 4, then from 63 to 31, results in a 189 cm distance between node 4 and 63. With a better direction (Subfigure 4d), the distance is reduced to 34 cm.

Figure 4.
Example for the importance of optimizing wire direction

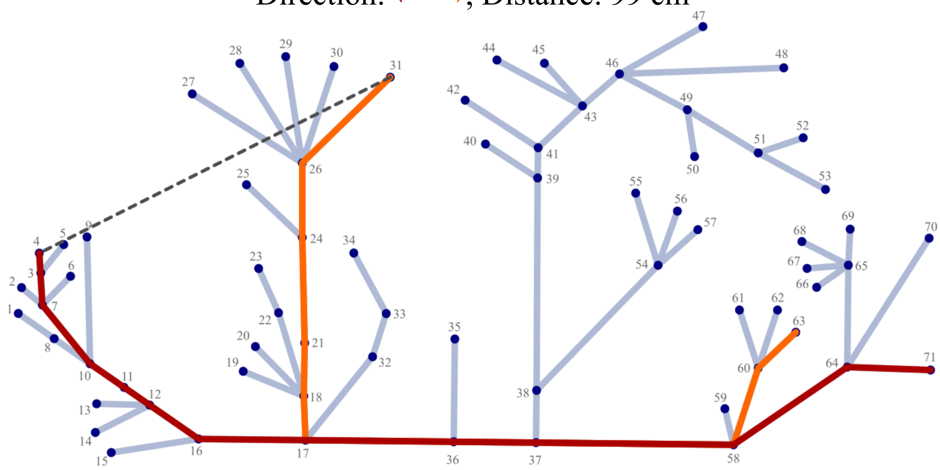
Subfigure 4a
Direction: ← ←, Distance: 189 cm



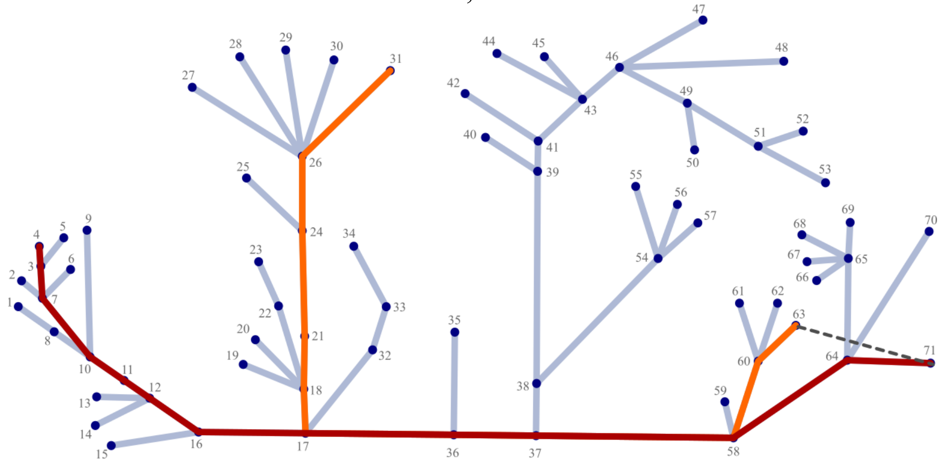
Subfigure 4b.
Direction: → →, Distance: 150 cm



Subfigure 4c.
Direction: ← →, Distance: 99 cm



Subfigure 4d.
Direction: → ←, Distance: 34 cm



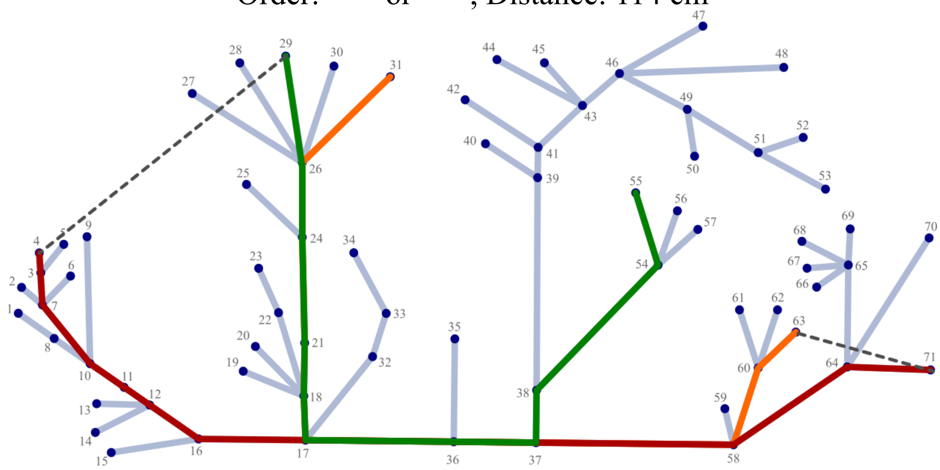
Source: own elaboration.

The **order** of wires should also be optimized to minimize the distance between their endpoints, as demonstrated in Figure 5. To isolate the effect of order, the direction of each wire is always selected to minimize the distance from the previous endpoint, ensuring that direction is not a limiting factor. In this way the example shown in Figure 5 can be traversed in two ways, both of which are indicated in the figure caption.

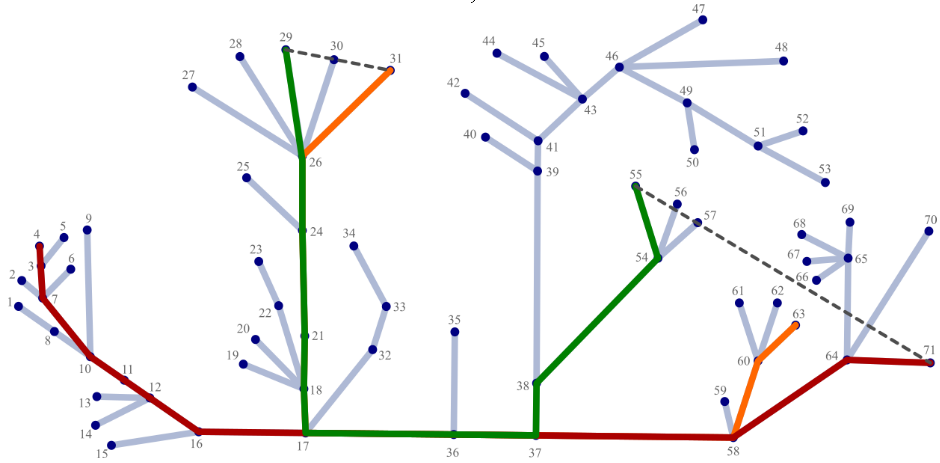
In the example of Subfigure 5a, the orange wire is routed from node 31 to 63, followed by the red wire from 71 to 4, and the green wire from 29 to 55. An equivalent path is obtained by reversing the order: starting with the green wire at node 55 and ending with the orange wire at node 31. In both cases, the total distance is 114 cm. By choosing a better order (Subfigure 5c), this can be reduced to 59 cm.

Figure 5.
Example for the importance of optimizing wire order

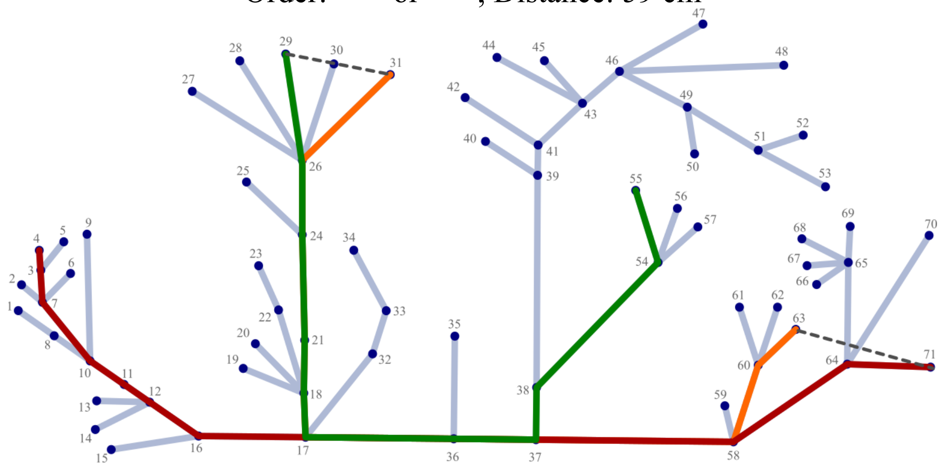
Subfigure 5a.
Order: • • • or • • •, Distance: 114 cm



Subfigure 5b.
Order: • • • or • • •, Distance: 108 cm



Subfigure 5c.
Order: • • • or • • •, Distance: 59 cm



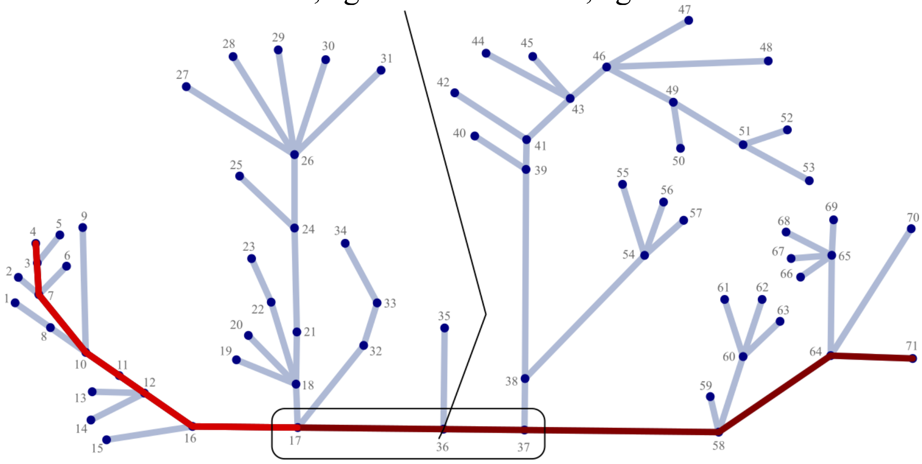
Source: own elaboration.

In order not to interfere with each other, the workspace of agents usually split in manufacturing. The intersection of these regions defines a set of potential **handover nodes**, where one agent transfers the wire to the other. In Figure 6, nodes 17, 36, and 37 represent such points, though the actual set may vary.

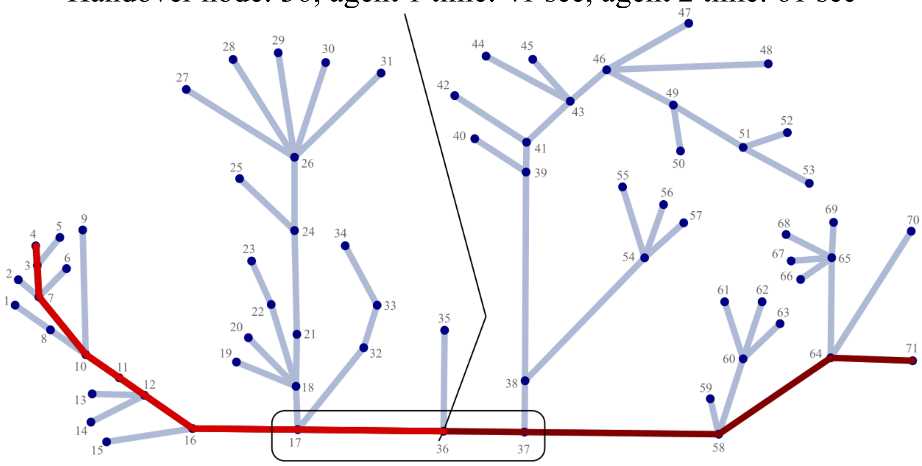
The choice of **handover node** significantly affects task balancing between agents. Since agents may have different speeds, the optimal handover point is not necessarily the midpoint of the wire but the point that minimizes the time difference between their tasks. This is critical, as both agents must complete their tasks before proceeding – meaning any idle time increases the overall task duration. In Figure 6, with Agent 1 moving at 3 cm/s and Agent 2 at 2 cm/s, the optimal handover node (Subfigure 6c) reduces both imbalance and idle time.

Figure 6.
Example for the importance of optimizing handover node

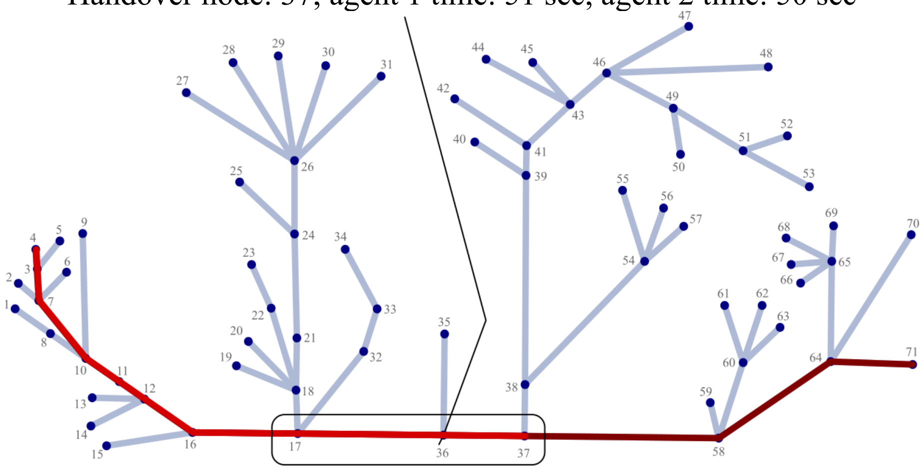
Subfigure 6a.
Handover node: 17; agent 1 time: 32 sec, agent 2 time: 80 sec



Subfigure 6b.
Handover node: 36; agent 1 time: 41 sec, agent 2 time: 61 sec

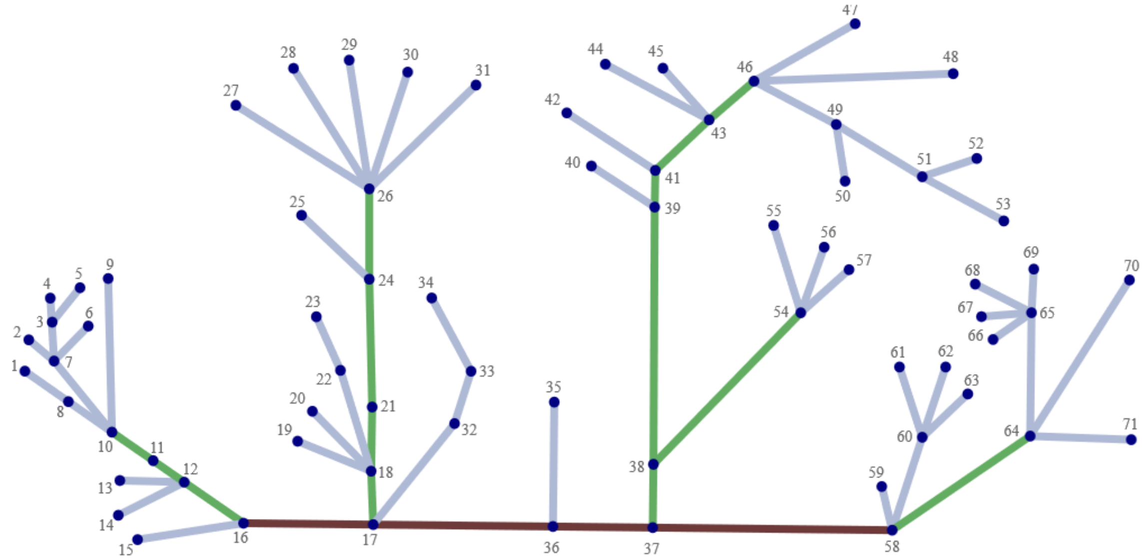


Subfigure 6c.
Handover node: 37; agent 1 time: 51 sec, agent 2 time: 50 sec



Agent speed is not constant and depends on both the task and the area of the assembly board. Task "switching between wires" are generally faster than "wire routing". Additionally, routing speed is influenced by board area: in peripheral zones – where fixtures are dense and routing is more complex – movement is slower, whereas in central, sparser areas, it is faster. As illustrated in Figure 7, edges are categorized based on traversal speed: base (marked with blue), faster (marked with green), and fastest (marked with brown).

Figure 7.
Visualization of the impact of different assembly board areas on task execution speed



Source: own elaboration.

Problem Formalization

As a genetic algorithm is used, the goal is not to find the optimal solution but to evolve a good enough solution from an initial population of randomly generated candidates, based on the principles of natural selection. For this process to be effective, it is essential to evaluate the quality – or fitness – of each solution. This section presents a general formalization of the problem.

To aid in understanding the problem formulation and the optimization process, all variables and notations used are summarized in Table 2.

The possible solutions contain a task assignment for each agent, so it contains n lists and stores the order in which an agent routes the wires. The agent list contains all the wires that pass through the workspace of the agent, in random order.

Equation 1.

$$x = [y_1, y_2, \dots, y_n] y_a = [w_{a,1}, w_{a,2}, \dots, w_{a,m_a}]$$

In Equation 1 x is a possible solution, y_a is a task assignment for an agent (in sort, an agent list) for n agents. w is the wire object, we have m wires in total. w_a is a wire object, which pass through the workspace of agent a, we have m_a of them in total, and $m_a \leq m$.

Wire objects show which wires should be routed in which direction along their route, and where the handover node of the wire is.

Equation 2.

$$w_{a,o} = \left(i_{a,o}, dir_{a,o}, H_{a,o}\right) H_{a,o} = \{\hat{v}_{1,2}, \hat{v}_{2,3}, \dots, \hat{v}_{a',a''}\}$$

In the Equation 2 $w_{a,o}$ is a wire object, which is in the o^{th} position at the agent list of agent a. i is the identification number of the wire, $dir \in \{\rightarrow, \leftarrow\}$ is the direction of the wire, and $H_{a,o}$ the set of the handover nodes of the wire. It contains $\hat{v}$ handover nodes, and $\hat{v}_{a',a''}$ denotes the handover node between agent a' and agent a''.

In the graph of the harness assembly board we have a set of nodes (or vertexes), and there are workspaces for the agents to not interfere with each other. Between the workspaces of two agents is the set of possible handover nodes.

Equation 3.

$$V = \{1, 2, \dots, p\} V_a \subset V \hat{V}_{a',a''} = V_{a'} \cap V_{a''}, \quad \left|\hat{V}_{a',a''}\right| = q_{a',a''} v \in V \hat{v}_{a',a''} \in \hat{V}_{a',a''}$$

Table 2.
Defined variables and notations

Symbol	Meaning
x	a possible solution
A	set of the agents
A_r	list of the agents for the wire route r
b_r	index of an agent in the list of agents for the wire route r
y_a	task assignment of an agent in the solution
u_a	velocity of an agent
w	wire object
$dir_{a,o}$	direction of the wire route
R	list of the wire routes
$r_{i_{a,o}}^{dir_{a,o}}$	a wire route (a list of nodes)
V	set of the nodes in the graph
V_a	set of the nodes in the workspace of agent a
$\hat{V}_{a',a''}$	set of the possible handover node between agent a' and a''
$H_{a,o}$	set of the handover nodes of $w_{a,o}$
v	a node
$\hat{v}_{a',a''}$	a handover node between agent a' and a''
D	matrix of the distances between two nodes
$d_{k,l}$	distance between two nodes

Symbol	Meaning
$T(x)$	total time of a solution
T_a	total time of an agent
T_a^{switch}	total time switching between wires for one agent
T_a^{wait}	total time waiting for another agent for one agent
T_a^{route}	total time of wire routing for one agent
n	number of agents
m	number of wires
m_a	number of wires in the workspace of agent a
p	number of nodes in the graph
q	number of handover nodes
s_{r_i}	number of nodes in a wire route
a	running index in A, refers to one agent
o	running index or order number in $y_a, refers\ to\ one\ wire\ object$
i	running index in R, refers to one wire route
j	running index in r_i, refers to one node
k, l	running indexes in D refers to one distance
f	factor that refines the speed of the agents
f_t	factor of task
f_r	factor of region

Source: own elaboration

In the Equation 3 V is the set of the nodes in the graph of the harness assembly board, V_a is the set of the nodes in the workspace of agent a, $\hat{V}_{a',a''}$ is the set of possible handover nodes between the workspace of agent a' and agent a'', and we have $q_{a',a''}$ handover nodes between the workspace of agent a' and a'' (so the cardinality of $\hat{V}_{a',a''}$ is $q_{a',a''}$). In addition, v is a node, and $\hat{v}_{a',a''}$ is a (possible) handover node between the workspace of agent a' and a''.

The wires have predefined routes that cannot be changed when routing the wires. There are two ways to route a wire: right to left and left to right.

Equation 4.

$$R = \left[(r_1^{\rightarrow}, r_1^{\leftarrow}), (r_2^{\rightarrow}, r_2^{\leftarrow}), \dots, \left(r_p^{\rightarrow}, r_p^{\leftarrow}\right)\right]$$

Equation 5.

$$r_i^{\rightarrow} = \left[v_1, v_2, \dots, v_{s_{r_i}}\right] r_i^{\leftarrow} = \left[v_{s_{r_i}}, v_{s_{r_i}-1}, \dots, v_1\right]$$

In Equation 4 R is a vector containing the routes of all wires in both directions. In Equation 5 r_i is the route of a given wire, and we can get it for a specific direction. Each wire object

$w_{a,o}$ has an id $i_{a,o}$, and it can refer to the route of the specific wire object. So the route of $w_{a,o}$ wire object is $r_{i_{a,o}}$. The $w_{a,o}$ also contains the direction of the route of the wire, that is $dir_{a,o}$. The route of the wire object $w_{a,o}$ in a specific direction is $r_{i_{a,o}}^{dir_{a,o}}$.

Each wire route has a list of which agents' workspaces the wire route passes through and in what order.

Equation 6.

$$A_{r_i^{dir}} = \left[a_1, a_2, \dots, a_{n_{r_i^{dir}}}\right]$$

In Equation 6 $A_{r_i^{dir}}$ is the agent list of the wire route r_i^{dir}, and $n_{r_i^{dir}}$ is the number of agents in the agent list of wire route r_i^{dir}.

To compare the different solutions, it is necessary to know the distance between each node, because it allows us to determine the length of the wires and the distances between the end nodes of the wires.

Equation 7.

$$D = \begin{bmatrix} 0 & d_{1,2} & d_{1,3} & \cdots & d_{1,q} \\ d_{1,2} & 0 & d_{2,3} & \cdots & d_{2,q} \\ d_{1,3} & d_{2,3} & 0 & \cdots & d_{3,q} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ d_{1,q} & d_{2,q} & d_{3,q} & \cdots & 0 \end{bmatrix}$$

In Equation 7 D is a matrix which contains the distance between each node. $d_{k,l}$ is a distance between two nodes, for example $d_{1,2}$ is the distance between node 1 (v_1) and node 2 (v_2). Because it costs the same amount to take the same edge from both directions, the graph is not directed. Because of this the values under the main diagonal are the same as above the main diagonal.

The possible solutions are better the less time it takes to solve them. The time it takes an agent to complete their task is determined by three factors: **routing time** (when the agent is routing the wire on the assembly board), **switching time** (when the agent is switching from one wire to another after finishing one), and **waiting time** (when the agent is waiting for its next wire to be brought to the handover node by another agent).

Equation 8.

$$T_a = T_a^{switch} + T_a^{wait} + T_a^{route}$$

In Equation 8 T_a is the total time required by agent a to execute their assigned tasks within the possible solution, T_a^{switch} is the total time of switching between wires by agent a, T_a^{wait} is the total time while agent a waiting for other agents, and T_a^{route} is the total time of routing wires on the assembly board by agent a.

The agents are working simultaneously, and because of this the full time of the solution is equal to the largest agent time. This is because when some of the agents finish earlier, they need to wait for the others, so the total time of the solution will be equal to the largest agent time.

Equation 9.

$$T(x) = T_a$$

In Equation 9 T_a is the time required by agent a to execute their assigned tasks within the solution, x is a solution, and $T(x)$ is the full time of that solution.

The total time of switch between wires is calculated by going through the list of agents, identifying the endpoints of the wires, finding the distance between them, and dividing this by the speed of the agent to get the time it takes the agent to travel the distance from the endpoint of one wire to the startpoint of the other.

It is important to note that the speed of switching between wires is often not the same as the speed of wire routing, so the speed of the agent needs to be multiplied by a task factor.

It is also important to note that the end point of the previous wire is not always the last element of the path vector, just as the start point is not always the first element of the path vector.

Equation 10.

$$T_a^{switch} = \sum_{o=2}^{m_a-1} \frac{d_{\tilde{v}_{end},v_{begin}}}{u_a \cdot f_t} \tilde{a}^{next} = \{a_{b_{r_{i_{a,o-1}}^{dir_{a,o}}}+1}\ if\ b_{r_{i_{a,o-1}}^{dir_{a,o}}} < n_{r_{i_{a,o-1}}^{dir_{a,o}}} a^{prev}$$

$$= \{a_{b_{r_{i_{a,o}}^{dir_{a,o}}}-1}\ if\ b_{r_{i_{a,o}}^{dir_{a,o}}} > 0 \tilde{v}_{end} = \{last\left(r_{i_{a,o-1}}^{dir_{a,o}}\right) if\ a$$

$$= last\left(A_{r_{i_{a,o-1}}^{dir_{a,o}}}\right) \hat{v}_{a,\tilde{a}^{next}}\ otherwise\ v_{begin} = \{first\left(r_{i_{a,o}}^{dir_{a,o}}\right) if\ a$$

$$= first\left(A_{r_{i_{a,o}}^{dir_{a,o}}}\right) \hat{v}_{a,a^{prev}}\ otherwise$$

In Equation 10 $d_{\tilde{v}_{end},v_{begin}}$ is the distance between the endpoint of the previous wire and the startpoint of the current wire, u_a is the speed of agent a, f_t is the factor of task, $\tilde{a}^{next}$ is the next agent in the agent list of the previous wire, and a^{prev} is the previous agent in the agent list of the current wire, $b_{a,r_{i_{a,o-1}}^{dir_{a,o}}}$ is the index of the agent a in the agent list of the previous wire, and $b_{r_{i_{a,o}}^{dir_{a,o}}}$ is the index of the agent a in the agent list of the current wire. $last\left(r_{i_{a,o-1}}^{dir_{a,o}}\right)$ is the last node in the route of the previous wire, and $first\left(r_{i_{a,o}}^{dir_{a,o}}\right)$ is the first node in the route of the current wire. $last\left(A_{r_{i_{a,o-1}}^{dir_{a,o}}}\right)$ is the last agent in the agent list of the previous wire, and $first\left(A_{r_{i_{a,o}}^{dir_{a,o}}}\right)$ is the first agent in the agent list of the current wire. $\hat{v}_{a,\tilde{a}^{next}}$ is the separator point between agent a and agent $\tilde{a}^{next}$, and $\hat{v}_{a,a^{prev}}$ is the separator point between agent a and agent a^{prev}.

I calculate the total waiting time for an agent by going through the list of agents, and if the agent has to continue a wire from the handover node, I look at when that wire reached the handover node and subtract from it when the agent reached the handover node. If the value is greater than zero, it means that the agent had to wait until the wire could be started.

Equation 11.

$$T_a^{wait} = \sum_{o=1}^{m_a} \quad max\left(0, t_{a^{prev},o} - t_{a,o}\right) a^{prev} = a_{b_{r_{i_{a,o}}}^{dir_{a,o}}-1}$$

In Equation 11 $t_{a^{prev},o}$ is the time when the previous agent in the agent list of the current wire puts down the wire at the handover node between agent a and agent a^{prev}, and $t_{a,o}$ is the time when agent a arrives at the handover node.

I calculate the total time spent running wires for an agent by going through the agent list and adding up the length of the wires in the agent's workspace. This is calculated by looking at the wire route with the agent's start direction from the starting point to the hand-over node.

Equation 12.

$$T_a^{route} = \sum_{o=1}^{m_a} \quad \sum_{j=v_{begin}}^{v_{end}-1} \quad \frac{d_{v_j,v_{j+1}}}{u_a \cdot f_r} a^{prev} = a_{b_{r_{i_{a,o}}}^{dir_{a,o}}-1} a^{next} = a_{b_{r_{i_{a,o}}}^{dir_{a,o}}+1} v_{begin}$$
$$= \{first\left(r_{i_{a,o}}^{dir_{a,o}}\right) if\ a = first\left(A_{r_{i_{a,o}}^{dir_{a,o}}}\right)\ \hat{v}_{a,a^{prev}}\ otherwise\ v_{end}$$
$$= \{last\left(r_{i_{a,o}}^{dir_{a,o}}\right) if\ a = last\left(A_{r_{i_{a,o}}^{dir_{a,o}}}\right)\ \hat{v}_{a,a^{next}}\ otherwise$$

In Equation 12 we go through the list of agent a, so we take all the wire objects one by one. Within that, we traverse the route associated with the given $w_{a,o}$, more precisely, the part of the route that is in the workspace of agent a. The first node of the route part is v_{start}, and the last is v_{end}.

If agent a is the first agent in the agent list of the wire route, the agent starts the routing from the first node of the route $first\left(r_{i_{a,o}}^{dir_{a,o}}\right)$, else the agent starts the routing with the handover node between the current and the previous agent of agent list ($\hat{v}_{a,a^{prev}}$).

If agent a is the last agent in the agent list of the wire route, the agent finishes the routing with the last node of the route $first\left(r_{i_{a,o}}^{dir_{a,o}}\right)$, else the agent finishes the routing with the handover node between the current and the next agent of agent list ($\hat{v}_{a,a^{next}}$).

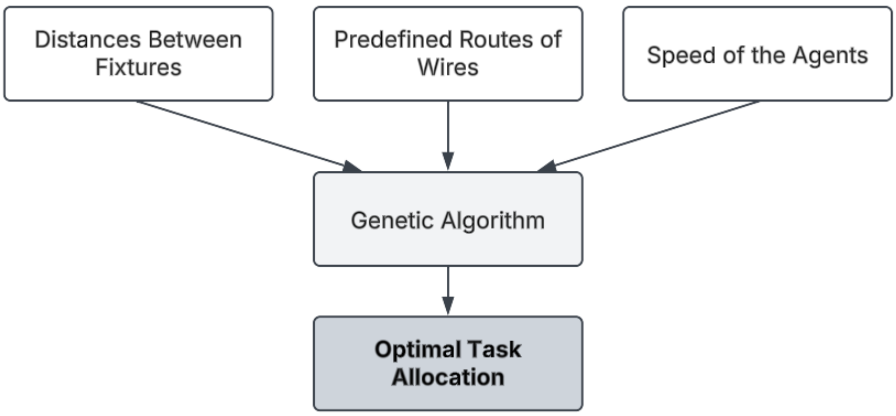
$d_{v_j,v_{j+1}}$ is the distance between two nodes, u_a is the speed of agent a, and f_r is the factor of region.

It is important to note that not all possible solutions are valid, because in the case where both agents reach a point where they are still waiting for a wire to be routed to the handover node by the other, a deadlock condition occurs and the task assignment is not valid.

The Developed Algorithm

The objective of the developed algorithm is to optimize routing on the assembly board and coordinate collaboration between two agents by creating an optimal task allocation. As shown in Figure 8, the basic data needed to run the algorithm is the distance between the fixtures on the assembly board, the route of the wires, and the speed of the agents. This information is used to compute the cost of each possible solution, allowing comparisons based on calculated efficiency.

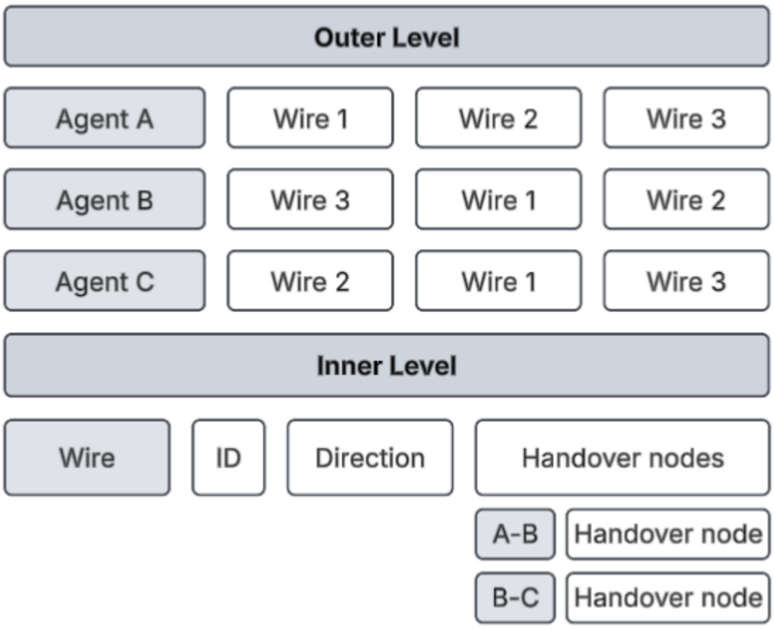
Figure 8.
Overview of the algorithm



Source: own elaboration.

The genetic algorithm was implemented in Python following the steps outlined in Section Genetic Algorithm. A two-level genome representation was constructed, as illustrated in Figure 9. The outer level contains a list of task assignments for each agent, where each list holds the wires passing through that agent's workspace in random order. Wires are stored as object references, ensuring that any modification to a wire's attributes in one list is reflected in all others. This guarantees consistency within a solution. Each wire has attributes including an identifier, routing direction, and a dictionary of handover nodes, where the key is the pair of the agents involved in the handover.

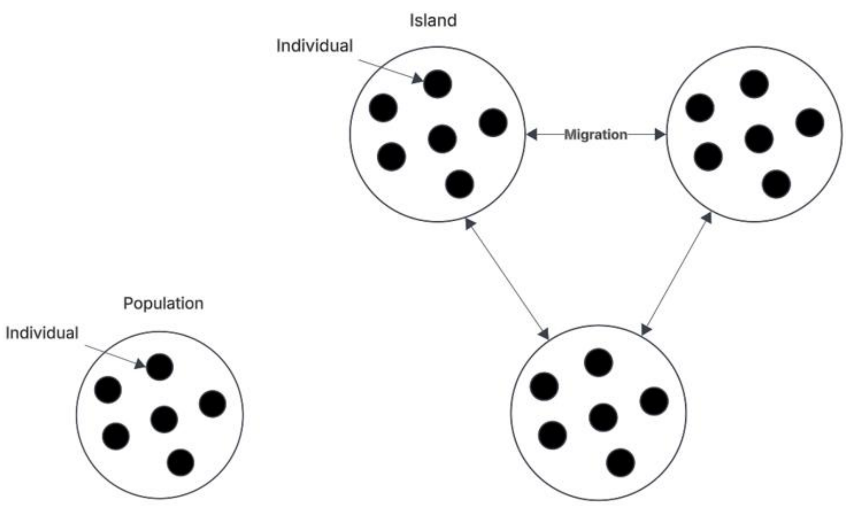
Figure 9.
Two-level genome



Source: own elaboration.

To maintain diversity and avoid premature convergence, the island model was applied during population generation (Houbad et al., 2022; Medeiros & Fernandes, 2020). As shown in Figure 10, this model divides the population into multiple isolated subpopulations (islands), allowing independent evolution between migration events. This separation prevents local optima from dominating the entire population, while periodic migration ensures some level of information exchange. During migration, the best individual from the best island – defined as the one containing the globally best individual – replaces the worst individual on the worst island, where the worst island is defined by having the weakest best individual among all islands.

Figure 10.
Comparison of the usual (left) and the island model (right)



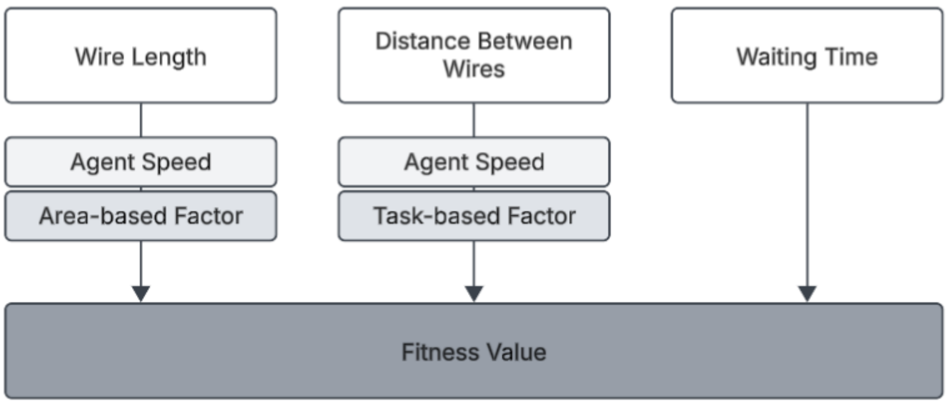
Source: own elaboration, based on Houbad et al., 2022

During fitness evaluation, the completion time of each individual's task assignment is assessed. As shown in Figure 11, the evaluation is based on three components.

The wire length is a factor that cannot be modified; however, since agents may operate at different speeds, it must be taken into account when defining the fitness value. The distance between wires is intended to be minimized by optimizing the direction and order of the wires, while the waiting time is reduced by appropriately selecting the handover node and coordinating task assignments among the agents.

Meanwhile, we also take into account that agents switch between wires and perform wire routing at different speeds, and that they perform wire routing at different speeds in different parts of the board, so a task-based factor and an area-based factor are introduced.

Figure 11.
Fitness value



Source: own elaboration.

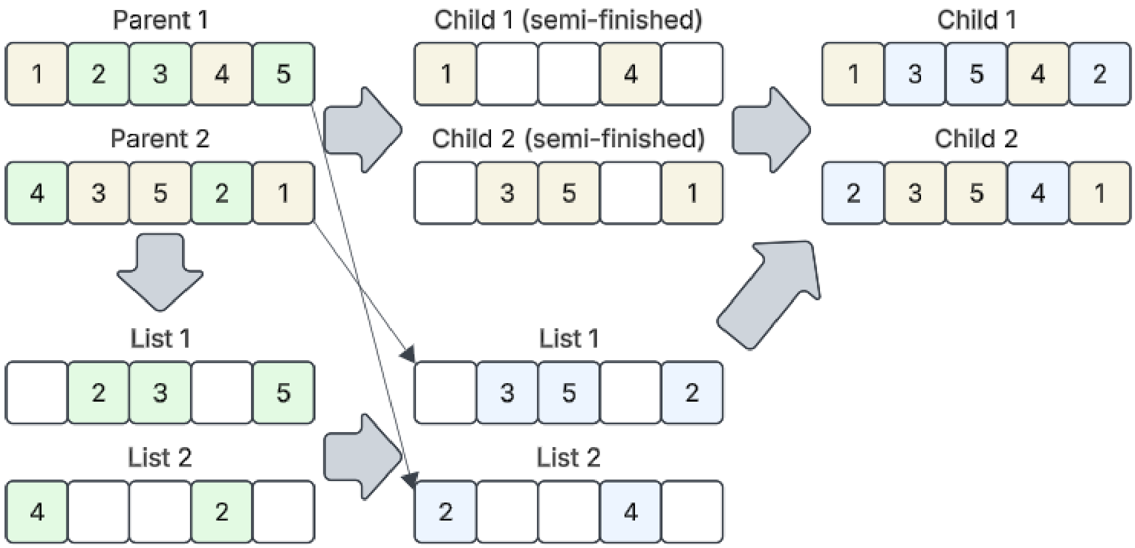
After fitness evaluation, parent individuals are selected using tournament selection to preserve diversity and avoid premature convergence. In this process, six individuals are randomly chosen from the population on each island, and the best among them is selected. This is repeated twice to obtain two parents. Crossover is performed on both genome levels. At the outer level, a crossover operator suitable for permutation-based genome representations is applied (Álmos et al., 2002; shown in Figure 12). The process involves the following steps:

A random bitmask is generated. For the first offspring (Child 1), the values from Parent 1 are copied into the corresponding positions wherever the bitmask contains a 1. The remaining values are collected into a separate list (List 1). Conversely, for the second offspring (Child 2), values from Parent 2 are placed into positions where the bitmask is 0, and the rest are stored in a separate list (List 2). At this stage, both the offspring and the lists contain gaps in the unfilled positions.

The values in each list are then reordered to resemble the order of the opposite parent as closely as possible. Specifically, the order in List 1 is aligned to match the sequence of values in Parent 2, while List 2 is reordered to match Parent 1.

Finally, the remaining empty positions in each offspring are filled with the corresponding reordered list values, preserving their relative positions. At the inner level, wire attributes (direction and handover nodes) are inherited randomly from the two parents.

Figure 12.
Crossover of permutation-based genome

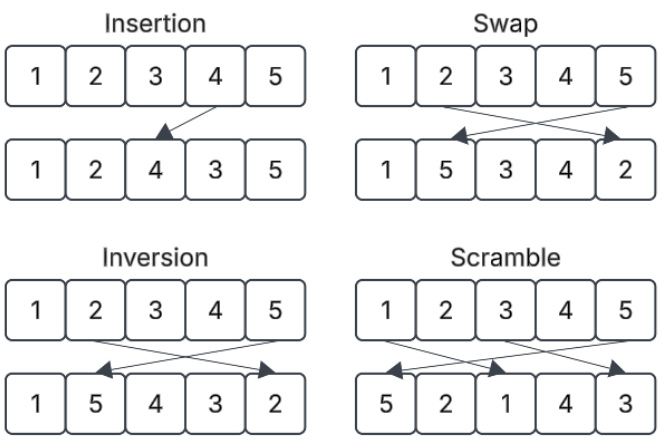


Source: own elaboration, based on Álmos et al., 2002

Mutation is also applied on both levels. At the outer level, mutation of permutation-based genomes can be implemented in several ways (Álmos et al., 2002; shown in Figure 13). In this work, the *insertion* mutation was applied, as detailed in the Case Study section.

At the inner level, another possible value is chosen at random at the inner level during mutation. For direction, it is the other direction. For handover nodes, it is another handover node from the set of possible handover nodes.

Figure 13.
Mutation of permutation-based genome



Source: own elaboration, based on Álmos et al., 2002

To further maintain diversity and reduce the risk of premature convergence, a steady-state genetic algorithm model is used instead of a generational one (Lozano et al., 2008). In contrast to the generational model, which replaces the entire population in each generation (except elite individuals), the steady-state model introduces only one or two offspring per generation. A modified family competition replacement scheme is applied, where offspring typically compete with their parents for population entry, but occasionally replace the worst individual to better preserve diversity.

The algorithm terminates when the best individual remains unchanged for a specified number of generations, indicating convergence.

Case Study

The distances between fixtures were measured on a real assembly board, while wire routes were defined as example data. Also arbitrary values were assigned to agent speeds. These three inputs were used to demonstrate the functionality of the algorithm.

Parameter tuning of the optimization algorithm was performed using Bayesian optimization with the Optuna Python package. The algorithm was tested with 1, 2, and 3 agents, and with 5, 10, and 15 wires using the example data. For each configuration, the tested parameter intervals are shown in Figure 14. Bayesian optimization was executed for 100 iterations per case, resulting in 100 parameter combinations per search space setting. Descriptions of the parameters are provided in Table 3.

Table 3.
Explanation of the parameters

Parameter name	Explanation
Number of islands	The number of isolated population is the island model
Population size	The number of individuals in each population
Last generation	This many generations should pass since the last change of the best individual before the run stops
Mutation chance	The probability that the mutation event will occur
Replacement chance	The probability that the offspring replaces the worst individual on the island instead of its parent
Immigration chance	The probability that the migration event occurs
Mutation type	There is 4 different mutation type for permutation type genome (swap, scramble, inversion, insertion)

Source: own elaboration

Figure 14.
Parameter intervals used for parameter tuning

Search space		GA Parameters												
Number of agents	Number of wires	Number of islands step: 1		Population size step: 10		Last generation step: 100		Mutation chance step: 0,01		Replacement chance step: 0,01		Immigration chance step: 0,0001		Mutation type -
1	5	3	5	10	60	500	1000	0,01	0,2	0,01	0,2	0,0005	0,0015	all
2	5	3	7	40	100	500	1000	0,01	0,2	0,01	0,2	0,0005	0,0015	all
3	5	3	10	60	120	500	1000	0,01	0,2	0,01	0,2	0,0005	0,0015	all
1	10	3	10	60	120	500	1300	0,01	0,25	0,01	0,25	0,0005	0,002	all
2	10	3	10	60	120	500	1300	0,01	0,25	0,01	0,25	0,0005	0,002	all
3	10	5	12	60	120	500	1300	0,01	0,25	0,01	0,25	0,0005	0,003	all
1	15	7	15	100	160	800	2000	0,01	0,25	0,01	0,3	0,0005	0,003	all
2	15	7	15	100	160	800	2000	0,01	0,25	0,01	0,3	0,0005	0,003	all
3	15	7	17	110	170	800	2000	0,01	0,25	0,01	0,3	0,0005	0,003	all

Source: own elaboration

The optimization algorithm was run 20 times for each parameter setting. A score was assigned to each set by adding the standard deviation of the fitness values to the minimum fitness value, reflecting both solution quality and stability. Considering future needs for faster performance, run times were also analyzed, with scores based on the minimum and standard deviation of run times. The fine-tuned parameters and their corresponding scores are shown in Figure 15.

Figure 15.
Results of the parameter-tuning

search space		GA parameters							results	
Number of agents	Number of wires	Number of islands	Population size	Last generation	Mutation chance	Replacement chance	Immmigration chance	Mutation type	fitness (min+sd)	runtime (min+sd)
1	5	3	56	600	0,11	0,12	0,001	swap	383 s	3,11 s
2	5	6	55	900	0,18	0,16	0,0008	insertion	187 s	15,24 s
3	5	3	71	700	0,12	0,16	0,0006	swap	147,99 s	7,08 s
1	10	8	68	1200	0,23	0,19	0,0009	scramble	765 s	93,46 s
2	10	8	76	1000	0,14	0,23	0,0017	insertion	367,05 s	72,34 s
3	10	8	100	1100	0,17	0,17	0,002	insertion	287,39 s	133,94 s
1	15	13	139	1700	0,25	0,11	0,0028	swap	1227,89 s	435,72 s
2	15	14	131	1600	0,13	0,24	0,0023	insertion	649,43 s	289,66 s
3	15	17	108	1600	0,14	0,04	0,0022	swap	522,23 s	370,18 s

Source: own elaboration

Since parameter tuning is time- and resource-intensive – especially with a large number of wires – yet the optimal values vary with the search space size, a rule-based parameter adjustment strategy was developed (see Equation 13). This approach adapts parameters based on the number of agents and wires.

The number of islands was set to a minimum of 3, calculated as the ceiling of half the sum of agents and wires, ensuring scalability.

The population size was determined by initially setting the number to 50 and then increasing it by a factor of three per additional agent or wire to align with the expanding search space.

For the generation limit without improvement, a base of 500 was used, with an added 70 per wire to reflect the influence of problem size, because the number of wires was more likely to influence the parameter size. The mutation probability started at 0.1, with an increment of 0.01 per agent and wire, capped at 0.3. The replacement probability followed a similar logic, though less affected by wire count and thus excluded from scaling.

The immigration chance was adjusted proportionally to the number of islands by multiplying it by 0.0002 and adding a base value of 0.0004.

Finally, based on the balanced performance of swap and insertion mutations during tuning, the insertion mutation was selected.

Equation 13.
Set of rules to define parameters based on the number of wires and agents

$$Number\ of\ islands = max\left(3;\ \lceil\frac{agents + wires}{2}\rceil\right) Population\ size$$
$$= 50 + 3\ \cdot agents\ \cdot wiresLast\ generation$$
$$= 500 + 70\ \cdot wiresMutation\ chance$$
$$= (0.1 + 0.01\ \cdot (agents + wires); 0.3)\ Replacement\ chance$$
$$= (0.1 + 0.01\ \cdot agents; 0.3)\ Immigration\ chance$$
$$= 0.0004 + 0.0002\ \cdot islandsMutation\ type = insertion$$

For comparison, Figure 16 shows the results of the runs with the parameters defined by the rules.

Figure 16.
Results with the parameters based on the rules

search space		GA parameters							results	
Number of agents	Number of wires	Number of islands	Population size	Last generation	Mutation chance	Replacement chance	Immmigration chance	Mutation type	fitness (min+sd)	runtime (min+sd)
1	5	5	65	850	0,16	0,11	0,0014	insertion	383,00 s	7,47 s
2	5	5	80	850	0,17	0,12	0,0014	insertion	187,37 s	10,62 s
3	5	6	95	850	0,18	0,13	0,0016	insertion	148,98 s	18,84 s
1	10	8	80	1200	0,21	0,11	0,002	insertion	765,41 s	96,87 s
2	10	9	110	1200	0,22	0,12	0,0022	insertion	370,90 s	102,90 s
3	10	9	140	1200	0,23	0,13	0,0022	insertion	299,33 s	166,83 s
1	15	12	95	1550	0,26	0,11	0,0028	insertion	1232,70 s	226,60 s
2	15	13	140	1550	0,27	0,12	0,003	insertion	661,01 s	184,85 s
3	15	13	185	1550	0,28	0,13	0,003	insertion	547,59 s	396,29 s

Source: own elaboration

After running the algorithm with example data, the solution looks as shown in Figure 17. The order of the wires (or at least a part of it) for each agent can be observed by their IDs, along with the handover nodes on the wires and the direction of the wires.

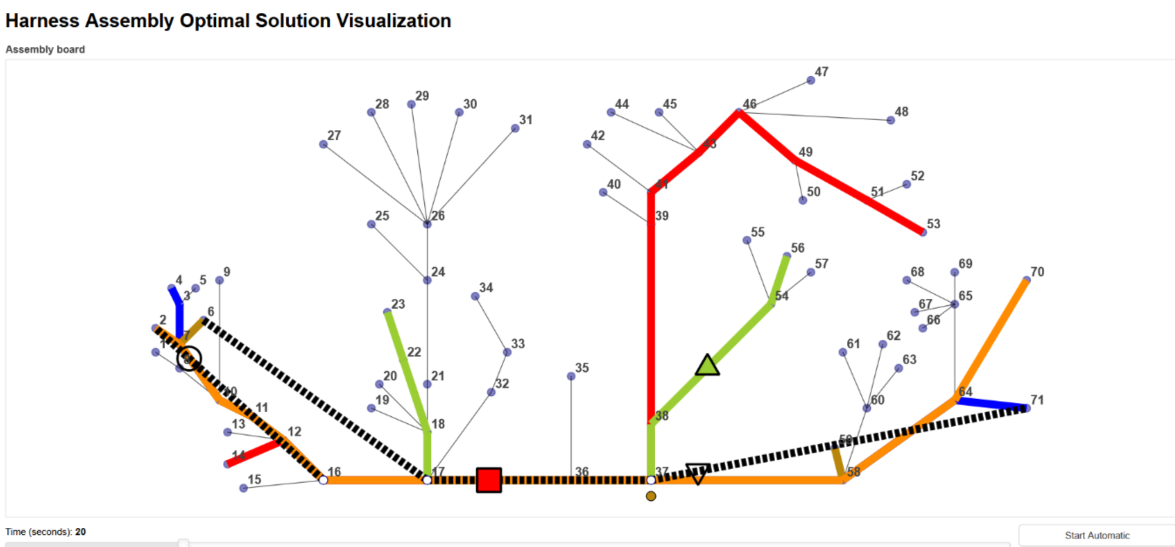
Figure 17.
An optimized solution for 4 agents and 5 wires

```
Fitness: 113 seconds
Agent 1 speed: 2 cm/sec
Agent 2 speed: 2.5 cm/sec
Agent 3 speed: 1.5 cm/sec
Agent 4 speed: 2 cm/sec
agent1: [(1, {frozenset({0, 1}): 16, frozenset({1, 2}): 37}, ->), (4, {frozenset({0, 1}): 16, frozenset({1, 3}): 37},
agent2: [(1, {frozenset({0, 1}): 16, frozenset({1, 2}): 37}, ->), (3, {frozenset({0, 1}): 16, frozenset({1, 3}): 37},
agent3: [(2, {frozenset({1, 2}): 37}, <-), (1, {frozenset({0, 1}): 16, frozenset({1, 2}): 37}, ->)]
agent4: [(3, {frozenset({0, 1}): 16, frozenset({1, 3}): 37}, <-), (0, {frozenset({0, 1}): 17, frozenset({1, 3}): 37},
```

Source: own elaboration

As the algorithm's output is difficult to interpret and not usable as work instructions, a Bokeh-based Python simulation was created to visualize the optimized solution, showing agent movements, positions over time, and routed wires.

Figure 18.
Simulation of a solution for 4 agents and 5 wires



Source: own elaboration

In Figure 18, the same solution is shown as in Figure 17. At second 20, agent 1 (circle) is about to pick up the orange wire, agent 2 (square) is routing the red wire, agent 3 (up-triangle) is routing the green wire, agent 4 (down-triangle) is about to pick up the brown wire at the handover node, and the brown wire is waiting at handover node 37 for routing to continue.

Agent movements can be observed by adjusting the slider at the bottom, which also allows tasks to be followed manually by users in sync with the simulation.

A demonstration was conducted during the Researcher's Night event. It was shown that, despite some difficulties, two participants unfamiliar with wire routing successfully followed the optimized task allocation and collaborated effectively.

However, observations revealed that certain real-world constraints had not been fully modeled. Routing along peripheral edges took longer than along central ones and switching between wires was faster than actual routing. Consequently, participants lagged behind the simulation at the edges but caught up in central areas and during wire transitions.

These findings led to the introduction of task factor and region factor parameters to more accurately reflect task and region-specific timing. While these adjustments have so far only been validated in the simulation, further real-world testing is planned to evaluate the improvements and assess the algorithm's robustness across different board types and wire assignments.

Conclusion

In this work, a genetic algorithm-based optimization tool was developed and tested for coordinating agent collaboration on a wire harness assembly board. The proposed method effectively distributes tasks among agents with varying speeds and accuracies, optimizing task allocations to minimize both idle time and overall task duration.

The approach was validated through a demonstration, where two participants – unfamiliar with wire routing – were able to follow the optimized task assignments and collaborate effectively. Notably, the agents' waiting times were minimized. Based on this experience, the model was refined to account for variations in agent speed due to different task types and board regions.

Future work will focus on testing the algorithm with additional assembly boards, varied wire assignments, and real industrial data to further evaluate its robustness and applicability.

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Judit Horváth – Computer Programmer Student
horvath.judit@mk.uni-pannon.hu
ORCID ID: 0009-0002-2062-3865

András Pál Darányi – Research Assistant
daranyi.andras@mk.uni-pannon.hu
ORCID ID: 0000-0002-2968-3509

Tamás Ruppert PhD – Associate Professor
ruppert.tamas@mk.uni-pannon.hu
ORCID ID: 0000-0001-9441-843X

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History

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Prestige and salary patterns across Hungarian local governments

The case study of Somogy, 1806-1830

Dániel László Kovács
Department of Modern History, Faculty of Humanities and Social Sciences, University of Pécs

ABSTRACT

This study investigates the relationship between prestige and salary within the local administrative elite of Somogy County, Hungary, between 1806 and 1830. Drawing on a prosopographic dataset compiled from archival sources, I analyze the career paths of county magistrates to assess how material and immaterial forms of recognition aligned. Building on recent historiographical debates—especially the findings of Tamás Pintér—the paper introduces a metric to rank offices based on prior career experience. The study concludes that while both prestige and payment reflected administrative hierarchy, social origin, personal connections, and prior service all played significant roles in shaping access to influential offices. The case of Somogy contributes to broader comparative efforts to understand local governance and elite formation in Hungary.

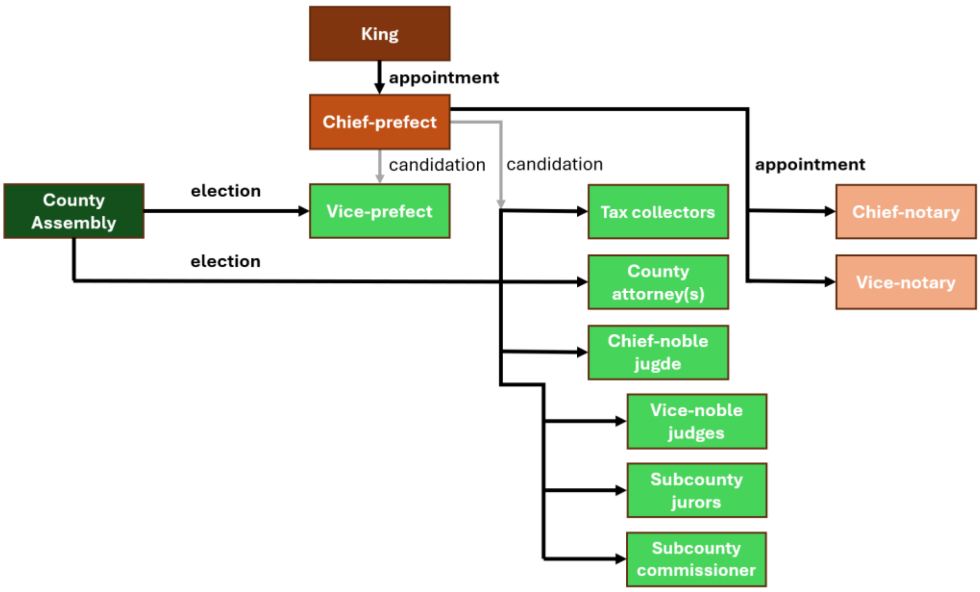
Keywords: elite, prosopography, archontology, social history, office

The purpose of the study

In recent years, numerous prosopographic studies have investigated the local elites of the Southern Transdanubian region. The aims of these studies exhibit considerable variation, even within the context of the modern period. Some studies aim to understand how institutions reorganised themselves following the end of Ottoman rule (e.g., Gőzsy & Varga, 2009), while others examine how Serbian forces interned Hungarian officials after World War I (Vörös, 2023). What is the common thread among these seemingly disparate studies? Beyond their shared geographical focus, all these publications strive to identify common characteristics contributing to a group identity. Instead of imposing contemporary historical categories, we must seek to understand the classifications of the era. We must inquire what transformed a collection of individuals into a cohesive unit.

If a researcher aims to examine a social group that existed in the past, it is essential to reconstruct both the group itself and its internal structures. To understand the magistrates, the so-called office-holding elite of the Hungarian local governments (vármegye or comitatus), we must first define who belonged to this category. Between 1790 and 1848, government reforms generally left the Hungarian counties and their personnel unchanged, making it relatively straightforward to list all the significant positions associated with prestige and salary. I will analyse these two variables and their relationship using primary historical sources (HU-MNL-SVL-IV.1.b.). Did material and immaterial recognition coincide, or can we identify notable discrepancies where the prestige and salary of certain officeholders do not align? Recently, Tamás Pintér conducted similar research in Baranya County (Pintér, 2025), where he reflected on my earlier findings in Somogy (Kovács, 2024a). He argued that the two variables do not necessarily correlate. Now, I will test his hypothesis using my previously created prosopographic dataset, and I will introduce a metric that quantifies the ratio of prior career positions,[8] enabling a ranking of all offices (Diagram 1.).

Diagram 1.
Visualization of the office-holding elite of the Hungarian local governments



Career paths

Reconstructing the hierarchy of county magistrates poses a significant challenge, as the positions within this system were not static. While some roles, such as vice-prefects and chief-notaries, held consistent leadership positions in daily administration over time, others experienced frequent changes as professional career paths evolved. In a previous study, I utilized attendance records from county assemblies to determine the relative prestige of

[8] In this model, I list the county magistrates who held office from 1806 to 1830 in Somogy, while also recording their previous experiences to provide a comprehensive view of their careers.

individuals, with the assumption that important figures would appear earlier in the lists (Kovács, 2025). However, in this current research, I have opted for a different approach: analyzing the number and types of offices held by individuals before being appointed. By quantifying career advancement through this method, we aim to gain a deeper understanding of the internal hierarchy within the county administration. This analytical framework will provide valuable insights into career progression.

The general findings suggest that by the early 19th century, the position of vice-prefect in Somogy County was predominantly reserved for individuals with connections to the established networks of county magistrates (Figure 1). The significance of prior administrative experience is underscored when examining both the list of elected officials and the group of prefect candidates. Between 1790 and 1830, over two-thirds of the candidates had either previously held a paid county position or were currently serving in one. The data clearly indicates that individuals aspiring to reach the highest ranks of county administration were expected to have proven their capabilities in lower-ranking roles.

Figure 1.
Career backgrounds of elected vice-prefects in Somogy County, 1806-1830

Career background	Vice-prefects (Total)		First vice-prefects		Second vice-prefects	
Promotion from another office	13	100%	5	100%	8	100%
From second vice-prefect	2	15%	2	20%	0	0%
From chief-notary	1	8%	0	0%	1	13%
From chief-noble judge	2	15%	2	20%	0	0%
From county court-judge	8	61%	3	60%	5	63%
Without prior office	0	0%	0	0%	0	0%

A notable deviation from the prevailing trend is evident only during the county elections of 1800. Ferenc Széchényi, the chief-prefect of Somogy,[9] nominated a considerable number of court-judges (*táblabírák*) as vice-prefects, rather than the conventional salaried officials. This anomaly can be attributed to two potential factors. Firstly, a significant number of individuals who had previously held senior positions within the administrative hierarchy had either died or retired, thereby diminishing the pool of candidates with appropriate prior experience. Secondly, the newly appointed chief-prefect may have aimed to integrate prominent landowning families into the administration, such as the Zichys, Inkeys, Boronkays, Lengyels, Somssiches, and Baron Pongráczes, who had previously distanced themselves from county administration. Although the leading members of these families did not occupy salaried county offices, they had been actively involved in local public affairs. As noted by

[9] Chief-prefects were not county magistrates, but rather royal delegates appointed to oversee the county. This is why I chose to exclude them from my analysis. Before county elections chief-prefects nominated the possible candidates.

Szijártó regarding the 18th century, holding "lesser" offices was often perceived as beneath their social standing (Szijártó, 2010, 2021). For instance, in 1785, József Somssich declined the position of vice-notary due to other commitments (HU-MNL-SVL-IV.1.b.-24/1785. Jan. 10.). Ultimately, Károly Inkey, a member of large landowning families, was elected as the new first vice-prefect in 1800.

Inkey's career exemplifies the limitations of traditional prosopographic approaches. Prior to his appointment as vice-prefect, he had not held any salaried county office; however, his election was not without a background in public life. His career progression can be traced only outside the formal ranks of county officials. In his early twenties, he inherited his father's estate in Iharosberény, which encompassed tens of thousands of acres. Around 1785, he was a member of the same Masonic lodge in Vienna as Ferenc Széchényi, the chief-prefect who presided over his election in 1800. In 1790, he served as one of Somogy County's delegates to the Diet while holding the office of county court-judge. He was later granted the titles of Knight of the Golden Spur and Royal Counselor. Throughout the 1790s, he frequently participated in county assemblies. In 1796, he contributed to drafting the county's instructions for the Diet, and in 1798, he was the first member of the delegation sent to the newly appointed Széchényi. Between 1800 and 1807, he served as first vice-prefect, and in 1802 and 1805, he was once again elected as a delegate to the Diet. According to an 1806 census, he was one of the largest landowning members of the common nobility (köznemesség) in Somogy County. His son, Antal Inkey, held the office of vice-notary during his father's term as vice-prefect (Kovács, 2024b).

If we aim to categorise all the vice-prefects of Somogy County included in the study, two fundamental career strategies can be identified. One of these strategies is exemplified by figures such as Inkey, whose advancement occurred largely outside the formal structure of the county offices. Rather than securing salaried positions, they demonstrated their competence through active participation in public life—serving on committees, in delegations, and in the county's banderia. Among these roles, serving as a delegate to the Diet appears particularly significant. In the study, I also consider these public activities as previously held "offices" because they served similar functions in demonstrating competence.

The other observable path to a vice-prefect's career involved progressing from one office to the next. The most illustrative example of this route is Ferenc Edvi Illés, who—almost uniquely during this period—ascended from the subordinate ranks of county administration to its highest post. According to Béla Baranyai, this Lutheran minor noble family arrived in Somogy via the so-called "Lengyel inheritance," and their nobility was officially recognized in the county during the census of 1754 (Baranyai, 1914). Illés married into the Catholic Farkas family of Kisbarnak in 1778, at a time when Protestant office-holding was severely restricted. He converted to Catholicism upon marriage. According to Szijártó, he first served as a subcounty-juror (járási esküdt), then as vice-noble judge (alszolgabíró), and for three years as chief-noble judge (főszolgabíró; Szijártó, 2010). Due to declining health and frequent illness, he resigned from his post in 1791; however, at his own request, the chief-prefect appointed him as a county court-judge (táblabíró). After the death of chief-notary Zsigmond Novák in 1795, Illés assumed his position before being elected second vice-prefect in 1800. An illness again forced him to resign in 1805, though he remained active in public life. Due to the deteriorating health of Károly Inkey and the absence of the second vice-prefect, he temporarily served as acting magistrate. In 1808, he was elected as a delegate to the Diet, and in 1809, he once again became second vice-prefect following the resignation of the incumbent Mihály Záborszky. He died in office in 1812 (Kovács, 2024b; Figure 2.).

Figure 2.
The Life and Career of Ferenc Edvi Illés

LIFE EVENT/HELD OFFICE	DATE
Birth	1750
Marriage and Conversion to Catholicism	1778
Subcounty-Juror	c. 1785
Vice-Noble Judge	1785
Chief-Noble Judge	1788
County Court-Judge and first “retirement”	1791
Chief Notary	1796
Second Vice-Prefect (first-time)	1800
Second “retirement”	1805
Acting or Deputy Vice-Prefect	1807
Delegate to the Diet	1808
Second Vice-Prefect (second-time)	1809
Death	1812

Contrary to initial expectations, the career-path quotient per office-holding is actually higher for the position of second vice-prefect than for that of the first vice-prefect—albeit the difference is minimal (3.14 versus 3.00). The “underperformance” of the higher-ranking position does not indicate a flaw in the metric; rather, it underscores that several second prefects began their careers at the very bottom of county administration due to their backgrounds as small landowners (e.g., Ferenc Edvi Illés started as a subcounty juror). In contrast, among the elected first vice-prefects, we typically find individuals from wealthy or middle-landowning families (such as the Inkeys, Csapodys, or Somssiches), whose financial resources and social prestige enabled them to enter county public life at a higher level—through positions such as vice-notary, court-judge, or by serving as delegates to the Diet. Consequently, they bypassed the “extra” steps in office-holding, which, in this case, elevated the average quotient in favour of the second vice-prefects. Overall, it can be concluded that both positions were typically held as the fourth office in an official’s career, clearly distinguishing these posts from other county offices in terms of their prestige.

Frequent personnel changes were evident in the office of chief-notary. Throughout this timeframe, no officeholder was reappointed more than once, and historical records indicate only a single instance of death in office. This phenomenon may be attributed to the escalating administrative demands faced by the county. The predominant career trajectory leading to the position was notably the role of vice-notary, with five out of seven individuals having previously served in this capacity. This pattern highlights the traditional career progression, where individuals who have demonstrated their skills in junior positions are promoted to senior roles. There were, however, two notable exceptions during this timeframe. Antal Igmándy assumed the chief-notary position while concurrently serving as the chief-noble judge of Szigetvár, and József Bodonyi, who had formerly held the position of manorial prosecutor. Bodonyi's case is particularly interesting, as he was previously employed in the private service of Ferenc Széchényi. The chief-prefect appointed one of his own staff members to oversee the administration of the county, which raised potential issues related to conflicts of interest. Bodonyi was eventually dropped from the office only two years later.

In the group of vice-notaries, an interesting shift can be observed compared to the 18th century. The position now appeared less as an entry-level role: 10 out of 15 office-holders had already gained some form of career experience prior to their appointment. This phenomenon is partly attributable to the emergence of new entry-level positions. The careers of archivists and county attorneys closely resembled these trends. The central offices of tax administration also required prior experience within the government. It is noteworthy, however, that this expected background was not linked to specific positions; career paths included roles such as vice-notaries, archivists, noble-judges, subcounty tax collectors, jurors, commissioners, and county court-judges. Uniquely, a transition between the offices of accountant and chief-tax collector occurred only once: Károly Barcza was promoted from the former to the latter. Unlike other groups of offices, there was a noticeably low level of professionalisation. Apart from Barcza, only two individuals advanced from a lower to a "higher" version of the same office: Pál Thulmon became chief-tax collector as a subcounty tax collector from Kaposvár, and László Hunkár was elevated from Kanizsa. The high failure rate observed among accountants may also indicate the lack of professional career paths and the absence of necessary prior experience—out of six elections, incumbent officials were not re-elected on four occasions.

Significant changes can be observed in the offices of noble-judges compared to the 18th century. In the early 1800s, it was observed that nearly all of them, with one exception, had previous experience in their positions. The most notable signs of professionalization were particularly evident within the subcounty-level administration. The transition of new officials from other roles, such as notarial, tax collection, or prosecutorial positions, was relatively rare. This suggests that internal promotion practices within specific office groups were becoming more established. Additionally, the significance of prior office experience was increasingly valued among vice-noble judges. These developments in Somogy appear to be reflective of broader trends, as Tímea Sáfrány has documented similar findings in Csongrád County (Sáfrány, 2022).

Subcounty officials such as jurors, tax collectors and commissioners typically held entry-level positions within the administrative hierarchy, but by the end of the examined period, an increasing number of officeholders arrived with prior career experience. This trend was primarily due to the growing number of preliminary office-holdings resulting from honorary appointments.[10] It can be established that a significant portion of the new personnel entering the county administration did so through the group of honorary (unpaid) offices, even if they did not initially receive any salary for their work. In half of the cases, these honorary positions were followed by a change in office—an advancement to a paid position. By the 1820s in Somogy, honorary service had become the first step on the path to an official career.

After observing the entire office-holding elite, we can now classify the examined magistrates. At the apex of the administrative hierarchy, vice-prefects are distinctly differentiated from other roles, exhibiting a career background index that exceeds 3.00 (Level 1). Likewise, the positions of chief-notary, chief-tax collector, and chief-attorney were similarly inaccessible to individuals lacking prior administrative experience, typically requiring the attainment of two preceding positions (Level 2). Although the role of chief-noble judge generally functioned as a secondary office and was ranked below other central administrative roles, it nonetheless served as a significant "recommendation letter" for promotion to a vice-prefect position. This category also encompassed the offices of financial accountant, vice-notary, archivist, and vice-attorney (Level 3). The latter three positions, along with the vice-noble judge and subcounty-tax collector roles, were situated at the threshold between the third and fourth tiers. These offices were only differentiated by the career background ratio. Typical entry-level positions within county administration included roles such as jurors, commissioners, and, with a few exceptions, honorary assignments (Level 4; Figure 3.).

Figure 3.
Typical position of the given office in a career trajectory based on the career experience ratio. Based on: Somogy County, 1806–1830

Fourth office	Third office	Second office	First office
Vice-prefect	Chief-notary	Chief-noble judge	Vice-noble judge
	Chief-tax collector	Accountant	Subcounty-tax collector
	Chief-attorney	Vice-notary	Subcounty-juror
		Archivist	Subcounty-commissioner
		Vice-attorney	Most of honorary offices

[10] Honorary magistrates only received per-diem payments for their work.

Prestige and salary

After reconstructing the hierarchy of county magistrates, we can now analyse how prestige and material recognition correlated in the era. As noted by Pintér in his research on Baranya, it is evident that these two variables may occasionally exhibit varying levels, but the fundamental order remains consistent. An interesting anomaly we discovered was the honorary position of acting vice-prefect, held by only one individual in the dataset—Ferenc Edvi Illés. Illés, with five previous positions under his belt, was the most experienced official in the sample, making his appointment to this unique role quite noteworthy. When looking at the "regular" vice-prefects, we observed that despite having similar career experience levels (typically fourth office), the salaries of the first and second magistrates differed significantly—the latter only earning half of the former. This salary gap can likely be attributed to the administrative responsibilities associated with the first vice-prefect's office, which essentially served as the county's leader in the chief-prefect's absence. Presiding over legal proceedings and managing the daily operations was a full-time job, while the second vice-prefect functioned more as a deputy or reserve official.

Chief-notaries and chief-tax collectors were among the most crucial magistrates in maintaining administrative continuity ("Words come and go; only the written word remains."). Both positions held equal prestige and payment, receiving 600 Ft for their dedicated work. The chief-attorneys, on the other hand, earned a slightly lower salary of 400 Ft, perhaps reflecting the perceived difference in responsibility between the roles. It could be speculated that recruiting individuals with legal knowledge was easier than finding those with specialized skills for chief-notaries or tax collectors. Eye problems or managing estates could easily make someone ineligible for certain duties. The early 1800s also saw a significant increase in administrative tasks due to the French wars, potentially deterring suitable candidates. A higher salary undoubtedly served as a greater motivator for those willing to take on the demanding roles.

Chief-noble judges and chief-attorneys were both essential roles in the administration of justice, earning similar salaries of 400 Ft. This is not surprising, as they shared some responsibilities. Chief-noble judges, operating at the subcounty level, not only handled administrative duties but also presided over legal cases. On the other hand, chief-attorneys served as public prosecutors at the county level. Supporting these senior officers were accountants, vice-notaries, archivists, and vice-attorneys, who earned around half the salary of "regular" magistrates, ranging from 250-300 Ft. Vice-notaries and archivists received higher pay due to the monumental tasks they carried out at the county's chancellery. The professionalization led to an increase in paperwork, and the registration of old documents required immense effort. The rise of modern bureaucracy brought various challenges. While the jobs of accountants and vice-attorneys were also not easy, their focus was primarily on supporting their senior officers.

At the subcounty level, vice-noble judges, tax collectors, jurors, and commissioners carried out daily operations under the supervision of central magistrates. The size of the counties required magistrates who were present locally and could easily reach the communities they served. These positions were typically held by noblemen who were not part of the first line of the elite but rather members of the lesser nobility. They relied heavily on their salaries, as they did not own large estates, and holding office provided them with a significant source of income. Noble judges and tax collectors received payments comparable to other junior officers in the central administration, earning around 250 Ft. However, jurors and commissioners were paid significantly less, receiving only half of what others earned, ranging from 100-150 Ft. These offices were considered entry-level positions, with only every second magistrate having administrative experience.

The honorary daily-paid magistrates were typically newcomers, with only a few retired jurors receiving honorary appointments later in life. The distinction between salaried and honorary officials was complex, as an annual salary alone could not guarantee a living. Chief-prefect Károly Sigray stated in 1791: “The noble members of the County Magistracy do not work for salaries, but for honour.” (HU-MNL-SVL-IV.1.b.-11/1791. márc. 21.). However, a regular income could have been beneficial for small and medium-sized landowning families to cover the costs associated with their duties. For example, László Czindery once resigned his honorarium in favour of Albert Sárközy, demonstrating the financial challenges faced by these magistrates (HU-MNL-SVL-IV.1.b.-1430/1813.; Figure 4.)

Figure 4.
Proportion of office holdings with prior career experience, and the career experience ratio per office holding in Somogy, 1806–1830

Office	Salary[11]	Prior experience		
		%[12]	#[13]	_[14]
Acting vice-prefect	–	100%	5,00	–
First vice-prefect	1000	100%	3,00	Fourth
Second vice-prefect	500	100%	3,14	
Chief-notary	600	100%	2,14	Third
Hon. chief-notary	–	100%	2,00	
Chief-tax collector	600	100%	2,00	
Chief-attorney	400	100%	2,17	
Chief-noble judge	400	96%	1,70	Second
Accountant	250	80%	1,60	
Vice-notary	300[15]	67%	1,07	
Archivist[16]	300	71%	1,00	
Vice-attorney	250	57%	1,00	
Vice-noble judge	250	73%	0,93	First
Subc.-tax collector	250	67%	0,89	
Subcounty-juror	100	53%	0,62	
Honorary juror	–	38%	0,58	
Commissioner	150	46%	0,50	
Hon. vice-noble j.	–	33%	0,33	
Hon. vice-notary	–	13%	0,27	
Hon. vice-attorney	–	13%	0,25	
Hon. accountant	–	0%	0,00	
Hon. commission.	–	0%	0,00	

[11] Annual salary in Hungarian Forint. Based on: HU-MNL-SVL-IV.1.b.-3/1790. máj. 19.
[12] The proportion of office holdings with known prior career experience.
[13] Prior career experience ratio per office holding.
[14] Typical ordinal position of the given office in a career trajectory based on the career experience ratio.
[15] In 1790, two vice-notaries were in service: the first vice-notary earned 300 forints annually, while the second received 250 forints.
[16] The position was only created a year later, in 1791.

Conclusions

In conclusion, it can be stated that in most cases, the payment typically corresponded to the prestige associated with the position. The conditions in Baranya and Somogy counties clearly show similarities, with differences arising only from a few local particularities (for example, in Baranya, the chief-tax collector was assisted by an assistant collector, whereas in Somogy, individual tax collectors operated in each subcounty alongside the central administration). A nationwide comparative study of county conditions would certainly be an intriguing research question. However, this would require a broader collaboration among researchers, as in many regions, the lists of officeholders are incompletely documented. Previously, Szijártó attempted to compare career paths. However, the quality and depth of the officeholder records he used made the comparison difficult (Szijártó, 2021). The research has primarily covered counties located within present-day Hungary; including counties beyond the current borders would require a larger international scholarly discourse.

Although in the period, it was ultimately the central government—the Royal Council of Governor (Helytartótanács)—that decided on the salaries of county officials, the amounts negotiated by individual counties can nonetheless help us understand regional differences. In Somogy, for example, the archivists' salaries were initially set at 300 Ft when the office was established in the early 1790s, aligning with national standards. Over time, however, it became clear that cataloging old documents was a physically and mentally demanding task. Archivists also had to participate in day-to-day administrative duties (e.g. issuing proofs of nobility based on archival records). To make the position more attractive and sustainable, the county eventually secured a salary increase to 400 Ft (HU-MNL-SVL-IV.1.x.).

The term "county elite" is a concept that is difficult to interpret in the context of the present day. The political decision-making used to rest on the shoulders of the local nobility. However, after 1849, political power gradually became centralised. The competencies of the counties were hollowed out, with intermediary functions becoming dominant. County elites no longer exist, as the meso-level they once dominated has drastically diminished. Nevertheless, researching this group is not without purpose, as the patterns, tendencies, and deviations observable in the past can often be paralleled with phenomena of the reader's own time (e.g., local governance, identity, career-building, corruption).

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Archival sources serving as the base of prosopographic dataset

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Dániel László Kovács – PhD student
kovacs.daniel.laszlo@pte.hu
https://orcid.org/0009-0005-6906-5093

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Cosmonaut cult in Baranya county

Péter Nagy

Interdisciplinary Doctoral School, University of Pécs

ABSTRACT

Beyond its military, scientific, and political dimensions, space race also has a deeply symbolic meaning: who would lead humanity's cosmic exodus? Expectations and myths permeated everyday life, from rocket-shaped playground structures to youth literature and the naming of public buildings. For obvious reasons, both the Soviet Union and the United States constructed their own "national space myths." Soviet narratives were adopted across the socialist bloc in the early stages of the space race, including in Hungary. However, the cult of heroism surrounding cosmonauts, given that they were living persons, was contrary to one of the principles of the Kádár regime: the prohibition of personality cult. In this study, I examine how public discourse around the cult of Soviet cosmonauts evolved in Baranya County from the 1960s to the present. Drawing on archival records, contemporary press, public speeches, and state sentiment reports, it explores why the young mining city of Komló, rather than the metal industrial stronghold of Dunaújváros (then Stalin City), was selected as the key destination for Yuri Gagarin's 1961 visit to Hungary, as well as its local implications. I also investigated how and why the cult of another Soviet cosmonaut, Vladimir Komarov, emerged in the city of Pécs and why it ultimately faded, unlike Gagarin's lasting cult in Komló. By unpacking the dominant narratives of this era, this study places Hungarian interpretations of space exploration within the broader context of the Cold War. It also contributes to the understanding of everyday life during the Kádár era. Furthermore, the upcoming second manned spaceflight of Hungary (and Poland), scheduled for the summer of 2025 underscores the timeliness of this research and its relevance to Hungarian and broader Central European space historiography.

Keywords: Baranya County, Cold War space history, cosmonaut cult, identity, Hungary, Komló, Soviet space propaganda, Pécs

Introduction

In June 2025, the exploration of space in Hungary will garner significant public and scientific attention. Forty-five years subsequent to Bertalan Farkas' space flight, a Hungarian citizen, Tibor Kapu, will once again embark on a journey into space. This development positions Hungary among a select group of nations with more than one citizen who has participated in a manned space mission. This event holds substantial significance for the Hungarian scientific community, as it is anticipated to yield numerous valuable scientific outcomes. Furthermore, it represents a pivotal moment in the evolution of the Hungarian national space narrative. The space flight also presents an opportunity for Hungarian historiography to engage more deeply with international and domestic space history research, with particular emphasis on the history of space competition, space propaganda, and the interplay between space exploration and legitimacy, identity formation, and political representation.

Given the lack of complex historical and social science analyses of the impact of space exploration, space race, and space propaganda in Hungary, this area is an unexplored field of research. Currently, there is little substantive knowledge available on how these global processes emerged and their political-social-cultural impact in the Hungarian context. Exceptions are Yuri Gagarin's visit to Hungary in 1961 (Gyánti & Kult, 2018; Kocsis, 2011) and Bertalan Farkas' space flight in 1980, the archival documents that have been processed by the Hungarian National Archives in an excellent source publication (Kocsis & Ólmosi, 2011). In the 1980s, a number of educational and scientific works were produced, such as the Űrhajózási Lexikon (Space Navigation Enciklopedia; Almár & Horváth, 1984), but these were mainly technical and chronological. The social science of the manned missions of the Interkosmos program was not initiated by researchers from the countries concerned, such as Hungary, but by Western authors (Burgess & Vis, 2016). It is important to emphasize that the impact of space history and Soviet space propaganda in particular did not disappear at the end of the Cold War. Certain elements live in collective memory, are embedded in local identities, and can be found in today's public discourse, even in the form of debates and conflicts. According to Hungarian law adopted in 2012, no organization or public space may bear the name of a person "*who played a leading role in the establishment, construction, or maintenance of the authoritarian political regimes of the 20th century*" (Act CLXVII of 2012 on the Amendment of Certain Laws Related to the Prohibition of Names Linked to 20th-Century Authoritarian Regimes, 2012, p. 1). The law designates the Hungarian Academy of Sciences as adjudicating disputes, and its position is that Yuri Gagarin does not fall within the prohibitive scope of the law (MTA BTK-T/5/2013). However, there is also a civil initiative to advocate for renaming these public spaces. Despite this, there are still at least 18 Hungarian municipalities with streets or squares that bear Gagarin's name (Magyar Patrióták Közössége, 2019). The discourses related to it, stemming from space history and space propaganda, have opened up new research perspectives in the fields of memory politics, public representation, and identity formation.

The present study examines one of the central narratives of Soviet space propaganda, the cult of the spaceship, and its adaptation in Hungary in a local context: the example of Baranya County. This research seeks answers to the question of how the cult of Soviet cosmonauts appeared in the public sphere of the Kádár regime and the role it played in the discourses of legitimation and modernization. To what extent were the narratives of Hungarian propaganda identical to the Soviet model? What are the specific features of the space race and cult of the spacecraft in Hungarian discourse? What was the significance of Gagarin's visit to 1961 in this context? How was the cult of Komarov and Gagarin formed in two prominent cities in Baranya County: Pécs and Komló?

The first chapter of the paper briefly reviews the historiography of the topic and the theoretical background of Soviet space propaganda based on the literature and the Hungarian context from 1957 onwards. I examine the narrative elements that shaped Soviet propaganda on the Cold War space race and the historical-cultural factors and regional specificities that influenced their adaptation and reception in Hungary.

In the second chapter, I analyze the appearance of Soviet space propaganda, especially the cult of the cosmonaut in Baranya, exploring how the narrative of the space race and the heroic cult of Soviet cosmonauts prevailed in the cultural discourse, what characteristics the Hungarian public without a personal cult showed, and what made Komló a prominent site during Gagarin's visit in 1961.

I conclude the paper with a summary chapter, in which I draw my own informed professional conclusions based on objective data and evidence.

In this study, I use international space history literature (see Chapter 1), archival sources (mostly sentiment reports), contemporary newspaper articles, publications, and film news to examine the issues raised. In the case of archival sources, I used party documents from the Hungarian National Archives in the Baranya County Archives of the Hungarian National Archives, the materials of the agitation and propaganda departments of the Baranya County Committee of the Hungarian Socialist Workers' Party (MSZMP), mainly mood reports, and the documents of the MSZMP committees of the towns of Pécs and Komló. My research concept was that since Yuri Gagarin had visited these towns, the strongest traces of the discourse were probably found here. These documents are, therefore, the most promising sources for studying the social resonance of the space race and cosmonauts. Further sources will be the published papers of party congresses and the published speeches of party leaders, as I have hypothesized that the totality of these might provide a complex picture of the public discourse of the period that can be researched today. In this paper, I will pay particular attention to the study of the cult of Gagarin and Komarov, which is largely derived from my research concept of the significance of Gagarin's visit to Hungary, as mentioned above. In addition, these two cosmonauts, due to their age and tragic deaths at a young age, occupied a special position in the politics of memory of the Kádár era. This dual factor has made it possible for their names, no longer living, to be borne by many public institutions and public spaces, such as those of the heroic Soviet cosmonauts. In contrast, for the remaining Soviet cosmonauts, the prohibition of personality cults, the diminishing momentum of the Soviet space program, and the diminishing importance of the legitimacy function in a changing political environment have combined to prevent this. Accordingly, the analysis of the sources suggests that cult building among these cosmonauts was much more modest, less intensive, and less effective.

The space race as a research field, Soviet space propaganda and its context in Hungary

To understand how Soviet space propaganda was interpreted in Kádár-era Hungary, especially in Baranya County, we first needed to establish a theoretical and historical framework for interpretation. To do so, I will review the most important research findings and theoretical approaches to Soviet space propaganda and present the Hungarian political and cultural context of the period that determined the adaptation and reception of propaganda in Hungary.

The space race as a research field

From the very beginning, international space history research was centered on the United States, where the first chronological accounts of American space activity began to appear in the 1960s, in parallel with the events of the space race. By the 1980s, space history became a sub-discipline in its own right in American historiography (Chamberlain & Hade 1981). The turn of the 1920s saw a major shift in the theoretical framework (Siddiqi, 2000), the emergence of new sociological perspectives and the expansion of the source base, for example with Soviet/Russian archival material and personal recollections (Chertok, 2005). These developments have increasingly embedded the history of space exploration into the analytical contexts of political, social, and cultural history. Currently, the focus of research has shifted away from summarizing works towards less processed topics, such as the role of the Global South in the space race (Siddiqi, 2025) or the study of the links between politics, space propaganda, and science fiction (Banerjee, 2018).

As mentioned in the introduction, the exploration of Hungarian aspects of space history is still in its early stages. This is partly understandable since Hungary was not an active player in the space race. However, the study of Hungarian interpretations of space exploration not only allows us to decode the narratives of the period but also sheds new light on the role of Hungarian cosmonauts. This perspective can also contribute to a deeper understanding of the everyday reality and cultural and political milieu of the Kádár era. In particular, it can play an important role in examining the legitimation efforts of the Communist Party, given the symbolic association (visual and verbal) of their rule on the basis of modernization ideology with Soviet space propaganda and cosmonauts, which were also present in everyday life.

Features of Soviet space propaganda

Following the historiographical overview, we now turn to the main features of Soviet space propaganda. One of the basic aims of Soviet propaganda was to create a new identity and myth for the new socialist society. In this spirit, for example, the myths and legends of the Great October Socialist Revolution and the Great Patriotic War became central to official historiography. At the same time, the regime did not hesitate to incorporate the cultural legacy of the tsarist era into its new narratives, as long as they could serve the goals of Soviet ideology (Gerovitch, 2015).

The content of the new narratives was essentially determined by the emphasis on the supremacy of the party and ideology, and their aim was to justify the system's uniqueness and historical necessity. The function of these narratives was to legitimize the party's exercise of power while simultaneously becoming a means of ideological education. This logic was also applied to space propaganda: the Soviet state gradually developed its own master narrative of space exploration, centered on the myth of the "founding father". Among the narratives of space history constructed in a national context, this took a particularly distinctive form and still determined the social discourse on this subject in the et-Russian cultural-political space. Its key figures and symbols are briefly summarized in Tsiolkovsky, Gagarin, Korolev, Laika, Sputnik, and Vostok. These names and events are not only the cornerstones of Soviet/Russian space history, but also occupy a prominent place in the narrative of humanity's cosmic presence. Without them, any discourse on global spatial history and spatial activity is either impossible or difficult to interpret. This is not only a result of their scientific achievements, but also, to a large extent, of successful Soviet space propaganda. At the heart of the master narrative was collectivized heroism and the technological and political achievements that were systematically achieved to provide ideological legitimacy and identity for the socialist state (Siddiqi & Andrews, 2011). Organically embedded in this discursive construct was the cultural and philosophical trend of utopian-spiritual orientation towards outer space that emerged in Russian thought from the late 19th century onwards, which interpreted cosmic horizons as the arena for social and moral development. In this context, Soviet space propaganda not only articulated a narrative of scientific and technological progress, but also actively participated in the discursive construction of the new Soviet idea of man, in the service of identity politics (Gerovitch, 2015).

The heroic cosmonaut - along with the revolutionary, the Red Soldier, the partisan, and the living-worker hero–proved in the 1960s to be impeccable in his work and in his ideological loyalty. His existential identity was constituted by a belief in a communist future, an important pillar of which was the ideological vision of continuous progress. While his predecessors had triumphed over the tsarist autocracy, the difficulties of post-civil war reconstruction, and fascism, the generation of cosmonauts was predestined–symbolically–to triumph over capitalism after the conquest of nature (soviet virgin lands, outer space). Soviet propaganda in the space race was also characterized by militant rhetoric. While the American discourse was dominated by word exploration, Soviet terminology, by contrast, used the term conquest, which signalled the ideological-cultural and geopolitical stakes of the space race (Gerovitch, 2015). Thus, space was not only the arena of scientific competition, but also the arena of ideological salvation, where Soviet man could ultimately fulfil his historical mission. This ideal, constructed from narrative elements, served as the basis for the social and cultural institutionalization of the space cult.

As alluded to earlier, the narratives constructed by Soviet propaganda formed an interconnected, mutually reinforcing network of meanings, whose basic function was to legitimize the monopoly of power of the Communist Party and ideology. A central element of this narrative structure was the view of continuous progress derived from Marxist-Leninist ideology, which interpreted historical progress as a necessary and irreversible process towards communism. The essence of this construction is that both social and technical progress are proof and consequences of the correctness and omnipotence of communist ideology. The success of the Soviet space program became a symbolic achievement of communist modernization within this narrative. At the XXI (1959) and XXII (1961) congresses of the Communist Party of the Soviet Union (CPSU), Khrushchev declared under the slogan догнать и перегнать (catch up and overtake) that within twenty years the economic and social foundation would be established on which the entire structure of communism could be built within the foreseeable future (Fedor, 1959, 1962). This historic goal and its stages will be achieved by the states of the socialist camp under the leadership of the Soviet Union, moving forward together. The other decisive dimension of progress was belief in scientific and technological progress, which was also ideologically based. Gherman Titov, the second Soviet cosmonaut, said in a contemporary statement that „*Vostok - the Aurora of the Space Age*" (Titov, 1976, p. 7), suggesting that the conquest of space also marked a new era in the Soviet historic mission. In this discourse, Marxism-Leninism appeared not only as a doctrine of social organization but also as a scientific explanation of the world, the validity of which seemed to be confirmed by the results of technical progress (especially space exploration). According to this narrative, the realization of communism required collective effort, sacrifice, and intensive work, but scientific and technical breakthroughs, especially in the space race, were to prove its validity and historical necessity. This construct of thought culminated on April 14, 1961, and can be interpreted symbolically as the culmination of Soviet civilization. In the Red Square, in front of a celebrating crowd, Nikita Khrushchev and Yuri Gagarin held hands to display the supremacy of ideology, the unity of the Party and the new man, and the symbolic intertwining of political and technological modernity (Siddiqi & Andrews, 2011). In the propaganda vision, all this was embedded in a broader narrative of civilization, where the East, in allegorical form, defeated the West. The Soviet spacecraft Vostok (meaning East) overtook the US Mercury program and Alan Shepard, as the Moskvitch symbolically overtook Ford, representing the capitalist world. The Soviet man thus became not only a participant, but also a carrier in the progress of history.

Of particular importance for the cosmonaut myth and its associated identity narratives, as well as for the legitimizing function of space propaganda, was a discursive practice that emphasized the positive relationship between cosmonauts and the ruling party. The heroic cosmonaut, as a cosmos conqueror, also became a role model of ideological loyalty. Communist convictions were an integral part of his identity, which also reinforced the two pillars of the developmental ideal discussed earlier: the Marxist-Leninist interpretation of historical progress and faith in scientific and technological progress. The cosmonaut, as "Columbus of the cosmos", appeared as both a symbolic representation of Soviet scientific rationality (dialectical materialism) and party loyalty. Party membership in this narrative meant not only political loyalty but also personal dignity, social status, and stability of identity. Party membership is seen in a cosmonaut's self-understanding as a source of moral strength that motivates him to carry out his heroic mission. This role concept has been explicitly articulated by both Gagarin (Gagarin, 1962) and Titov (Titov, 1976) in their autobiographical writings. The legitimizing function of propaganda has evolved dynamically according to the current power interests of the party. A striking example of this can be seen in the representational strategies of first cosmonauts. Nikita Khrushchev regularly appeared with the cosmonauts at public events and in photographs, where visual rhetoric consistently placed him in a paternal position vis-à-vis the cosmonauts. This symbolic arrangement served not only to promote Khrushchev personally but also to articulate the harmony between the party and science and technological modernity. The importance of this visual legitimation is particularly clear in the changes that occurred after the Khrushchev-Brezhnev transition of power in 1964. After that, official propaganda began to distribute only those previously marginal shots in which the cosmonauts (including Gagarin and Titov) were already in the company of the new party leader Brezhnev. The legitimacy of the relationship between cosmonauts and the party is illustrated by the new party leader's need for representation. Titov's autobiography, published in Hungarian in 1976, was already published, with a selection of photos edited accordingly (Titov, 1976).

Among the ideological narratives of space propaganda, special mention should be made of the discourse on scientific atheism, which was also an integral part of the legitimation system of communist ideology. Scientific atheism was not only a tool in the cultural and power struggle against religion but also an attempt to build a coherent scientific basis for a socialist worldview. One of the best-known rhetorical topos of this narrative is that of Yuri Gagarin, who declared on his space flight that he had seen neither heaven nor God. In this statement, he implicitly denied the validity of religious transcendence while directly questioning the legitimacy of the churches and their teachings. In the Khrushchev era, the concept of 'positive atheism' emerged as a new form of anticlerical campaign, which sought to assert anti-religion in a scientific and enlightening framework rather than outright rejection. Its aim was not only to weaken the social influence of religion but also to replace it culturally. Ritual and symbolic religious practices have been replaced with secular alternatives. Religious festivals have been replaced by socialist state ceremonies and social celebrations. Thus, the symbolic occupation and transformation of cultural space were replaced by planetariums. The latter served to popularize the scientific-materialist view of the universe and was often taken to rural locations in travelling versions–mobile planetariums. Speakers with scientific qualifications confirmed what cosmonauts had already said: There is no God or heaven in the sky. What is the land of communist promise? The cosmonauts' role in this ideological construction was symbolic: they embodied the practical credibility of the 'scientific worldview,' acting as 'cosmic witnesses' against the religious worldview. According to this secular mythology, heavens are not a scene of divine transcendence, but of communist modernity, now dominated by science and technology and, by implication, by ideology. The planetarium has become a new sanctuary and cosmonaut for the high priest of communist cosmology (Mauer et al., 2011).

In the analysis of Soviet propaganda, it is essential to explore the specificities of visual and verbal representation strategies. The content communicated to the public was characterized by marked selectivity: the technical details of the space program, the development processes, and the operational aspects of the preparations were typically left in the background, while plans for future missions were not publicly communicated. Failures consistently hushed up. Thus, the narrative focused exclusively on success, suggesting the linearity and ideological fulfilment of the historical process. The Soviet military, a key player and financier of the space program, was never explicitly mentioned in propaganda. This was because emphasizing military presence would have been incompatible with the official narrative of the peaceful and scientific objectives of socialism. Along similar lines, the depiction of the rocket as a technical tool and space asset was also restrained and often stylized, even naïve, in its visuality. Much of the imagery has been retouched, avoiding realistic technical details and presenting the means of conquering the cosmos with almost childlike simplicity. Interestingly, while the rocket as a technological object remained a reduced object of propaganda as a weapon, a demonstrative instrument of military power, it became a regular feature of the Red Square parade during the Khrushchev era. The names of the scientific-technical elite, engineers and researchers, also remained in the background: they could not appear in public during their lifetime, and only after their death was it possible to mention their names (Siddiqi, 2000). Instead, official communication featured spokespersons who had little or no connection - real or symbolic - with the space program, but who fitted well into the formal requirements of the ideological narrative. The emphasis was thus not on the real operators of the program, but on stylized figures who embodied the ideal type of Soviet man and thus became a means of representing the legitimacy of the political system and the superiority of socialist ideology (Siddiqi & Andrews 2011).

When examining Soviet propaganda, one cannot ignore its narrative of the foreign public. Its aim was to reach audiences outside the Soviet Union, particularly in the context of the Cultural Cold War and particularly in the West. A similar approach was taken in the United States: the propaganda of the two superpowers towards each other's audiences showed similar structures. Trevor Sean Rockwell's comparative study of the media representations of Russian-language America (the US publication in the USSR) and the English-language Soviet Life (the US publication in the US) concludes that, despite ideological differences, space propaganda used similar topos in several respects, such as the space program as a joint endeavor of mankind, peaceful exploration, and the emphasis on scientific superiority (Rockwell, 2012). Nevertheless, the objective of Soviet international space propaganda was to amplify the impact of the Sputnik shock and Soviet technological advances in the west. This ideological construct was linked to the self-image of the victorious state: the image of the Soviet Union that had won the Second World War, was internally strong and capable of development, and was socially capable of surpassing capitalism in peaceful competition. One of the key representational spaces for this narrative was the World Expo in Brussels (Expo 1958), which served as a cultural battleground between the two world systems. It offered the Soviet Union an exceptional opportunity to demonstrate its technological achievements and the results of its social system in an international, but ideologically hostile environment. The centerpiece of their exhibition was the Soviet Pavilion, designed by young architects in a modernist, futuristic style. Visual material in the interior can be divided into two main groups: photographs of everyday life in socialism and the well-being of the working man, and object and image representations of space exploration. The first two Sputnik replicas attracted a great deal of international attention and recognition from both professional jury and visitors. At the same time, propaganda in the press of socialist countries reporting on exhibitions consistently reinforced the image that the Western world was equally astonished and appreciative of the development of Soviet science and technology (Siegelbaum, 2012).

The propagandistic exaggeration of Soviet scientific and technological achievements, especially under Khrushchev, served not only as a means of internal legitimacy, but also as a means of exerting international political pressure. In the course of the so-called missile diplomacy that is associated with Khrushchev's name, the Soviet leadership regularly over-emphasized the achievements of military missile technology and the development of space assets, often exaggerating their capabilities and numbers. This discourse became a tool of strategic deterrence and political influence, and missiles were presented as symbols of Soviet technological superiority, often in the form of threats. This rhetorical and political strategy was closely intertwined with the foreign-policy dimensions of space propaganda. The timing of the launch of Sputnik-2 on the 40th anniversary of the October Revolution and Gherman Titov's Vostok-2 spaceflight, which coincided with the construction of the Berlin Wall, were not only symbolic but also conveyed a conscious political message. As Fischer pointed out, these timings were at Khrushchev's direct initiative and were intended to demonstrate the West the Soviet Union's technological potential and strategic scope and to provide an alternative subject for both the Western and Soviet bloc media. Framing events in this way fit well into the internationally oriented narrative of Soviet space propaganda, where technological success was not only a symbol of scientific progress, but also a justification of the viability and foreign policy weight of the Soviet world system (Fischer, 2014).

The development of Soviet space propaganda was not the result of a single event, but of a gradually evolving ideological and communication practice. As an initial step, following the launch of Sputnik-1 in the late evening hours of October 4, 1957, official information took extremely sparse form: the next day, only a succinct TASS release and a short news item appeared on the pages of Pravda (Siddiqi & Andrews, 2011). The actual propaganda campaign was launched after a delay of a few days, after the Soviet leadership sensed the reactions in the Western press, especially in the US, which interpreted the satellite launch as a strategic threat. It was then that the US public realized that the Soviet Union, previously considered technologically backward, might now be able to target the United States. The shock, which also recalled the traumatic memory of Pearl Harbor in World War II, was framed not only as a military defeat, but also as a scientific and technological one. This perception appears in the Khrushchevian narrative as a historical triumph of the socialist system over capitalism. In this way, the Sputnik beep-beep signal from Earth orbit (Siddiqi & Andrews, 2011) was used as a victory narrative in the Khrushchevian narrative of "peaceful competition". Soviet leadership then consciously exploited and amplified the emerging discourse, which was served by increasingly professionalized propaganda strategies. In January 1959, timed to coincide with the 21st Congress of the USSR, the Luna-1 lunar probe (so-called "Lunik") was launched into orbit and was the first artificial planet in the solar system to appear in official communications. In his address to the Congress, Khrushchev interpreted the historic event as a triumph of Soviet science, and, fitting it into the ideological narrative, said: "*All this: a great event of the era of building communism. How can we, the Soviet people, not rejoice in these successes? The first artificial moon on Earth was the Soviet moon. The first artificial planet in the solar system was the Soviet planet. Throughout the boundless spaces of the universe, it proudly bears the state emblem of the Soviet Union and the words „Union of Soviet Socialist Republics. January 1959"*„ (Fedor 1959, p. 16-17). Khrushchev spoke at length about achievements in space exploration and returned to the subject in the closing speech of Congress. In this way, as if to indicate, the ideological interpretation and political exploitation of space successes is the expected pattern for the parties within the sphere of influence of the Soviet Union and the context in which these successes can and should be interpreted. The narratives of Soviet space propaganda were finally completed in 1961. With the arrival of Yuri Gagarin in space, a cult of the heroic Soviet cosmonaut was created: the embodiment of the new human ideal, which became a living symbol of ideological and technological superiority.

From the mid-1960s onwards, public opinion in both the East and West gradually became accustomed to space exploration and its achievements. Space events, which had previously attracted unprecedented interest, gradually became part of everyday life, especially when a mission did not offer any new „firsts." After the peak of the Soviet Union and, to some extent, American—space propaganda, the public's threshold for excitement rose, and space flights, which were becoming increasingly frequent and routine, lost their initial sensational value. This process is clearly evident in the United States in the decline of public support for the Apollo programme and the resulting reduction in the number of missions. On the Soviet side, this trend became increasingly apparent after 1964 for several interrelated reasons. After the spectacular successes of the Vostok program, their advantages melted away relatively quickly, and the innovative momentum of the Soviet space program was broken. After the power shift, the new party leadership, headed by Leonid Brezhnev, no longer attached strategic importance to the space race, at least not to the same extent as his predecessor Nikita Khrushchev. Technical challenges and human tragedies also contributed to the fall of the Soviet space program. Partly because of the Komarov disaster of the Soyuz program in 1967, their moon program stalled, while the United States successfully reached the surface of the moon. The American side won this „moon race," which was significant in both technical and political terms, bringing an end to the era of spectacular victories for the Soviet Union in the space race. From then on, long-term human presence and space stations became the stage for modest propaganda on Soviet superiority. According to some interpretations (Rockwell, 2012), the space race primarily served propaganda purposes. Although formally launched as a scientific endeavor, Sputnik opened up a new symbolic Cold War front for the Soviet Union, which became a prominent theatre of ideological struggle. During this period, both sides were essentially captured by the symbol of space exploration, a war of representation. The Soviet space program was built on the pursuit of propagandistic victories, while the American Apollo program aimed to surpass them. However, neither the Soviets' space program to achieve firsts nor the US moon landing directly served the long-term goals of scientific research or technological development. "*Among other things, the early space race was a discursive struggle over who had the right to represent universal humanity in the greatest story of the modern world. Who would be the scriptwriter and protagonist of humanity's cosmic exodus?*" (Bryld & Lykke, 2000; cited from Siddiqi, 2006, p. 476-477).

Hungary at the opening of the Space Race

Soviet space propaganda was taken up not only by the countries within the Soviet sphere of influence but also by the Communist parties of countries outside the bloc. In practice, this was mainly manifested in the adoption by national party leaders and the press of statements and rhetorical turns of the CPA, Pravda, Khrushchev, and other Soviet leaders. As a result, a unified public discourse and ritual forms of space propaganda emerged. As in the Soviet model, at the heart of the discourse was the emphasis on legitimacy, the idea of progress, and the triumph of socialism over capitalism. At the same time, as we will see in the Hungarian example, there were some differences from Soviet narratives, mainly due to the adaptation to local political and social conditions.

On October 23, 1956, a revolution and fight for freedom broke out in Hungary against the Stalinist regime led by Mátyás Rákosi. The uprising was put down by reorganizing communist leadership with the help of the Soviet army. For the regime under János Kádár, which sought to restore the socialist system, the adaptation of Soviet propaganda was therefore a particularly difficult task. One reason for this was that the Communist Party and its ideology had never enjoyed broad social support in Hungary, even to the extent that it had in the Soviet Union (Gyarmati, 2011). The Rákosi regime tried to compensate for the legitimacy deficit by constructing its own myths and interpreting Hungarian history from a class-warrior perspective. According to this narrative, communists are the heirs of national liberation struggles and progressive traditions, and their power is, therefore, historically necessary (Gyarmati, 2011). "*The planned construction of socialism has no such limits, no such boundaries as capitalism had (...) the sky is the limit*" (Rákosi, 1951, p. 321-322) - illustrates this ideological framework. The adoption of the Soviet model, socialist establishment, and the leading role of the Communist Party in this conception were a means of overcoming millennial backwardness and ensuring progress. They sought to justify the difficulties of the present with the promise of a future utopian. However, reality did not justify these promises; the disruptions of the Soviet-style economic and social model and the dictatorial exercise of power only deepened the crisis of legitimacy of the system. The uncritical adoption of the Stalinist model and the resulting chain of events of social discontent led to the 1956 Revolution. After the suppression of the uprising, the reorganized communist party, the MSZMP, began to exercise power with an even more serious legitimacy deficit. In this context, it had to accept itself not only with Hungarian society but also with the international community as the new, legitimate political leadership of the country.

The official Kádár position was that Soviet-style socialism was neither structurally flawed nor dysfunctional. Rather, the problems were caused by isolated individual

implementation failures. According to party ideology, these distortions could be remedied by a return to "pure Leninist" ideals, and thus, the historical mission of realizing communism could be fulfilled. This interpretation maintained the myths and view of history that had been perpetuated during the Rákos era, since their legitimating function remained unchanged. Simultaneously, certain elements, especially the cult of personality, were relegated to the background and disappeared. Their place was taken by the development-oriented rhetoric of the Khrushchev era, which emphasized modernization, the rise in living standards, the defeat of capitalism through peaceful economic competition, and the slogan "catch up and overtake". However, this future-oriented optimistic tone was far from credible in Hungarian society. Nikita Khrushchev, whose name was associated with these slogans, was identified by the majority with the man whose tanks had crushed the Hungarian revolution. Moreover, one of the triggers of the 1956 uprising was the socialist social organization and economic policy itself, which led the country to quasi-bankruptcy. This cast considerable doubt on the credibility of Khrushchev's statements in the domestic social milieu. In this political and social context, the first satellite, Sputnik-1, was launched in the autumn of 1957. The date was symbolic: for the Soviet Union, it was the eve of the 40th anniversary of the Great October Socialist Revolution, a huge propaganda victory, while in Hungary, the news reached society and communist leadership at the time of preparation for the first anniversary of the 1956 revolution. The duality of this period was illustrated by the fact that Time magazine awarded the title of „Man of the Year" to the „Hungarian freedom fighter" in 1956, and to Khrushchev in 1957 - with the first satellite in his hands.
In the light of all this, the „beep-beep" sound signal of Sputnik-1 not only marked the beginning of the Soviet space age on 4 October 1957, but also conveyed a symbolic message to Hungarian society: the promise of „*the sky is the limit*" - to be interpreted in the context of restored Hungarian socialism.

Soviet spaceship cult in Baranya County

The interpretation of Soviet space propaganda in Hungary 1957-1960

It is not the purpose of this study to present a detailed account of the reception of Soviet space propaganda in Hungary between 1957 and 1960. A comprehensive examination of the Hungarian press, political communication, and publicity during this period would require a separate study, which would go beyond the scope of this essay. However, for the sake of completeness of the analysis, it is necessary to briefly refer to these aspects as well, since without them, the Hungarian appearance of the ideal type of the heroic Soviet cosmonaut, which emerged in the early 1960s, cannot be fully understood. Therefore, the following is only a sketch of the most important Hungarian phenomenon of the period:

It is important to note that Hungarian society was not unprepared at the beginning of the space-age. However, unlike public opinion in many Western countries, especially the United States, the Hungarian public did not attach much importance to it. The social perception of space at this time was still essentially a scientific endeavor of the distant future, bordering on the fantastic, with little practical understanding or recognition of its significance.

The Hungarian press reports about sputniks from October 6, 1957. From this point on, not only the news of the satellite launch but also the Western and Soviet reactions burst into the Hungarian public sphere, based on the Soviet narrative, so that an independent, neutral Hungarian interpretation of the events could not even emerge - the Hungarian public followed and adopted the messages of the emerging Soviet space propaganda. My research in the Arcanum Digital Press Archive database shows that, between 1946 and 1957, the number of articles related to space exploration in the Hungarian language press gradually increased. The term „artificial planet" was used as a keyword in this study, the most frequently used term for satellites in the period. During the period in question, approximately 200 different press articles were identified, which were, in fact, articles with different content, published in different newspapers, and on different days. This figure does not include the repetition of central announcements, which are often taken over without change by national and provincial newspapers. The quantitative breakdown shows the following distribution over time: between 1946 and July 1955 about 50, between August 1955 and December 1956 about 90, and in 1957, up to October 6, about 60 relevant articles. Thus, on average, at least two articles per day were published on the subject, with the stated messages of Soviet space propaganda, clearly with the aim of legitimization. The figures show a clear upward trend, indicating the emergence of (mainly Soviet) achievements, alongside a gradually growing press interest in the subject. The discourse on space exploration was still in its formative stages during this period, but the early linguistic and ideological patterns that later became stable elements of the Soviet Union and Hungarian space propaganda are already discernible. The restraint of the initial Soviet reaction was also reflected in the Hungarian press. By contrast, the Western public, especially the American public, was genuinely shocked. Soviet propaganda quickly recognized this reaction and exploited it effectively; the narrative that had been consolidated in the wake of the Sputnik shock was soon adopted by Hungarian propaganda, incorporating it into the ideological framework of socialist modernization.

In order to get a picture of how Hungarian propaganda and the controlled public interpreted Soviet space successes and to what extent they served to legitimize the system, it is essential to compare the forums of official discourse (press, party congress materials, film news, etc.) with the sources where different, even critical opinions could appear. In this respect, this study relies primarily on sentiment reports. Through these documents, the authorities sought to map the current opinions of the population. Although the reports were produced at the local level, their content was processed along a territorial hierarchy and deliberately included negative reactions (Fitzpatrick, 1999). Even the binary arrangement of positive and negative feedback reflects the enemy-friendly logic of dictatorial regimes, which leaves no room for nuanced expressions. In the absence of a critical reading, a false interpretation of reality is easily drawn up, in which two groups are pitted against each other along divisions that are not the result of a democratic decision. Reports often present a constructed reality: myths, identities, and attitudes toward them, which may have been distorted by the personal motivations of the report writer, even through the inclusion of created, conformist opinions (Corner, 2008). After 1956, the Agitation and Propaganda Department of the Central Committee of the MSZMP was responsible for the production of documents, coordinating data collection in a hierarchical system down to the lowest levels of party organizations (Huhák, 2022). Reports were often produced on a weekly basis or in connection with extraordinary events such as Gagarin's space flight. They were used to provide management for the overall assessment. The large volume of regular reporting required places a considerable burden on the apparatus, which may have affected the reliability of the content itself. In the world of discourse shaped by socialist propaganda, the ability to "speak Bolshevik" gradually emerged - report writers, the public and the political elite all became part of this linguistic code (Huhák, 2022). As a result, the political direction and language of the party, thematized by the party's central newspaper, *Népszabadság* (*Liberty of the People*), was often reflected in the wording of sentiment reports. In more than one case, it is difficult to believe that this was what the public was really concerned about and that this was the form in which they expressed their opinions. Therefore, these sources require criticism. At the same time, an informed reading offered an opportunity to develop a more nuanced picture of how social reactions to Soviet space successes may have appeared in Hungarian public discourse, and to what extent they contributed to the Kádár regime's legitimation strategies.

The opinions of the population expressed in the sentiment reports examined were largely consistent with official propaganda narratives. The most common elements of positive feedback are joy, pride, reassurance, and various forms of humor. In contrast, the so-called "hostile expressions", as the reports put it, initially ranged from panic, incomprehension and doubt to negative humour and even arrogance (!). Following the subsequent Soviet successes, these were gradually joined by anti-Sovietism and criticism of the waste of economic resources, especially investment at the expense of living standards. To understand the broader context, I analyzed the period between 1957 and 1960, using documents held in the Archives of the Capital of Budapest and the Hungarian National Archives of Baranya County. Based on this, it can be concluded that the reports from Baranya County (mainly from Pécs and Komló) contain predominantly positive reactions, while in the Budapest documents, there are also several critical or skeptical voices. Negative opinions came mainly from church actors (HU-BFL-XXXV-1-c-2, 1957-1960; HU-MNL-BAML-XXXV-1, 1957, 1959; HU-MNL-BAML-XXXV -9, 1959; HU-MNL-BAML-XXXV-10, 1959).

One of the most important events in the reception of Soviet space propaganda in Baranya County was the „Sputnik Exhibition", which was displayed in Pécs between December 10 and 20, 1958. The event was jointly organized by the Hungarian-Soviet Friendship Society, Association of Technical and Natural Science Associations, and Scientific Dissemination Society. The exhibition was presented to the press in Budapest on November 19, 1958, and then opened to the public at a ceremony on November 21 (Népszabadság, 19.11.1958). The press of the time emphasized that Budapest was the first city (and thus Pécs the second) among the People's Democratic countries to host the exhibition after

Moscow, Geneva and Brussels. According to speeches and reports, ordinary workers looked with admiration at the model of the third Soviet satellite, which was already referred to as „our Sputnik" (Magyar Nemzet, 26.11.1958).

In summarizing the general interpretation of the adaptation of Soviet space propaganda in Hungary, it should be emphasized that János Kádár was its primary domestic mediator and the definition of the framework of official discourse. For lower-level party organs, Kádár's public utterances served as a normative model that established a clear direction for the localization of Soviet narratives. The adoption of Khrushchev's ideological framework in Hungary was not a mechanical translation but a targeted interpretation adapted to the specific Hungarian political, social, and ideological context. This process of adaptation was primarily in the service of political legitimacy and the ideas of socialist modernization: the interpretation of Soviet space successes in Hungarian discourse was not only a technological achievement but also a proof of the superiority of the socialist social order. Thus, Hungarian space propaganda built its own set of linguistic and ideological narratives on the basis of Soviet models but with different emphases. In one of his speeches in March 1959, Kádár explicitly formulated the legitimacy of Soviet space success in the context of the Hungarian socialist system. In doing so, he not only articulated his recognition of Soviet technological achievements but also confirmed their ideological embeddedness, integrating them into the rhetoric of Hungarian socialist modernization. In this discourse, the conquest of outer space was not only a proof of the historical superiority of socialism but also a proof of the normality of the post-1956 restored communist regime in Hungary. The national propaganda structured its own set of messages accordingly, adapting to the Soviet narrative framework in which space successes became a symbol of the system's stability and capacity for modernization. "*Now the communists, the progressive people, can ask a long series of questions: what do you think of the Soviet Union being the first to conquer space, what do you think of the seven-year plan adopted at the 21st Congress? Among other things, they can also ask, How do you feel about the fact that things are going well in Hungary? Socialism is in a good position now.*" (Kádár 1964. p. 7-8) With this statement, Kádár directly linked the consolidation of the socialist system in Hungary after 1956 and the legitimacy of the Communist Party to a central element of Soviet space propaganda, the narrative of development. This rhetorical framework simultaneously justified the necessity of the Soviet-style establishment and its ideological correctness, and presented the Soviet Union's successes in space as proof of the system's effectiveness.

Thus, from 1959 onwards, it can be clearly observed that the primary function of Soviet space propaganda in the Hungarian public sphere was not the legitimization of the Soviet Union but the legitimization of the domestic socialist system within the Soviet Union's federal sphere - more specifically, the justification of the political rule of the MSZMP. From then on, the discourse on space exploration and Soviet space successes was almost constantly present in Hungarian media and public life. During major events, such as a successful mission, the intensity of the topics increased and dominated the press coverage. The rhetoric and tools that characterized space propaganda in Hungary were becoming finalized: a triumphalist narrative based on progress and intended to convey the promise of a socialist Hungarian future.

Soviet cosmonaut cult in Baranya

On April 12, 1961, the first man, Yuri Gagarin, a Soviet citizen, flew into space. In this context, it is noteworthy that the front page of the Dunántúli Napló (Dunántúli Napló, 12.04.1961) published on the same day a statement by the Soviet academic Andrei Kuznetsov that manned space flight was „*not a problem of the future, but of the present for Soviet science*". Interestingly, according to my research, this statement has not been picked up by national daily activities.

The sensationalism of spaceflight was fully exploited by propaganda: the face of the successful Soviet space program was a smiling young man, Gagarin, who could also be seen as the 'new face' of communism. At the same time, the adoption of Soviet propaganda in Hungary and the adaptation of its legitimizing functions also revealed ideological tensions. The heroization of Soviet cosmonauts - especially Gagarin - occurred at the very time when Hungarian political leadership was actively trying to combat the cult of personality associated with the Rákos era. In this spirit, it was forbidden in Hungary to name a public institution or to erect a statue after a living person. In a move to emphasize collectivism, the socialist brigade movement was introduced at this time, in which individual merit was replaced by collective achievement, in sharp contrast to the individualized heroic image of the Soviet space shuttle cult.

The Hungarian press paid special attention to Gagarin's space flight and the success of the Soviet space exploration. Following the event, a cult of personality began to develop soon after, in which the print press played a central role. In the newspapers I have studied, especially Népszabadság and Dunántúli Napló in 1961, there were regular, often front-page reports on Gagarin and the Soviet space program (Dunántúli Napló, 1961; Népszabadság, 1961).

The April 13, 1961, issue of Népszabadság (Népszabadság, 13.04.1961) was the first to mention the Hungarian Gagarin Brigades, which can be interpreted as the earliest sign of the emergence of the personality cult in Hungary. On the same day, Népszava reported that the busiest avenue in the Soviet Union, in Kishinev, had been named after Yuri Gagarin (Népszava, 13.04.1961). The Soviet practice of naming a city after Gagarin deserves special attention in the context of efforts to destroy the country. Naming a public space after a living person, especially in the capital of a less centrally important member republic, Moldova, can be interpreted as a cautious but strong signal that it is possible to rebuild the cult of personality if not on a Stalinist scale. The first five pages of the April 13, 1961, issue of Dunántúli Napló (Dunántúli Napló, 13.04.1961) were almost exclusively devoted to Gagarin's successful space flight. The paper also reported on the reactions in the county - rallies, outbursts of joy, and enthusiasm - which coincide with the content of the mood reports from Pécs that I have examined. The information report of the Pécs City Internal Affairs Committee of the Hungarian Socialist Workers' Party, specifically written in connection with the April 12 space flights (HU-MNL-BAML-XXXV-9, 1961), also supports this picture. "*Based on feedback received by the Municipal Police Department, city employees are talking about their first holiday with similar enthusiasm. Copies of the Evening Pécs Journal, which appeared on the afternoon of the 12th, were snapped up almost instantly as people took to the streets and squares to discuss and debate the extraordinary event. One industrial student, among others, remarked, „now that's a big slap in the face for the Americans." Comrade Dr. Jáhni, who worked at the Children's Clinic, said that the doctors at the clinic expressed their amazement and appreciation for this great event and subsequently joined the Hungarian Soviet Friendship Society in almost all cases. The workers in our city's factories also discussed the importance of the trip in an enthusiastic atmosphere. No hostile manifestations of the Soviet people's triumph over the world were observed."* (HU-MNL-BAML-XXXV-9, 15.őe., 13.04.1961, p. 1-2)

The mood report of the Committee of the Hungarian Socialist Workers' Party's Pécs City Internal Affairs Organs on April 17, 1961, reported that 95% of the population was still preoccupied with Gagarin's space flight, and the feedback was overwhelmingly appreciative (hu-mnk-baml-xxxv-9, 1961). In the same report, a criminal episode was reported: on April 12, a bicycle was stolen from in front of a GP's surgery in Pécs - a good illustration of how, in the midst of world events, everyday problems lived on. The report of April 24 showed that public interest in Gagarin's flight was still lively, and by then, the Cuban-American conflict was also being discussed. Dunántúli Napló, in line with national media and propaganda trends, continued to publish articles praising Soviet space exploration and Gagarin. The front page of the 15 April 1961 issue also featured a statement by János Kádár on Gagarin (Dunántúli Napló, 15.04.1961). *"(...) All Hungarian people who are building socialism feel and think in the same way. This is well expressed by the fact that, within an hour or two of Gagarin's successful return, our self-conscious workers formed a series of socialist brigades named after him and the Vostok spacecraft. Our Thursday morning newspapers have already carried poems on this heroic feat and declarations of appreciation and joy by masses of scientists, artists, clergymen, and ordinary workers."* (Dunántúli Napló, 15.04.1961, p. 1)

On April 18, 1961, of the Dunántúli Napló, the first news appeared about the formation of the first Gagarin brigades in Baranya County, both of which were based in Pécs. The first report about the Gagarin brigade in Komló was published in the 20 April issue of the newspaper (Dunántúli Napló, 20.04.1961).

Also, the 18 April 1961 issue of the newspaper reported that in the Soviet Union Gagarin's name was borne by kolkhozes, sovhozes, streets, squares, schools, and poems and songs were written about him (Dunántúli Napló, 18.04.1961). It is of particular interest to mention that the iron foundry workers of Stalin's town in Hungary - like Gagarin, who were iron foundry graduates - presented him with a small cast statue. This act is particularly noteworthy since Stalin's town was a model of the new socialist workers' town for communist propaganda in the years after 1949, as was Komló. However, after the 1956 revolution, practices linked to the cult of personality, such as naming living persons, were officially rejected by the Kádár regime. It was precisely because of the cult of Gagarin that the

Hungarian party leadership was forced to change this practice as it broke ideological barriers. Thus, partly through the conscious involvement of the press and partly through the public statements of János Kádár himself, following Soviet propaganda guidelines, the official Hungarian space cult began to take shape. One culmination of this process was Gagarin's personal visit to Stalin's city in August 1961. At the same time, official communication at the time sought to avoid emphasizing the "Stalinist" character of the city - the visit focused on the common identity of the workers rather than the ideological status of the settlement. On the other hand, in Komló, the Gagarin visit was linked to the tenth anniversary of the founding of the town, which allowed the cult to become more deeply embedded in local identity.

The cult of Gagarin quickly appeared in the communication of children and youth organizations. In the 19 April 1961 issue of the Pajtás newspaper, it was reported that the head of the Budapest Sputnik station sent a letter to Gagarin welcoming him and asking him to accept the title of honorary guard member. In the same issue, several pioneer letters were published, the authors of which regarded the cosmonaut as their role model (Pajtás, 19.04.1961). On April 23, Szabad Föld reported that a Hungarian pioneer patrol had taken up the name Gagarin (Szabad Föld, 23.04.1961). Shortly afterwards, on June 1, the Budapest KISZ Élet reported that Gagarin had been elected as an honorary KISZ member at a ceremonial meeting of members with the participation of the Soviet Embassy (Budapest KISZ Élet, 01.06.1961,).The above press reports, together with reports of Soviet naming, the appearance of Hungarian Gagarin brigades, the statement of János Kádár, and propaganda tools aimed at young people, suggest that in addition to spontaneous and voluntary naming and gestures, there was a conscious series of signals. This may have encouraged "grassroots initiatives by the working masses" in the naming of names, while helping to conceal the centralized, controlled nature of the personality cult. As I have no central MSZMP document for this effect at this stage of the research, this interpretation is hypothetical for the time being.

It is worth comparing Dunántúli Napló's report on the May Day 1961 march with the mood report of the MSZMP Pécs City Internal Affairs Committee dated May 8, 1961. The parallel analysis gives us the opportunity to explore the differences between the official press narrative and internal party documentation, especially in terms of the festive framework of the Gagarin cult, its reception by the public, and its political representation. "*Immediately after the orchestra, seven giant balloons floated on a silver rocket with a thin string, and when they reached the front of the grandstand, the balloons were released and the rocket went up. The ingenious spectacle creates a moment of silence, and we are moved to tears of joy as we watch the symbol of Soviet scientific supremacy soar into the air before a roar of applause. „Long live the Soviet Union!", „Long live Gagarin!", the enthusiastic voices ring out."* (Dunántúli Napló, 03.05.1961, p. 1).

"(...) 4.Regarding the political mood of the population, at 10 p.m. on May 2, 1961, Sergeant Major Károly Gruz noticed that a photograph of Comrade Gagarin in the window of a state department store was loudly jeered by three people, who made the following

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statement: "How the fellow runs, that's a big nonsense, only the Russians can sell it to the people.' The police patrol called them to the police station for identification, and after establishing their identity, produced the following persons: (...) The persons in question regretted their actions and were given written warnings. It is recommended that they be dealt with by the party organisation at their place of work." (HU-MNL-BAML-XXXV-9, 15.őe., 08.05.1961, p. 3-4).

This suggests that there have been, albeit few, criticisms of Gagarin. However, I believe that only a minimal number of these were passed on to the authorities or party organizations, at least in my research so far, and I have only found sporadic traces of this. This confirms the research hypothesis that the negative manifestations of Gagarin and Soviet cosmonauts, as well as the cult itself, existed outside the scope of official propaganda. However, further research is required to more precisely explore this phenomenon.
In May 1961, Gagarin's name appeared in the pages of the Dunántúli Napló fourteen times (during the same period, it was mentioned twenty-three times in Népszabadság), mainly in connection with Alan Shepard's „space jump" on May 5 Gagarin's trips abroad and a film about his life. On seven different days in June, his name appeared in the Dunántúli Napló (twelve times in Népszabadság), including the fact that the audio recording of the space flight was heard in Pécs, which was released on (Dunántúli Napló, 10.06.1961), and that a football tournament was organised in the district of Mohács under the name of „Gagarin Cup" (Dunántúli Napló, 15.06.1961).

In July, Gagarin's name was mentioned in the newspaper on 19 days, mainly to report on his new trips abroad (Népszabadság mentions him twenty-three times).From August 16, 1961, when the date of his visit to Hungary became official, until August 16, 1961, he was mentioned on nine days, three of which were related to his trip around the world, and in the second half of the month, he was in the news together with Gherman Titov (Népszabadság mentions him on thirteen days). In this context, it is worth mentioning János Kádár's statement on 8 August 1961, in which he declared that Hungary would welcome any Soviet cosmonauts - this was also reported in the Dunántúli Napló (Dunántúli Napló, 08.08.1961). On the same day, the Pécs MSZMP organization sent a letter to Kádár asking him to invite cosmonauts to visit Pécs if they came to Hungary. *„Dear Comrade Kádár! The workers of Pécs were delighted to hear and receive the statement made by Comrade Kádár in Moscow, in which he invited two giants of space flight, Comrades Gagarin and Titov, to Hungary. If you can accept the invitation of the two cosmonauts, we kindly ask Comrade Kádár to allow them to visit our city. We pledge on behalf of the miners and workers of Pécs that we will repay this honor with more successes and exploits for our beloved party. Yours sincerely*" (HU-MNL-BAML-XXXV-9, 104.őe., 08.05.1961, p. 1)

It is worth mentioning that on August 1 and 8, 1961, it was also recorded that a rumor was spreading among the workers that Gagarin would visit the city on August 20, together with Comrade Kádár, on the occasion of the tenth anniversary of the founding of the city. The rumors spread to such an extent that a special information meeting had to be called for the secretaries of the basic party organizations in Komló to refute the rumor (HU-MNL-BAML-XXXV-9, 1961). The source is particularly interesting in light of the fact that the issue of Gagarin's invitation was already on the agenda of party leadership at the time. At a closed meeting of the MSZMP Political Committee on June 6, 1961, it was decided to officially invite Gagarin into Hungary. At the same meeting, the Szeged school, which had already informally borne Gagarin's name and took his name on April 15, 1961, was also allowed to bear his name officially (HU-MNL-OL-M-KS-288-5, 1961). Gyula Kállai handed over the official invitation to the Soviet ambassador in 1961. According to the invitation, Gagarin was invited by the Patriotic People's Front and the Government of the Hungarian People's Republic - not by the MSZMP - to the national holiday on August 20 for a visit lasting several days. The program was finalized on August 15, 1961, at a meeting of the MSZMP Political Committee, where it was also decided that Gagarin would be invited together with his family (HU-MNL-OL-M-KS-288-5, 1961). As a further research question, it is worth asking when the MSZMP top leadership - especially János Kádár– became certain of Gagarin's visit. Clarification of this could shed new light on the party general secretary's statement on August 8, 1961, in which he welcomed the possibility of Soviet cosmonauts visiting Hungary. It would also be worth investigating the frequency with which party organizations in other municipalities sent similar requests to the Party leadership, asking for a visit by cosmonauts to their own town or region. Of particular interest is whether the program for Pécs and Komló had already been partially developed by that time and whether local communities had been informed of the expected events through informal channels. The rumors recorded in sentiment reports can be interpreted as spontaneous speculation, but it cannot be excluded that the party apparatus deliberately allowed these informal reports to circulate. The possibility therefore arises that the „whispering propaganda" tool was a deliberate technique used to increase public interest and enthusiasm, even before the visit was officially announced. This hypothesis is particularly relevant in light of the fact that Gagarin's persona at the time was no longer a mere political-military success but a symbol of socialist modernity and international prestige.

A fundamental research question arises as to why Pécs and Komló became the main destinations for Gagarin's visit to Hungary. This question is not only of decisive importance for this study but also for a deeper understanding of the political context of the visit. Based on the available sources, it is not possible to answer this question with complete certainty at this stage. Further archival research is needed to uncover the exact reasons. First, it is necessary to thoroughly examine the documents of the operational committee responsible for preparing the visit, which was subordinate to the Political Committee of the Hungarian Socialist Workers' Party (MSZMP), as well as the relevant documents of the organizational units responsible for directing party propaganda, primarily the Party and Mass Organizations Department and the Agitation and Propaganda Department. The analysis of these sources is essential to accurately reconstruct the factors influencing decision-making, the interests at stake, the internal logic behind the event, and the specific characteristics of the application of Soviet space propaganda in Hungary. At the same time, based on the results of my research thus far, it can be assumed that the selection of the settlements to be visited during the visit posed a serious challenge for political leadership. The role of Budapest was

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clear: the capital had an international airport and, as the country's transport hub, provided the opportunity for guests to travel to any part of the country. The primary goal of the visit was to mitigate the legitimacy deficit of the regime. In addition, propaganda related to the Soviet space program served as a suitable tool for representing socialist modernization and Khrushchev's "catch up and overtake" program in Hungary. In light of these goals, it is likely that priority was given to those settlements that were presented in the propaganda discourse of the era as new, socialist "model cities." Interestingly, Gagarin's visit only covered the western part of the country, even though similar towns could also be found in the eastern part. Several factors may have contributed to this decision. Komló, as a mining town, functioned as a symbolic space for socialist industrialization and modernization, especially since the tenth anniversary of its founding coincided with the date of the visit. At the same time, uranium mining flourished in Pécs, and the construction of the modern Uránváros district began. Nuclear energy has become an emblematic symbol of socialist modernity in official discourse. Furthermore, the Olympia Restaurant was built in the district, its architectural style reminiscent of the Hungarian pavilion at the 1958 World Expo in Brussels. (Sztankovics, 2016). It also served as a visual symbol of modernity, openness, and international presence. The choice was also justified from a logistical point of view: Pécs had a direct rail connection to Budapest, while Komló was only 25 km from Pécs and was easily accessible by road. Based on this, it is likely that the choice of locations for the visit embodies the system's important aspirations for legitimacy and modernization. The world's first astronaut, Soviet communist Gagarin, embodied both the socialist system and its scientific and technological superiority in a single person.

The front page of the August 16, 1961, issue of Népszabadság (Népszabadság, 16.08.1961) reported that Yuri Gagarin, accompanied by his family, visited Hungary on August 19. The announcement was also published in the Dunántúli Napló (Dunántúli Napló, 16.08.1961) . In the next day's issue (August 17), two different articles mentioned Gagarin's name, but the real „Gagarin fever" - to use the words of Népszabadság - only broke out in Pécs on August 18 (Dunántúli Napló, 08.18.1961). It was then official that the cosmonaut would visit the Baranya. In the days that followed, Dunántúli Napló devoted special attention to the visit: on August 18 and 19, Gagarin's name appeared in three separate articles. The 20 August issue of the newspaper (Dunántúli Napló, 20.08.1961). was published with a striking graphic design, with a red-bolded inscription in Russian on top and in Hungarian on the bottom („Welcome Yuri!"), in line with the Népszabadság's front page greeting of the previous day (Népszabadság, 19.08.1961). In this issue, Gagarin's name appears in a total of eight places, and his Budapest program is described in full-page articles.

The press coverage culminated in the Dunántúli Napló issue of August 22, which provided a detailed account of the visit to Pécs and Komló. The editorial was titled „*We took Major Gagarin into our hearts forever*" and three pages of the six-page issue reported exclusively on the visit to Baranya County, while another page covered the Budapest program and the farewell ceremony (Dunántúli Napló, 22.08.1961, p. 1).

The day after the visit, on August 23, 1961, the newspaper mentioned Gagarin's name in four different places, continuing to discuss the details of the visit. Below, I quote two different excerpts from this issue. "*It's not an everyday occurrence. On the feast of our constitution, the merged district football championship was in full swing in the sports field on Tüzér Street. The match was between the teams of Pécs Dózsa III. and Vasas Szigetvár, when István Csorba, chairman of the disciplinary committee of the county football association, shouted to the referee from the spectator's stand: „Comrade Dalos - Comrade Gagarin is coming!" János Dalos immediately called the team captains and scorekeepers and stopped the match. Within moments, the entire party was on a fence in front of the social home, waving their hands at the approaching cosmonaut. The referee Dalos shouted a greeting of „zdravstvuj tovaris" (hello comrade) to Comrade Gagarin, to which he smiled and replied with a greeting of, "zdravstvuj sudjent futbalnovo matcsa" (hello football referee), and then waved with a smile until his car passed. After five minutes the referee resumed the game with a ball toss, which Dózsa III won 4:1.*" (Dunántúli Napló, 23.08.1961, p. 6) The other source is the previously cited MSZMP Pécs City Internal Affairs Committee, weekly information report of August 21, 1961, which somewhat nuances the picture of the enthusiastic reception. „*Regarding the events of the past week, I have the following to report: (...) 4./ On August 20 at 11 a.m., at the reception of Comrade Gagarin, at the corner of Rákóczi Bercsényi utca, a small industrialist K. L. /non-party member, basket weaver, resident of 2 K. u., Pécs, made the following statement to Comrade Gagarin, who was passing by: „Go home to your mother, you motherfucker, Gagarin!" He then raised his first on his face. He was taken to the police station and handed over to the police investigation department for further assistance. No other hostile acts were observed.*" (HU-MNL-BAML-XXXV-9, 15.őe., 08.21.1961, p. 3)

The mood reports from Komló also underline the pride of the local population and party organizations that the Party found Komló worthy of hosting Gagarin. This honor put the municipality on par with world-class cities, such as London and Havana. It is also worth noting that bus services were organized from Pécs to Komló to give workers the opportunity to attend the cosmonaut's reception so that some people from Pécs may have been able to meet Gagarin at both venues. This illustrates the enthusiasm for the cosmonaut and the social importance of the visit to the area (HU-MNL-BAML-XXXV-10, 1961). The two different sources show that, although there was a minority of anti-Gagarin demonstrations, the majority of people (according to the sources of the time) were unanimously enthusiastic in their welcome of the cosmonaut, as were the majority of people in other major cities of the world. I think that the authorization and encouragement of the cult of Gagarin in Hungary, his invitation and the hysteria it created was a very conscious propaganda ploy on the part of the authorities, as it was the way the Kádár leadership tried to break out of international isolation, to gain „good points" among the population and to legitimize the acceptance and success of the Soviet-style social order.

I would like to cite another source that provides a new perspective on the phenomenon, reflecting the positive atheist narrative mentioned earlier, a Baranya County report to the State Church Office from September 1961: „*TOP SECRET! (...) What believers say. (...) In connection with the flight into space, some believers, especially the elderly, talk about whether this can go unpunished and whether the Russian people will not be destroyed by God. They openly talk about the fact that Gagarin was not in the spaceship, because those who went up came back dead; some people deny the whole space flight, saying that it is just propaganda that they want to deceive the people. Their view is that, whatever they say, Russians do not have the weapons that Americans have. These are mainly voiced by Catholics, but the Reformed pastor of Potykapeterd also spoke and doubted the existence of the crash (...)*" (HU-MNL-BAML-XXXV-1, 39.őe., 18.09.1961, p. 1)This is also interesting because after the space flights, there was a propaganda message that „they did not see God in the sky," which was mentioned by Gagarin in his autobiography (Gagarin, 1962).

Gagarin's name did not appear daily in the Dunántúli Napló after the visit of 23 August, but at that time - perhaps as an indirect effect of the visit - a new Gagarin Brigade was formed in Pécs (Dunántúli Napló, 25.08.1961). In September, his name appeared „only" 17 times. In October, Gagarin's name appeared again on 12 separate days in connection with the XXII Congress of the USSR, while in November it was mentioned only four times and in December 11 times. During the whole year 1961, Gagarin was mentioned 177 times in Dunántúli Napló and 310 times in Népszabadság. In the following years, this number steadily decreased: in 1962, 93 (Népszabadság: 156), in 1963, 31 (Népszabadság: 67), in 1964, 41 (Népszabadság: 26), in 1965, 40 (Népszabadság: 29), in 1966, 18 (Népszabadság: 21), in 1967, 19 (Népszabadság: 30), and finally, in 1968, the year of his death, his name was mentioned 35 times (Népszabadság: 57). It is important to note that in most cases, the focus in Dunántúli Napló was no longer on the cosmonaut himself but on the use of Gagarin's name to designate public spaces and brigades. The first street name of this kind comes from 1962 in Komló (Dunántúli Napló, 04.08.1961). The commemoration of the cosmonaut was mainly linked to the anniversary of the 1961 flight; for example, on April 12. In 1968, Gagarin was mentioned exclusively in connection with news of his death. In my research on sentiment reports, I did not find any documentary material related to him after August 1961.

Following the lifting of ideological restrictions on the cult of personality, especially after the death of Yuri Gagarin in 1968, the number of institutional and public names that came to honor him increased significantly. In Salgótarján, an elementary school took the name Gagarin at a naming ceremony on 20 December 1969, coinciding with the 25th anniversary of the liberation of the city (Nógrád Megyei Hírlap, 21.12.1969). In contrast, in the case of Komló, the name of a school "Gagarin Street Primary School" first appeared in the Dunántúli Napló of 26 March 1968, the day before Gagarin's tragic death (Dunántúli Napló, 26.03.1968). However, street names were already in use in 1962. The absence of a detailed press report on naming suggests that the naming process was spontaneous or locally coordinated rather than a centrally organized propaganda act. The naming of the school has had a longer-lasting impact at the local level, as illustrated by the Gagarin Cup, which was also organised on the 50th anniversary of the school's existence and which was a significant tradition in 2017 (Új Dunántúli Napló, 12.04.2017). In addition, a commemorative plaque was unveiled in Komló on April 12, 1969, with Dunántúli Napló highlighting the "*scientific victory of world historical significance*" and the political and cultural significance of Gagarin's visit to the town. The article also mentions Gagarin's pioneering race, the elementary school named after Gagarin, and the three Gagarin brigades in the town (Dunántúli Napló, 13.04.1969). The marble plaque thus symbolically commemorates the success of the Soviet space program and its local representation. Subsequently, in the local press, the names associated with Gagarin ("Gagarin's Road", "Gagarin's Street" and "Gagarin elementary school") appeared in parallel and alternately, thus indicating the intertwining of institutional naming and public designations.

In connection with the spread of the cult of astronauts, it can be observed that, following the unprecedented popularity of Yuri Gagarin, symbolic acts in honor of Soviet astronauts, such as naming institutions, brigades, and streets, also appeared in the case of other astronauts, albeit with reduced intensity. Similar phenomena can also be documented in the case of German Titov, the second Soviet cosmonaut, although these were mainly limited to the naming of socialist brigades, and his role in public life remained noticeably modest. In connection with the Vostok-3 and Vostok-4 missions (Andrian Nikolayev and Pavel Popovich), I did not find any names related to astronauts in the relevant issues of the Dunántúli Napló or in archival sources. By contrast, in the case of Valentina Tereshkova, the first female cosmonaut and pilot of Vostok 6, such references can be found, although they are typically limited to the naming of socialist brigades. This practice fits well with the narrative emphasizing the traditions of the women's and labor movements of the time, which included brigade names such as Eta Geisler (Hungarian communist youth worker martyr in the 1930s) and Klara Zetkin. Tereshkova's flight can also be interpreted as an event with strong propaganda aims: since the Vostok program was no longer able to achieve any new „firsts" in technical terms, female space flights nevertheless succeeded in achieving a symbolic victory over the West, demonstrating the equality of socialist women. Even during the space flight, official communications emphasized Tereshkova's unmarried status (Népszabadság, 18.06.1963) which later provided further propaganda opportunities: after her space flight, her marriage to Nikolayev was celebrated by the press as the first „space wedding." Gagarin was one of the witnesses at the wedding, while Khrushchev led the young couple to the registrar (Népszabadság, 05.11.1963), further enhancing the symbolic significance of the event. Nevertheless, it is important to note that after Tereshkova's flight, no other female astronauts were launched for nearly two decades, not only in the Soviet Union but anywhere in the world. Nevertheless, she continued to appear in the Hungarian press, especially on anniversaries highlighted by propaganda. For example, in 1965, as part of a Soviet delegation visiting Hungary to mark the 20th anniversary of the country's liberation, Tereshkova visited the shoe factory in Martfű, where a shoe was named after, Tereshkova visited the shoe factory in Martfű, where members of the brigade named after her presented her young daughter Yelena with a pair of children's shoes, an event that was extremely telling from a propaganda perspective, combining a personal gesture with the collective culture of labor (Népszabadság, 07.04.1965). This was particularly significant given that she had arrived with her husband, who was also an astronaut but appeared here alone. Finally, it is worth mentioning that on October 11, 1967, the Dunántúli Napló newspaper made reference to a Tereshkova socialist brigade in Pécs (Dunántúli Napló, 11.10.1967), but earlier issues did not report the exact date when the name was adopted.

The role of Komarov High School in Pécs and the institutions and sites named after Komarov is inescapable in the context of the space cult in Baranya. Vladimir Mikhailovich Komarov (1927-1967) was the first Soviet pilot and cosmonaut to go into space during the Voskhod-1 mission in 1964, as a member of a three-man crew. His second and fateful flight took place on April 23, 1967, when he was launched aboard the Soyuz-1 spacecraft, but he was killed on landing the next day, April 24. Komarov's reserve on this mission was his close friend Yuri Gagarin, whose life he saved by taking on the mission. According to contemporary sources, both Komarov and Gagarin, as well as ground control, were aware that the Soyuz-type spacecraft was not ready for flight: engineers listed some 203 faults with the spacecraft. Despite the risky nature of the mission, political pressure and technological competition were pressing: the Soviet space program was already lagging spectacularly behind the US Moon program. Therefore, testing of the Soyuz as a new generation of standardized spacecraft for mass production is needed as soon as possible. Ironically, however, it was Komarov's death and the tragedy of Soyuz-1 that led to the suspension of the program for a year and a half, which ultimately contributed to the success of the US Apollo program and confirmed US leadership in the space race (Múlt-kor, 2021).

Of course, the Hungarian press at the time did not provide an accurate picture of the circumstances of the accident. The Esti Hírlap of 24 April 1967 carried a front-page report on the launch of Soyuz-1, describing the mission as part of the Soviet lunar program (Esti hírlap, 24.04.1967). The article pointed out that Komarov was the first Soviet cosmonaut to return to space for the second time, and that the mission was aimed at testing a new type of controllable spacecraft that would be used to launch the four-man Soviet lunar expedition. This was published when Komarov no longer survived. The next day, the Esti Hírlap itself reflected on the absurdity of the situation, noting that never before had a newspaper gone out of print as quickly as yesterday's issue (Esti hírlap, 25.04.1967). The same day, Népszabadság also published Komarov's photo and the tragic news on its front page in black frames, while stressing that the mission had achieved its scientific objectives (Népszabadság, 25.04.1967).

Komarov's name started to be used in various names after his first space flight in 1964. However, due to the political and communication environment of the time and the gradual decline of space propaganda, the 1964 edition of Dunántúli Napló does not contain any mention of names related to space flight. Nevertheless, the naming wave gained momentum after Komarov's death in 1967 (socialist brigades, pioneer patrols), as happened with Yuri Gagarin (Pajtás, 18.05.1967). The 25 April 1967 issue of the Dunántúli Napló (Dunántúli Napló, 25.04.1967) - similar to Népszabadság (Népszabadság, 25.04.1967), published Komarov's death in a black mourning frame on its front page. The same format was used again a year later, when Gagarin died (Népszabadság, 29.03.1968). In the wake of the mourning, the naming of names also began in Baranya County: the first to take Komarov's name was a pioneer patrol in Pécs on 25 April 1967 (Dunántúli Napló, 26.04.1967). The next relevant mention appears only in the 6 September issue of the newspaper, according to which the KISZ basic organisation in Hosszúhetény took Komarov's name and a "Komarov corner" was also set up (Dunántúli Napló, 06.09.1967), and on 11 October a Komarov brigade from Pécs appears in the news without any name-taking history (Dunántúli Napló, 11.10.1967). These data suggest that the wave of name-taking unfolded gradually rather than explosively and that the local press documented these events selectively and sporadically over time.

The next significant stage of the Komarov cult was the secondary school built in Újmecsekalja, Pécs, which was inaugurated in 1967. The inauguration ceremony took place on November 7 which was referred to in the press as a „triple celebration": the 50th anniversary of the Great October Socialist Revolution was commemorated, the school was officially inaugurated and the school was named Komarov High School (Dunántúli Napló, 06.11.1967). The presence of the central figure of the Komarov cult was confirmed by the visit, which was reported in detail in Népszabadság (Népszabadság, 12.02.1968) and Dunántúli Napló (Dunántúli Napló, 17.02.1968). The press followed the program of their visit in several issues: for example, their meeting with the leaders of Komarov brigades in Budapest was documented (Dunántúli Napló, 21.02.1968). At the same time, the February 20 issue of Dunántúli Napló mentions the inauguration of a Komarov statue in Pápa, which took place in the framework of the „Komarov Week" (Dunántúli Napló, 20.02.1968). However, the report does not indicate that Komarov's widow was present at the event, nor does it indicate that she visited an eponymous high school in Pécs during her visit, which, given the symbolic connection, would seem logical. The absence of this,or at least the absence of any reporting, is noteworthy and suggests possible political and protocol considerations. The political exercise of commemorating Komarov added a new youth dimension in 1976, when the "Komarov Cup", a youth handball tournament, was launched in Baranya County. The tournament, like the "Gagarin Cup" in Komló, was organized specifically for young people, with matches being played in the Komarov Gymnasium sports hall. The name fits well with the trend in which the ideological framework for youth education was also defined by the cult of cosmonaut heroes (Dunántúli Napló, 04.01.1976).

One of the last significant moments of the Komarov cult in Pécs was a gift from the Hungarian-born sculptor Amerigo Tot: according to the Magyar Nemzet of 29 March 1979 (Magyar Nemzet, 29.03.1979) Tot "donated a sculpture of the space cosmonaut Komarov to the Pécs school named after the Soviet hero." (Magyar Nemzet, 29.03.1979, p. 6). Two days later, the Dunántúli Napló reported the event in a more detailed article (Dunántúli Napló, 31.03.1979). Tot's contacts in Pécs are discussed in the 1998 article by Pécsi Szemle (Pécsi Szemle, 01.06.1998). According to this article, the artist's first exhibition in Pécs was in 1969, and in 1978 he was given a permanent exhibition space in Pécs, with 13 works donated to the city. It is likely that this close local connection was the basis of Tot's dedication of his Komarov statue to the high school. The monumental motor-driven public

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sculpture, which according to some sources took 35 minutes to complete a complete rotation on its axis, and according to others 38 minutes, was placed on a concrete base in front of the school (Új Dunántúli Napló, 17.05.2007). This sculpture was erected in 1979. The sculpture arrived in Pécs on 6 August 1979 (Dunántúli Napló, 10.08.1979), which was also reported in Népszabadság (Népszabadság, 15.08.1979). The ceremonial unveiling took place on Monday October 1 at 3 pm, when the sculptor was present. The event was reported in a short news item in Dunántúli Napló (Dunántúli Napló, 01.10.1979), while the following day, the ceremony was reported in a front-page article illustrated with photos (Dunántúli Napló, 1979.10.02.). In addition to a photo of the seventy-year-old sculptor leaning on his monument to Komarov, a detailed report was published: the literary stage of the high school commemorated its namesake with a performance. The event was also reported in Népszabadság (Népszabadság, 02.10.1979). Despite all this, it seems that even then, the placement of the statue was more to emphasize the link with the world-famous Hungarian-born artist than to reinforce the local cult of the Soviet cosmonaut Komarov. This is also confirmed by the fact that on the occasion of Amerigo Tot's death in 1984, this very statue was wreathed in Pécs - not in memory of Komarov, but of Tot (Dunántúli Napló, 18.12.1984). The depth of the Komarov cult in Pécs has always remained limited, especially compared to the Gagarin cult in Komló. By 1988, the status had deteriorated considerably, and the surrounding vegetation was partly overgrown (Pécsi Szemle, 01.06.1998). The high school chose a new name in 1990, after the change of regime: Mihály Babits, Hungarian poet (Új Dunántúli Napló, 24.11.1990). Simultaneously, the name „Komarov Cup" was dropped, symbolically ending the era of local memory politics associated with Komarov.

The fate of the Komarov statue in Pécs is a particularly fascinating example of how the memory of Soviet space exploration lives in local cultural consciousness. In the issues of Új Dunántúli Napló published between 1998 and 2023, a total of 23 articles and letters from readers deal with the state of the statue and its perception (Új Dunántúli Napló, 1998-2023). It was reopened with the help of Béla Magyari, a Hungarian cosmonaut (Új Dunántúli Napló, 08.05.1998). Since then, however, the statue has deteriorated again, and in the last quarter of the century, it has had to be restored five times, while the moving part of the statue was no longer functioning. Interestingly, a strong local patriotic voice in the local public discourse has kept the statue on the agenda, stressing its preservation as a local treasure, the name of the creator, and the unique, mobile nature of the work, which is national curiosity. It also viewed the statue as a tourist attraction. The local press, especially the Új Dunántúli Napló, regularly carried this narrative, indicating that the Komarov statue is not just a neglected work of art but an important cultural symbol for the people of Pécs.

This suggests that the activity around the statue is limited to a relatively narrow, localized community, which is not primarily linked to Komarov himself but to the statue and its creator, and thus only marginally connected to the wider Soviet space cult. This contrasts sharply with Komló, where the memory of Gagarin is a living tradition in the community consciousness. The significance of the statue is not primarily in its name but in the person of its creator and the uniqueness of the work, which highlights the complex dynamics of local cultural memory.

Summary

In my research, based on the sources and literature used, I aimed to synthesize the available information and, based on this, to show how the discourse on space appeared in a local area, in Baranya County. Special attention was paid to the space cult as a local manifestation of a specific narrative of Soviet space propaganda and its contemporary survival.

A limitation of this study is that the processing of contemporary press products was primarily based on basic keyword searches; therefore, more targeted, context-based searches would be warranted in the future. In addition, further archival research on the collection of the Baranya County Archive from the Hungarian National Archives is needed. In particular, the documents of council and youth organizations, such as the Pioneers' Association and the Communist Youth Association, should be included.

Based on the sources and contemporary press products processed during the research, it can be concluded that a local form of spaceship cult did indeed exist in Baranya County, and in some elements, it still exists today. However, the depth, meaning, and memory of this cult differed significantly between Komló and Pécs and this difference persisted to this day. On a national scale, the intensity of the space cult gradually faded after the initial, sensational Soviet space successes - partly due to the fact that in Hungary the cult of the person was banned. After the deaths of Gagarin and Komarov, the cult was briefly revived, now without official restrictions, but was radically reduced or transformed during the regime change: its commemorative meanings were placed in a new context, partially or completely deprived of their former ideological charge.

Within Baranya County, Komló played the most prominent role in the development of the space cult, as Yuri Gagarin's visit coincided with the 10th anniversary of the town's foundation. This event fit perfectly with the mythmaking efforts described at the beginning of the study: the new, modern socialist city welcomed the iconic figure of the Soviet space cult. Gagarin's persona was the subject of genuine admiration in the city, which was further strengthened by the gesture of the visit, namely that the hero cosmonaut chose Komló. This spontaneous enthusiasm was deliberately amplified by official propaganda, and the overall aim was to create a cult that would become part of the city's local identity in the long term. Gagarin's tragic death further deepened this cult; the commemorative rituals that had been established, such as the wreath-laying ceremony, took on new symbolic meanings. At the same time, the local school took its name. As a result, the figure of Gagarin gradually moved away from the communist ideal constructed by propaganda and increasingly emerged in the local collective memory as the tragic conqueror of space.

In Pécs, a newly built educational institution also took the name of a (deceased) Soviet cosmonaut, earlier than Komló. Although further research is needed to establish this connection, the sources available so far suggest that there is a link between the Gagarin School in Komló and the naming of the Pécs High School after Komarov. In Komarov's memory, a statue by a renowned artist was later erected on the grounds of Komarov High School in Pécs. Although these two elements - the school's name and the statue - were not consciously and simultaneously created, and were not formally linked, together they could

have contributed to the development of a kind of local “Komarov identity”. Following the example of the Gagarin School in Komló, there have been attempts to do so. After the change of regime, the school was renamed relatively quickly, and the statue was neglected over time. This confirms the finding that, in Pécs, unlike Komló, the cult of the cosmonaut has failed to take deeper roots in the local identity and has remained an ideological surface phenomenon rather than a community tradition. However, while the school’s name change has now disappeared from public discourse, the Komarov monument’s fate is occasionally revisited in the local public sphere. However, the focus is no longer primarily on the Soviet cosmonaut himself, but rather on the statue and its creator and the cultural value of its preservation.

Based on the analysis of the Baranyan space cult, it can be concluded that the cult of Komarov, which was mainly shaped by top-down propaganda and lacked any real local attachment, gradually faded after the regime change. Komarov’s name is now mostly associated with the statue of him and the periodic flare-ups of public discourse surrounding it. The image of an alien, unknown cosmonaut, whose cult could not be embedded in the local identity, has thus been preserved in memory. In contrast, in Komló, the cult of Yuri Gagarin has become a living tradition that shapes the city’s identity. The combination of local admiration and Gagarin’s tragic and untimely death allowed his figure to partially detach itself from official propaganda narratives and to take on a commemorative meaning of its own as a prominent and proud episode in the history of the city.

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Péter Nagy – PhD student
nagypkttv@gmail.com
ORCID ID: 0009-0002-8221-045X

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Cypress in Texts of 'Orphic-Bacchic' Gold Tablets

Fanni Alexandra Ruppert
Department of Ancient History, University of Pécs

ABSTRACT

Archaeologists have discovered nearly fifty gold tablets in ancient graves across the Mediterranean. These lamellae likely belonged to individuals who had been initiated into mysteries associated with Orpheus. More than ten of them include a brief description of the Hall of Hades. The soul must avoid an unknown spring where a leuke (bright, white) cypress stands. In this paper, I will examine the significance of the appearance of the cypress and the reason for its epithet leuke.

Keywords: Orphic, gold tablets, Dionysus, cypress

Introduction

Gold tablets have been discovered in the graves of southern Italy and Greece from the nineteenth century to the present day. These tablets were engraved with special passwords and instructions intended to guide the deceased on their journey to the underworld and to ensure a blessed afterlife. Archaeologists have found almost fifty tablets of this kind, the earliest dates back to the 5th century BC and the latest from the 2nd century AD. In most cases, scholars associate these tablets with a religious group or mystery cult that could have been founded by Orpheus. For this reason, the term 'Orphic' frequently appears in scientific literature. However, Dionysiac motifs and even the name of Dionysus also occur in texts, which is why the terms 'Bacchic' or 'Bacchic-Orphic' are likewise common.[17] It is generally assumed that the owners of these objects had taken part in initiation and purification rituals during their lifetime. Yet, there is ongoing debate as to whether the initiates possessed the lamellae before their death, or whether the tablets were placed in their graves

[17] The naming of the tablets is problematic, since none of them explicitly mentions Orpheus. It is not the purpose of this paper to address the terminological debate in detail. In the following, I will refer to the tablets as 'Bacchic-Orphic'. In Pelinna (Thessaly), two gold foils dating from the 4th century BC were discovered, which texts mention Dionysus. The grave invoked the god: the foils were shaped like ivy leaves, and among the grave goods, archaeologists also found a little statue of a maenad (a frenzied follower of Dionysus; Bernabé & Jiménez, 2008, pp. 61–62; Edmonds, 2011, pp. 8–9; Kotansky, 2023, p. 206; Segal, 1990, p. 411).

afterwards.[18] The lamellae were usually placed directly on or near the body of the deceased – in the hands, on the chest, in or on the mouth, in case of cremation, inside the urn containing the remains. They occur in a variety of shapes, most are often rectangular, but sometimes are cut in the form of a mouth, a myrtle leaf, or an olive leaf. Their material, gold, is a permanent and incorruptible metal, which may symbolize the blessed afterlife awaiting the deceased.[19]

The lamellae can be classified into several groups according to their content. In this paper, I focus exclusively on those texts that provide a brief description of the deceased's journey to the underworld and the topography of Hades' realm. Within this category, two types of texts can be identified. The first group consists of ten brief texts from Crete and a single text from Thessaly, primarily in the form of dialogues between the deceased and unidentified questioner(s). The second group comprises more elaborate texts from southern Italy and Thessaly (Edmonds, 2004, 2010). In the following, I aim to address questions such as the meaning of *leuke* and the significance of the cypress standing beside the unnamed spring in the longer descriptions.

The cypress (κυπάρισσος)

Fruitless and evergreen plants are typically associated with the realm of Hades (Dimakis 2015). In ancient literature, we often encounter references to trees or groves in the Underworld. Trees that are connected with the chthonic sphere also appear in funerary contexts. For example, Pliny the Elder records that Marcus Varro[20] (116–27 BC), the Roman poet, received a Pythagorean-style burial, in which he was interred with leaves of black poplar, myrtle and olive (Bernabé–Jiménez, 2008; Graf–Johnston, 2013). The cypress (κυπάρισσος), too, has long been linked to the infernal sphere, both in antiquity and in

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[18] The Pelinna tablets were not rolled up; both foils were placed on the chest of the deceased woman. Creases can be observed on the foils, suggesting that they had been rolled up several times. This indicates that the deceased woman may have used them during her lifetime. However, Charles Segal interpreted the lamellae from Pelinna within the context of burial, emphasizing their urgent tone and formulaic expressions (Chrysanthou, 2020, p. 114; Graf, 1993, pp. 248–249; Segal, 1990, pp. 413–414).

[19] A silver tablet is known from Poseidonia. In Thurii (southern Italy), silver tablets without any inscriptions have also been found (Tzifopoulos, 2010, p. 66, note 61; Zuntz, 1971, p. 291, note 1)

[20] *"Indeed moreover many people have preferred to be buried in earthenware coffins, for instance Marcus Varro who was interred in the Pythagorean style, in leaves of myrtle, olive and as black poplar; the majority of mankind employs earthenware receptacles for this purpose. Among table services Samian pottery is still spoken highly of; this reputation is also retained by Arettium in Italy, and, merely for cups, Sorrento, Hasta, and Pollentia, and by Saguntum in Spain and Pergamum in Asia Minor."* (*Pliny, Natural History*, 35.160; trans. by Riley & Bostock, 1860).

modern Greece. One only needs to recall the myth of Apollo's beloved Cyparissus, who was transformed into a cypress in his grief after he had accidentally killed his stag (Metamorphoses, 10.106; Dimakis, 2015; Rummery, 2021). The cypress is an evergreen and hardy tree, a symbol of burial in Greek and other traditions, and was often used to make coffins (Bernabé–Jiménez, 2008; Dousa, 2011). Moreover, it was also used to carve statues of gods, suggesting to us the meaning of 'immortality' (Graf, 1990; Graf–Johnston, 2013):

> "*Moreover, when he set out upon his expedition, it appears that there were many signs from heaven, and, among them, the image of Orpheus at Leibethra (it was made of cypress-wood) sweated profusely at about that time. Most people feared the sign, but Aristander bade Alexander be of good cheer, assured that he was to perform deeds worthy of song and story, which would cost poets and musicians much toil and sweat to celebrate.*"
>
> (*Plutarch*, *Alexander*, 14.5; trans. Perrin).

It is therefore not surprising to find cypress in the texts. At the same time, it remains unclear why, among the many plants associated with the chthonic sphere, the cypress in particular was chosen by the maker of tablets (Zuntz, 1973).

Leuke

The other question that we shall examine is the meaning of *leuke*. The word has several possible meanings, since it can be translated both as 'white' and as 'bright' (Bernabé–Jiménez, 2008; Graf–Johnston, 2013). In the Mediterranean region, however, cypress trees are not white. According to Rummery, Bernabé, and Jiménez, the species *Cupressus sempervirens* was typical in ancient Greece, and its trunk is dark green or brown. For this reason, some scholars have suggested that the makers of tablets may have confused the cypress with another tree. Several have attempted to identify it with the white poplar (λεύκη), which in ancient tradition was also associated with the underworld (Bernabé–Jiménez, 2008; Rummery, 2021; Zuntz, 1971). This interpretation is plausible. The grammarian Harpocration (2nd century AD) records that wreaths were made of white poplar:

"*Demosthenes in For Ktesiphon, <crowned with fennel and white poplar.> Those performing Bacchic ritual are crowned with white poplar on account of that plant's being chthonic, and the fact that Persephone's Dionysos is also chthonic. And they say that white poplar grew by the Acheron, whence it is also called 'acherois' in Homer: "And he fell as when an oak falls, or a poplar, or a tall pine"*."

(Harpocration *Leuke* 11., translated by *Harpokration On Line project,* see Burkert, 1987).[21]

In Harpocration's account, the Acheron – one of the rivers of Hades – appears. Since white poplars grow on its banks, the description closely resembles the imagery of the gold tablets: the deceased, upon entering the underworld, the first thing they encounter is a river or spring beside which a shining or white tree stands. On this basis, it is possible that a *leuke* cypress – or perhaps a poplar – marked the entrance to the hall of Hades for the souls. In Homer *Odyssey*, the protogonos encounter a white rock rather than a tree at the entrance to the underworld (Bernabé–Jiménez, 2008; Edmonds, 2010; Graf–Johnston, 2013):

"*Past the streams of Oceanus they went, past the rock Leucas, past the gates of the sun and the land of dreams, and quickly came to the mead of asphodel, where the spirits dwell, phantoms of men who have done with toils.*"

(Homer *The Odyssey* 24. 11–14., translated by A. T. Murray 1919).

Bernabé and Jiménez (2008) have suggested that the epithet 'white' may also have a symbolic interpretation. In their view, 'white' could refer to the clothing of the deceased, or to the shroud in which the initiate was buried. They cite a few *Hieroi Logoi*, which prescribed that visitors wear grey garments or offer white sacrifices to the gods.[22] Archaeological

[21] In the case of a Cretan gold foil, it has been proposed that one of the misspelled words could be corrected to 'black poplar' (αἰγίρω). Tzifopoulos (2011, pp. 178–179) quotes Verbruggen (1981, pp. 90–91). See the appendix for the text of the tablet.

[22] *IG* XII,594 = *SEG* 14:531, Ceos, 4th century BC.; Pausanias 4.13.3, translated by W. H. S. Jones, Litt. D. and H.A. Ormerod: "*Aristodemus, who was already in despair, thought the dream foretold the end of life for him, because the Messenians used to carry out their chiefs for burial wearing a crown and dressed in white garments. Then he received news that Ophioneus the seer could no longer see but had suddenly become blind,*

evidence supports this interpretation. An excavation at Thurii (southern Italy) in 1879, five new gold tablets were unearthed. In one of the graves contained two tablets, the deceased had been veiled in a white shroud, which had been frayed due to decay of the organic material after the discovery of the grave.[23] Bernabé and Jiménez interpreted this as a possible reference to the garment of the initiated. Euripides' lost play, *Cretans,* also seems to support this connection. The chorus, in a Dionysiac context, alludes to rituals, taboos, and lifestyle practices.[24] Here, not only white clothing is mentioned but also a shrine made of cypress (Tzifopoulos, 2010). It would thus appear that trees associated with the chthonic world realm – whether poplar or cypress – were closely linked with Dionysiac ritual practice. The colour white appears in the myth of the dismemberment of Dionysus/Zagreus, a story often cited and analysed in Orphic teaching. According to this myth, Dionysus was the son of Zeus and Persephone. Out of jealousy, Hera incited the Titans to kill the child. They smeared their face with white gypsum, distracted Dionysus with toys, and, once he strayed from his guardians, tore him apart and, according to some sources, consumed him (Edmonds, 2010). Many scholars, however, interpret *leuke* notes 'white' but as 'bright'. Ancient tradition (see Aristophanes, *Frogs*, 273; Euripides, *Hecuba*, 1–2) typically describes the realm of Hades as a place of darkness, and gold tablets give similar references.[25] In this context, the 'bright cypress' could have functioned as a kind of beacon for souls in the

as he was at first. Then they understood the oracle, that by the two starting forth from the ambush and again meeting their doom the Pythia meant the eyes of Ophioneus." (Bernabé-Jiménez, 2008, p. 26; Edmonds, 2010, p. 223.).

[23] Bernabé and Jiménez (2008, p. 28) and Graf and Johnston (2013, p. 160) note that *"Furthermore when the excavator Francesco Cavallari opened the main tomb on March 23, 1879, he found 'un bianchissimo lenzuolo,' 'a very white shroud,' lying over the cremated remains of the deceased. As soon as the excavators touched the shroud, however, it turned to dust. Thus, it is impossible to determine from what sort of material this shroud was made. In the light of the Herodotean passage, I think linen is very likely."* Graf refers here to the testimony of Herodotus (*Histories*, 2.81), who stated that it was forbidden to bury the deceased in woollen garments: *"They wear linen tunics with fringes hanging about the legs, called 'calasiris,' and loose white woollen mantles over these. But nothing of wool is brought into temples, or buried with them; that is forbidden. In this they follow the same rule as the ritual called Orphic and Bacchic, but which is in truth Egyptian and Pythagorean; for neither may those initiated into these rites be buried in woollen wrappings. There is a sacred legend about this"* (trans. Rawlinson).

[24] *Euripides*, fr. 472 Kannicht = OF 567 (trans. Collard & Cropp, with modification of Bernabé, 2016): *"Son of Phoenician-born Europa / and of great Zeus —you who rule / Crete and its hundred cities! / I have come here from the most holy temple / whose roof is provided from native cypress wood / cut into beams with Chalybean axe / and bonded in exact joints with ox glue. / Pure is the life I have led since / I became an initiate of Idaean Zeus, / celebrated the thunderbolts of night-ranging Zagreus / and performed his feasts of raw flesh; / and raising torches high to the Mother of the mountain, / among the Curetes, / I was consecrated and named a Bakchos. / In clothing all of white I shun / the birth of men, and the places of their dead / I do not go near; against the eating of animal foods / I have guarded myself."* (Bernabé & Jiménez, 2008, pp. 26 note 76, 28; Edmonds, 2010, p. 223)

[25] *Tablets from Petelia*, line 14 (trans. Edmonds, 2004): *"[...] shadow covering around"* (Bernabé & Jiménez, 2008, pp. 21, 25; Edmonds, 2004, p. 49; Edmonds, 2010, pp. 222–224; Graf & Johnston, 2013, p. 109).

underworld (Dousa, 2011; Graf–Johnston, 2013). The goal of these mystery cults was to reveal hidden truths – truths learned not through study but through direct experience (Edmonds, 2010; see Aristotle fr. 15 Rose at Ustinova, 2009). The essence of initiation was to recreate the initiate’s journey through the underworld as vividly as possible, making it essential to provide the proper setting and contrasting elements of light and darkness. In this context, ancient authors often quote Plutarch’s account of what the initiates were supposed to experience during the rites at Eleusis (Seaford, 2010; Ustinova, 2009):

> “*(...) In the beginning there is straying and wandering, the wariness of running this way and that, and nervous journeys through darkness that reach no goal, and then immediately before the consummation every possible terror, shivering and trembling and sweating and amazement. But after this, a marvelous light meets the wanderer, and open country and meadow lands welcome him; and in that place there are voices and dancing and the solemn majesty of sacred music and holy visions. (...)”*
>
> (*Plutarch*, fr. 178; trans. Sandbach).

In several mystery cults, initiation ceremonies were performed in enclosed and dark spaces, often in caves (see e.g. the mysteries of Mithras). Torches were used during these rites: the presence of light in the darkness could symbolise spiritual enlightenment (Ustinova, 2009). In an altered state of consciousness, the initiates became far more sensitive to audiovisual stimuli. Such states could be induced in various ways – fasting, use of drugs, sleep deprivation or confinement. According to Richard Seaford, these rituals, which began in stressful and dark surroundings but concluded in bright, welcoming, and calm environments, closely resemble the experiences reported in modern near-death phenomena (Seaford, 2010; Ustinova, 2009). There is both literary and archaeological evidence that Bacchic rituals were also performed in caves. For example, a long inscription from Torre Nova (IGUR I 160, middle 2nd century BC) refers to *anthropylakes* (‘guards of the cave’). With regard to Bacchanalia scandal of 186 AD, Livy reports that those who resisted the cult were dragged into caves (Bremmer, 2013; Burkert, 1987; Plutarch *Morals* 564e [cited in Seaford, 2023]; Rosta, 2012; Ustinova, 2009):

> "*Men were alleged to have been carried off by the gods who had been bound to a machine and borne away out of sight to hidden caves: they were those who had refused either to conspire or to join in the crimes or to suffer abuse.*"
>
> (Livy 39.13, translated by William Heinemann, 1936).

In the case of two Cretan tablets, it has been discussed that initiates may have performed their rituals on the Nida plateau, near the Idean Cave, where poplars and springs provided an authentic setting for an imagined journey to the underworld.[26] In *Euripides' Bacchae* (line 608), the chorus proclaims, *"O greatest light of our holy revels"* (trans. Arrowsmith). According to Dodds' commentary on the *Bacchae*, the word φάος ('light') here is applied metaphorically to a person. Seaford argues that Dionysus himself is identified with the φάος in this passage. Thus, in the midst of suffering, Dionysus appeared to the chorus as the greatest light (Dodds, 1960; Seaford, 2010). Seaford cites another example from Aeschylus' lost play *Bassarai*, in which Orpheus worships Helius after his journey to the underworld, rather than Dionysus. Enraged, Dionysus incites the Thracian Maenads to kill the mythical singer. Seaford suggests that Orpheus must have witnessed something in Hades that led him to worship Helius instead (Seaford, 2010). Light also appears in other gold tablets, though not specifically in connection with the brightness of cypress (Kravaritou–Stamatopoulou, 2018). One lamella from southern Italy, focusing on the purity of initiation, states that the soul *"leaves the light of the sun*" (Tablet from Thurii, translated by Edmonds III, G. R).[27] Beyond the gold lamellae, references to light occur in other Orphic-Bacchic sources. The *Gurob papyrus* (3rd century BC) contains instructions for a ritual that includes imagery of thunderbolts. Similarly, the collection of *Orphic Hymns* – which may have been

[26] For the texts of the tablets from Rethymno and Heraklion, see Appendix. On the tablet from Rethymno there appears an untranslatable word, ΑΥΡΟΥ. Tzifopoulos suggested that it could be restored as <S>aourou, and thus, in combination with κράνας, translated as "the source of Sauros". Theophrastus, in his work *On plants* (3.3.4) referred to a Sauros spring surrounded by poplars: "*However in Crete there are a number of black poplars which bear fruit; there is one at the mouth of the Idaean cave, in which the dedicatory offerings are hung, and there is another small one not far off, and there are quite a number about a spring called the Lizard's (Sauros) Spring about twelve furlongs off.*" (translated by Sir Arthur Fenton Hort). The tablet from Heraklion also contains an untranstable word. Verbruggen suggested that it may be restored as αἰγί{δ}ρω, which would allow the line to be translated as „spring of the black poplar". Tzifopoulos (2010, pp. 28–29) and Verbruggen (1981, pp. 90–91) are quoted in Tzifopoulos (2011, pp. 178–179), who also discusses similar evidence (see Edmonds, 2010, p. 229; Tzifopoulos, 2011, pp. 178–179, 191–192).

[27] On the transition from light to darkness, see Euripides *Alcestis* 21–22., translated by Wm. Cudworth: "*Willing to die for him, and see no more / The light of day.*" (Kravaritou & Stamatopoulou, 2018, pp. 135–136).

arranged for nocturnal mystery rituals – includes two hymns addressed to Zeus *Astrapaios* and *Keraunos* (Bernabé–Jiménez, 2008; Graf, 2009; Graf–Johnston, 2013). As the examples above show, light was an integral part of initiation rites. It signifies the happiness that awaits the soul in the realm of Hades. In the shorter lamellae, although the word *leuke* does not appear (with the sole exception of a short text from Thessaly, now preserved in the Getty Museum), it is easy to imagine that the tree beside the spring played this symbolic role. This explanation, however, cannot be maintained for longer texts, since in them the cypress stands beside an unknown spring that the soul is instructed to avoid. Margherita Guarducci – who interpreted *leuke* as 'phosphorescent' – argued that the brightness of the cypress could offer hope to souls without knowledge as they wandered in the darkness of the underworld (Bernabé – Jiménez, 2008; Edmonds, 2004, quotes Guarducci, 1974).[28] It is also conceivable that the tree functioned rather as a warning to the deceased. Some scholars have proposed that the plant reminded the soul that this was the place where the initiated must demonstrate the extraordinary knowledge acquired during the initiation ritual. We know from several accounts and depictions that the dead were often imagined on their journey by a *daemon* or Hermes Psychopompos. The gold tablets, however, give no mention of such a companion. Thus, the initiated was expected to rely solely on his or her knowledge and on the lamella itself. The uninitiated, having no such aid, would be lured by the brightness of cypress (Edmonds, 2004; Edmonds, 2010; Graf–Johnston, 2013).

Conclusion

As we have seen, interpreting the motif of the cypress is not a straightforward task. The symbol carries multiple possible meanings, and it appears in all of the topographical texts, where its placement beside springs that the soul must either seek or avoid seems highly significant. Nevertheless, the concise wording of tablets does not provide a firm basis for determining the precise meaning of *leuke*. More clearly, however, the cypress conveys its traditional symbolism: it is a plant associated with grief and death (Bernabé–Jiménez, 2008; Dimakis, 2015; Graf–Johnston, 2013; Rummery, 2021, and see above myth of Cyparissus).

[28] *Plato*, *Phaedo* 107d–e (trans. Fowler): *"For the soul takes with it to the other world nothing but its education and nurture, and these are said to benefit or injure the departed greatly from the very beginning of his journey thither. And so it is said that after death, the tutelary genius of each person, to whom he had been allotted in life, leads him to a place where the dead are gathered together; then they are judged and depart to the other world with the guide whose task it is to conduct thither those who come from this world; and when they have there received their due and remained through the time appointed, another guide brings them back after many long periods of time"* (Edmonds, 2010, pp. 224–225; Graf & Johnston, 2013, p. 109).

Ultimately, only the initiates themselves would have known how to decode the obscure references inscribed on the tablets (Betegh 2011).

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Appendix

1. Gold tablet from Sfakaki, Crete (M. 2891, Archeological Museum of Rethymno, 2nd –1st century BC, Edmonds 2011, 34.; Tzifopoulos, 26.)

He is parched with thirst and he perishes. But give me to drink from the spring of Sauros on the left of the cypress. "Who are you? From where are you?" Earth is my mother and starry Heaven.

(translated by R. G. Edmonds III)

2. Gold tablet from Eletherna, Crete (X-A. 639, Archeological Museum of Herakleion, 3rd –1st century BC, Edmonds 2011, 27.; Tzifopoulos 2010, 15.)

I am parched with thirst and I perish. But give me to drink from the ever-flowing spring on the right, by the cypress. "Who are you? From where are you?" I am the daughter of Earth and starry Heaven.

(translated by R. G. Edmonds III)

3. Gold tablet from Thessaly (4th BC, Getty Museum, Edmonds 2011, 29.)

I am parched with thirst and I perish. But give me to drink from the ever-flowing spring. On the right is a white cypress. "Who are you? From where are you?" I am the son of Earth and starry Heaven. But my race is heavenly.

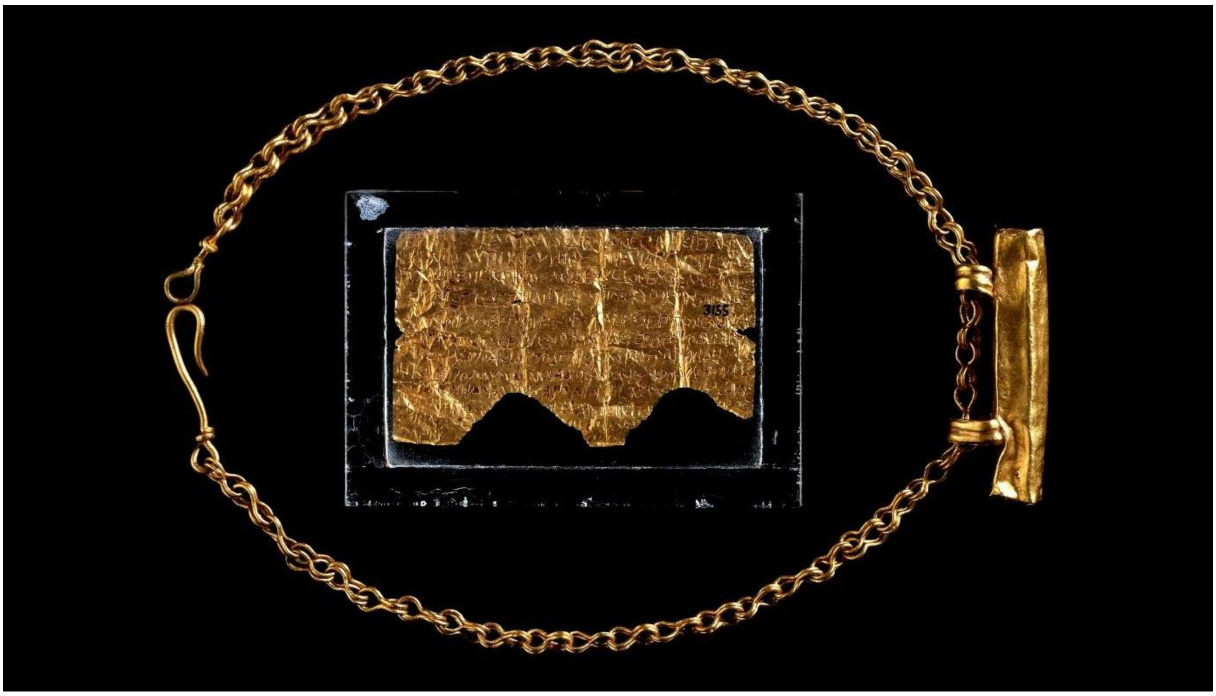
(translated by R. G. Edmonds III)

4. Gold tablet from Pharsalos (4th century BC, Archeological Museum of Volos, Edmonds 2011, 24.)

You will find in the halls of Hades a spring on the right,
and standing by it, a glowing white cypress tree;
Do not approach this spring at all.
Further along you will find, from a lake of Memory,
the refreshing water flowing forth. But guardians are nearby.
And they will ask you for what need have you come;
to them you should relate very well the whole truth;
Say: "I am the child of Earth and starry Heaven;
Starry is my name. I am parched with thirst; but give me to drink from the spring.

(translated by R. G. Edmonds III)

5. Petelian gold tablet (1843,0724.3, British Museum, 3rd–2nd century BC)



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Fanni Alexandra Ruppert – PhD student
ruppertfanny@gmail.com

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Role of Mountaineering in the Nazi Propaganda and Warfare

Focusing on Climbing the Elbrus

M. Johanna Vojcsik
Faculty of Humanities and Social Sciences, University of Pécs

ABSTRACT

1942 was an intense year of World War II, as National Socialist Germany turned eastwards and attacked the Soviet Union. Among the goals of the German leadership was the occupation of Soviet oil fields located in the Caucasus region. While both sides were engaged in brutal combat on the front lines, the German newsreel reported an interesting event:

"The Elbrus have been conquered! Our mountain troops have thereby accomplished a heroic act, not only in military but also in mountaineering terms."

German soldiers had climbed the highest peak of the Caucasus Mountains, the 5,633-meter-high Mount Elbrus. Troops from two mountain divisions reached the summit on August 21, 1942, and planted the imperial war flag there. This achievement can only be interpreted as a mountaineering success, since it held no military value for the German army fighting in the Caucasus.

Given this fact, it may rightly be asked why the mountain troops invested so much energy into a task that had no influence on the outcome of the war. After the analysis of the German mountaineering culture with the help of the so-called Bergfilm genre, as well as Nazi sport policy, it could be demonstrated how National Socialist propaganda reshaped the perception of the German society of mountaineering and mountains. From this perspective, it becomes clear why it was important for the mountain troops to achieve this glory for the Third Reich — and to rename the Elbrus as „Adolf Hitler Peak."

Keywords: Mountaineering, World War II, Caucasus, Propaganda, National Socialism

Introduction

In the Third Reich the National Socialist propaganda covered all areas of life, even the connections and feelings towards nature, mountains and alpinism that seem to be neutral concepts. The Nazi propaganda purposely took advantage of the patriotic feelings that are often linked with the love of nature and countryside, not just in the case of the members of the alpine clubs but in the whole society. By using several methods such as cinema, literature and the creation of a cult around tragic Himalayas expeditions, it was not surprising when the *Deutsche Wochenshau,* the German weekly newsreel reported about the victorious ascent of the 5,633-meter-high Elbrus peak in the Caucasus. The climbing group of the

1st and 4th Mountain Divisions reached the peak on 21st August 1942 and planted the swastika flag on the summit.

"The Elbrus has been conquered! Our mountain troops have thereby accomplished a heroic act, not only in military but also in mountaineering terms." (Deutsche Wochenschau Nr.627, 1942). Although the newsreel informed its audience about a huge achievement, it was just partly true. The conquest of the Elbrus could be interpreted as a success only by reading it as a significant alpinist performance – it had no effect on the outcome of the war. It may have even endangered the overall German strategy on the Eastern Front since the climb required reallocation of resources from the main theatres of combat operations.

With this essay the goal is to answer the question and explain the fact, what the role of alpinism and mountaineering was in the Third Reich.

Bergfilm, Himalayas expeditions and sport policy

Although the attempt to summit the Elbrus may seem irrational during the offensive against the Soviet Union, the ideological background of this act was planted several decades ago into the German society. The origin of the romanticized cult of mountains and alpine landscapes had started at the time of the Weimar Republic and it led towards that, mountaineering became a heroic and patriotic action for the glory of the nation and country. These feelings were strongly confirmed by some literature works. These books published after World War I, focused on a 'typical German lifestyle' in the countryside and encouraged people to turn their back on the civilization and emphasized the anti-intellectuality and timeless feelings. These short stories and novels widely spread the toposes of living in the Alpine environment and the myths of deadly mountains (Amständer, 1996).

Beside these approaches in the realm of literature, cinematography played an important role. The influence of mountaineering was so significant on the movies that the most popular genre of the Weimar era was the so-called *Bergfilm,* movies about mountains and alpine landscapes. The *Bergfilms* shaped the concept of German countryside and motherland not just in case of those who were engaged in the sport but among common people too, who had no other connection to the mountains save for the canvas of the cinemas. The characteristic of this genre was to show stunning high-altitude scenes where not just the beautiful landscapes awaken emotions but the storyline too as the plot is about a heroic act. The narrative often had its peak as the main character achieved something monumental against nature, while he/she sacrifices him or herself for the greater good. This thought later became easy to adapt into the Nazi ideology (Rentschler, 1996).

It must be thought that the *Bergfilm* was not only the product of the right-winged political movements, during the Weimar Republic, it was popular by the left too (Steiner, 1997). However, it would be a mistake to deny that the popularity of the mountain movies rose in the '20s and '30s, parallel to the ascent of the fascist ideology (Wilms, 2009).

The greatest pioneer of the genre was Arnold Fanck, who directed several important movies such as *Der Heilige Berg* (1926) and *Die weiße Hölle vom Piz Palü* (1929). Fanck created the characteristic elements of the mountain movies, which focused on the high mountain landscape and male camaraderie. His films differed from others set in nature in that he not only used the mountain environment as a visual element, but also made the mountains the deuteragonists of the plot. The themes of *Bergfilm* – exploration and victory, survival and endurance, loss and defeat, death and sacrifice, masculinity and comradeship – all had affinities with National Socialist ideology (Wilms, 2009).

Many actors and actresses who started in *Bergfilms* later had a huge career in the Third Reich. The best example is Leni Riefenstahl, who worked several times together with

Fanck and in Hitler's Germany she had a great impact on the Nazi cinematography. One of the most famous propaganda movies, the *Triump des Willens* was directed by Riefenstahl (Rentschler, 1996). But she started her director career after being an actress with a *Bergfilm, Das Blue Licht* in 1932. Although that time she still worked together with the left-winged Béla Balázs (Bernett, 2008).

Parallel to the cinematic representation of alpinism, the German society was well-informed about the achievements of the climbers. Newspapers reported regularly about different expeditions, even books were published about these events (Mierau, 2006). After World War I it could be observed not just in Germany but in many other European countries a race began to expand the (geological) spectrum of climbing and the importance of the first successful summit. Following this trend the German climbers also set their location beyond their traditional area, the European Alps, and from the late '20s till the outbreak of the war several expeditions took place in the Himalayas region. According to Höbusch these were motivated by a desire to reconstruct the German nation and pride in Europe after the lost Great War (Höbusch, 2002).

"In the German and Austrian alpine journals of the period, the perception that the mountains and the act of mountaineering could serve as an antidote to present feelings of national inferiority and lead Germany back on the part to greatness […]" (Höbusch, 2002, p. 51).

In this sense mountaineering was not simply a sport activity anymore. It served political and ideological purposes as well. The German mountaineers did not dream about less than conquering the region of the Himalayas. From the many peaks of the Himalayas the Nanga Parbat (8125 m) emerged with its significance for the Germans. Until 1939 five expeditions visited this region and at least 11 Germans died on this mountain. This resulted in the Nanga Parbat becoming associated with death and after the tragic events it gained the title *Schicksalsberg,* 'Mountain of Destiny' (Höbuschl, 2002).

The National Socialist propaganda used the story of the heroic deaths of the climbers. The anniversaries of the accidents were commemorated and were kept in the thoughts of the civilian population (Mireau, 2006).

The German nation was influenced not just by the propagandistic image of mountaineering that was created from the '30s, but also by the National Socialist sport policy. Hitler had already expressed the importance of sport and physical education. After the Nazi takeover the regime started a new era in the sport life of the country. Sport became a tool to achieve the ideal citizen of the nation. Training their body was not just a hobby for the individuals but it became a duty towards the nation (Bernett, 2008). The condition of the citizens' body, the collective body of the nation (*Gesamtleib*) had to be fit, it was a public affair (Hoberman, 1984).

In National Socialist Germany the state decided what was considered as a healthy and strong body, and their concept was linked with the racist fascist ideology. The ideal body at the time was the 'Northern type', which should be achieved via training. According to Hoberman, the Nazi image of the ideal body was more influenced by the question of racial theory than by actual points of health. For the politicians, the ideal body became the proof of German superiority (Hobermann, 2006).

Theoretically, sports should strive to form the German nation's strength, courage, discipline and endurance. It melted a mystic heroism, the roots of which could be found in the ancient Greek thoughts about the body and in the spirit of Germanic warriors (Amständer, 1996).

On a practical basis, this ideology appeared as examples in the schools, as young boys had five physical education lessons. The focus was mainly on swimming, soccer and boxing. Even in higher education, physical education remained obligatory. With these measurements, the training of the body and giving this a militaristic connotation began at quite a young age (Bernett, 2008).

Mountaineers as soldiers

Mountaineering played an important role in the ideology of the Third Reich. Even the sport itself became independent during National Socialism from other hiking movements (Mireau, 2006). The regime used the climbers' idealistic conceptions about nature, patriotism and fighting to parallel them with its own views. The expression of the similarities often appeared on a linguistic level as many phrases were used both in the field of sport or in the military (Zebhauser, 1998). A climber's good qualities were the same as a good soldier's at least according to the Nazi ideology, both of them heroically fighting for their goals, achieving success together with his comrades, at the peak of his physical and mental strength.

Stressing these similarities began even before the outbreak of World War II., as an example *Reichssportführer* Hans von Tschammer und Osten, who was responsible for the sport policy in the Reich, had already identified alpinism as a fight: fight against nature, while not just the physical body gets a better condition but also the mind, the main goal for the climber is to become a winner (Zebhauser, 1998).

The shadows of the approaching war made it clearer that the political leaders want to give concrete military tasks for the alpine clubs. A sign for that was the statement of Paul Bauer, the leader of the German mountaineer and hiking club, who put the sense of mountaineering in the service of the nation. Bauer thought the climbers have the right, but also the duty to work for the freedom and integrity of their country (Zebhauser, 1998).

Thanks to the growing communication about alpinism as a tool for protecting the country, and also through the increasing impact on the youth in sport clubs and in the *Hitlerjugend,* most of the German and Austrian mountaineers were willing to enrol and to fight for the Third Reich (Mailänder, 2011).

The outbreak of the new World War changed the life of the alpine clubs. The alpine huts and facilities were given to the *Wehrmacht,* the highly qualified climbers served as trainer officers for the Mountain Divisions or even fought on the frontline. The experiences of the climbers made them quite useful soldiers (Zebhauser, 1998).

The members of German and Austrian alpine clubs were counted as reinforcements for the Mountain Divisions, which were engaged not just in high altitude areas but in every area where the environment was challenging (Mailänder, 2011).

Several written propaganda works were published about the *Gebirgsjäger,* who were the light infantry of the Mountain Divisions. The book of Max Seidel, published in 1941, praised the endurance and patriotism of the *Gebirgsjäger*. This work summarized all the expectations towards the mountaineers from the Nazi side and also made sure to engross its readers with spectacular photographs, showing how important the protection of their beautiful country is. Seidel drew a parallel between the climbers' patriotism and the military activity: *"they [the Gebirgsjäger] know, when they are at the front lines, how beautiful is the country they are protecting – and this could be often forgotten if someone is stationed on a flatland."* (Seidel, 1941, p. 9).

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Fight in the Caucasus: Conquest of the Elbrus

After the ideological background of the relationship between alpinism and National Socialism, it is easier to understand the conquest of the Elbrus. The German leadership had planned the attack against the Soviet Union since July 1940. One of the biggest motivations behind this plan was to take over the oil deposits that were essential for continuing the war. This set the direction of the invasion, called Operation Barbarossa, towards the important industrial regions such as the Caucasus, from where 90% of all Soviet oil exploitation came (Müller, 2008). Fall Blau was the *Wehrmacht's* plan to capture the oil fields of Baku and also to cut the supply line presented by the River Volga, in order to crush the economy of the Soviet Union (Kaltenegger, 1997).

However, the German war plans were not adequate. The splitting of the army's offensive line between Stalingrad and the Caucasus did not produce the expected results. Hitler made a strategic mistake in organising the attack and setting the directions (Dörner & Güss, 2011).

Although at the region of the Caucasus several mountain divisions operated, the ascent of the Elbrus was not evident at all due to the fact the peak did not have any significant tactical or strategic importance for either side in connection with the operation. The idea of conquering the Elbrus was born in the mind of Huber Lanz, general of the 1st Mountain Division. He was the one, who thought the German soldiers should not miss an opportunity that could be used for propaganda purposes (Kaltenegger, 1997).

The Elbrus was in the operating area of the 1st Mountain Division and *Hauptmann* Heinz Groth planned to attempt the ascent with his own group of soldiers, the commandant of the XXXXIX. The Mountain Corps decided, in the hopes of preventing rivalry between the *Gebirgsjäger*, that the 4th Mountain Division should link up with the expedition. A group of experienced climbers was created, made up of members of both units, who had the task to plant the flag of the Third Reich on the top of the Elbrus (Kaltenegger, 1997). Hauptmann Max Gämmerler was in charge of the preparations, who even travelled back to Munich to read all information about the Elbrus in the library of the German Alpine Club. When Gämmerler returned after two weeks, he described himself as the following: *"I was a walking lexicon about the Elbrus."* (Braun, 1955, p. 198).

The soldiers who were chosen for this specific task started the expedition on the 12th of August, 1942. The march of soldiers, trucks and pack animals was secured by a *Gebirgsjäger* battalion (Kaltenegger, 1997). The last bigger settlement that they passed was Khursuk and with that the group reached the valley of Ullu-Kam. This was the first place where they had a camp at the altitude of 2241 metres. From here the march continued on the 17th of August till the so-called Elbrus House, which was a rest point and safehouse located at 4200 metres (Braun, 1955).

Before the Elbrus House the pass, Chotju-Tau loomed at the soldiers, which was a glacier. This meant the limit for the mules (Kaltenegger, 1997), from this point all equipment could only be carried by human force, the cargo was divided into packages of 20-30 kg per soldier (Braun, 1955).

Before the summit, the Elbrus House awaited the mountaineers. This shelter was a well-equipped building with about 40 rooms and 100 beds. The whole building had an interesting appearance, as the outside was entirely covered with aluminium sheets. In addition to the main building, there was a separate kitchen and a meteorological station (Braun, 1955).

The first group of climbers, led by Groth, experienced a nasty surprise at the Elbrus House. Soviet soldiers were stationed in the building. At this point, unfortunately, sources only give a vague description of the events. The Germans probably took refuge without any major fighting. Roland Kaltenegger, however, describes the event in a much more adventurous way. According to him, Groth and his troops believed the soldiers stationed in the house to be their own men from a distance, and so they went there without any suspicion. When the Soviets captured them, Groth resorted to a ploy. He made the Russians believe that the whole mountain was full of German mountain rangers preparing to attack. The Soviet soldiers, considering their situation, decided to descend the southern side of the mountain or surrender voluntarily. However, the accuracy of this event has not been confirmed by any other source (Kaltenegger, 1997).

After the German capture of the Elbrus House, the main building was renamed *General-Lanz-Hütte* after the general of the Mountain Division, and the meteorological station *Edelweiß-Hütte* (Braun, 1955).

The 18th of August was about acclimatisation for the mountaineers. Josef Martin Bauer, a member of the expedition, has written about the days spent in the Elbrus House. His description mentioned the shelter as a modern, fully installed house: *"Everything was ready and probably for foreigners who wanted to climb Elbrus from here. On the tins there are Russian and English inscriptions. The warehouse also had butter, grits, soap and top quality yellow shoe polish."* Bauer also reported that shaving has been banned among soldiers to make their faces more resistant to cold, wind and other natural conditions (Bauer, 1954, p. 117).

There were about forty mountaineers in the Elbrus House, and the next day, 19 climbers set off on the first ascent on 19th August. The team left the refuge at half past three in the morning, led by Groth (Kaltenegger, 1997). However, the weather proved to be particularly cruel on this day and Groth had to order a retreat due to snowstorms and fog at an altitude of 4800 metres. Hauptmann Gämmerler and a few of his companions tried to go on, but as the weather did not improve, they also returned to camp (Braun, 1955).

The idea of failure did not exist in the National Socialist conception. Bauer wrote *„We gave up and came home defeated.[...] yet ready to repeat the same thing the next day or any day."* (Bauer, 1954, p. 124).

The plan was not abandoned, but the weather did not improve the next day, and on 20th of August, in the stormy conditions, they did not attempt another summit. The next day, however, the weather looked more promising. At dawn on 21st of August, the climbers set off again for the peak. At eleven o'clock they reached the top of Elbrus, where they put up the German imperial battle flag and the division flags decorated with Edelweiss flowers. However, later, after the descent, in clear weather, it was noticed that the flags were not exactly placed at the highest point of the peak. To quickly correct the mistake, another ascent was made, during which propaganda shots were taken with a narrow film camera (Kaltenegger, 1997).

General Lanz called the success the victory of the swastika and the Edelweiss over the Soviet star, and wished that the highest peak of future Europe be called the Adolf-Hitler-Peak (Kaltenegger, 1997).

The reception of the successful ascent

Although the mountaineers showed their loyalty to the Führer by naming the peak after him, the effort was not a triumph for Hitler. According to Albert Speer, the main architect of the Third Reich and the head of the Ministry of Armaments and War Production, Hitler took the news very negatively. Speer wrote in his diary: *"I have often seen Hitler angry; but seldom did he erupt as he did at this news. He raged for hours as if his whole war plan had been destroyed by this enterprise. Even days later he was still complaining to everyone about these 'mad climbers' who should be sent on trial. They were going after their idiotic* *ambition in the middle of the war, he said indignantly, conquering a peak […]"* (Speer, 1993, p. 253).

In spite of Hitler's opinion not being initially favourable, still, the National Socialist propaganda immediately used the fact of the summit of the Elbrus. Despite Albert Speer's claim that Hitler was furious without his approval the propaganda would certainly not have reported the event as widely as it did (Kaltenegger, 1997).

The German weekly newsreel, *Deutsche Wochenschau* broadcast the footage from the summit to a wide audience. In the newsreel, viewers were able to follow the entire expedition. The narrative constantly emphasises the heroism of the soldiers, which is enhanced by the dramatic musical soundtrack. The summary concludes with an aerial view of the German soldiers dominating not only the huge mountain but also the skies above (Deutsche Wochenschau, 1942).

Of course, the conquest of Elbrus was also reported in the printed press. On August 26th, the official newspaper of the National Socialist German Workers' Party, the *Völkische Beobachter*, ran a headline about the flag-planting, which it described as a symbolic act that opened the way for German troops to Stalingrad. The writer of the article is amazed to note that this was not the first incredible feat of the mountaineers, but they always seem to be able to improve themselves, for them *„no mountain is too high, no valley too deep."* (Völkischer Beobachter, 1942, p. 1).

Another example: Mount Olympus

The conquest of Elbrus was not the only example of alpinist achievements of the *Gebirgsjäger* during the war. Same expeditions were done all over Europe, from Scandinavia till the Mediterranean. Similarities could be observed between Elbrus and Mount Olympus, as the latter might have been a motivation for the action in the Caucasus.

The Olympus is not just the highest mountain of Greece but also a symbolic mountain of the whole continent. However, with its 2919 metres the mount does not count as a serious challenge for climbers. Despite this, as its significance lies in historical role and symbolism, the conquest was important for the German troops.

Compared to the summit of Elbrus, the successful climbing of Mount Olympus in 1941 got smaller media attention. But after the event in the Caucasus in many newspaper articles the Greek peak was also mentioned retrospectively.

In his book, Julius Braun draws an almost unmistakable parallel between the two events, and paints the climbing of one mountain after another as an inevitable continuation. *„Just as the 6th Mountain Division had placed the imperial battle flag on the summit of Mount Olympus in Greece, so it had to happen on Mount Elbrus."* (Braun, 1954, p. 36).

The *Völkische Beobachter* was much more modest in its coverage of Olympus than Elbrus. But the emphasis on the heroism of the act is strong here too. The article points out that the seven mountaineers reached the summit without any equipment, while the battle was still going on in the immediate vicinity of the mountain. The climbers had to face not only this danger but also a snowstorm, according to the author (Völkischer Beobachter no. 114, 1941).

The front page of the 24th of April 1941 issue of the newspaper included a photo of the flag waving on the summit and the soldiers climbing to the top. (Völkischer Beobachter no. 114, 1941) In announcing the climb of Elbrus, a year and a half later, it is again referred to the fact that the climbers had already proved their mountaineering skills on Mount Olympus in Greece (Völkischer Beobachter no. 238, 1942). It should be noted once again, however, that the two conquests were carried out by members of three different divisions, the 6th Division on Mount Olympus and the 1st and 4th Divisions on Elbrus.

There may have been a rivalry between the different mountain warfare divisions, motivating them to achieve the highest possible alpinistic performance where they were stationed. This is confirmed by the fact that the ascent of Elbrus was carried out by two divisions in the Caucasus together, thus avoiding rivalry between the soldiers. It is likely that the action of the 6th Divisions climbers may also have influenced Commander Hubert Lanz when he came up with the idea of climbing Elbrus.

Conclusion

From the modern point of view the conquest of Elbrus might seem to be an illogical act, however, if we look at the mountaineering ideology of the time and the history of National Socialist alpinism, we can see that the ascent of Elbrus was a logical consequence of the cult that the Third Reich regime built around mountaineering. The emphasis on heroism and other virtues, the exaggeration of the patriotism associated with the mountains, and the parallel between the military and the mountaineering attitude all led to the regime's deliberate exploitation of the mountaineering society for its own goals.

The carefully constructed ideology gave the regime support at various levels. Mountaineering troops were prominent units in the fighting on several fronts. They also provided useful material for propaganda through their outstanding mountaineering achievements. With these facts in mind, it was a logical step for German mountain climbers to ascent the highest peak in the Caucasus during the Second World War.

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M. Johanna Vojcsik – PhD student
vojcsikjohanna@yahoo.com

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Getting to Know a Stranger

The Case of Rezső Bohuss[29]

Zsolt Vörös
Faculty of Humanities and Social Sciences, University of Pécs

ABSTRACT

The narrow subject of my research is the Serbian occupation of the Baranya-Baja region (1918–1921) after the First World War. In the course of this research, I began to uncover individual cases of internment during the occupation, which turned out to be a deliberate and systematic policy of the occupiers. The occupiers in the town of Valjevo in western Serbia interned important representatives of the administrative and social leadership of the region. The sources for this research are largely the ego-documents surviving from the internmented persons, in which the Roman Catholic chaplain Rezső Bohuss is mentioned several times. However, they do not contain much beyond a few brief personal descriptions. In my study, I want to show how the life of Rezső Bohuss was reconstructed (with the help of various sources and literature on church history) and to describe the life of the chaplain himself.

Keywords: First World War, Serbian Occupation, Internment, Valjevo, Rezső Bohuss

Introduction

By the autumn of 1918, it had become clear to all those in positions of leadership that the Central Powers, in this case the Austro-Hungarian Empire, had lost the First World War. The fact of defeat in the war and the social and ethnic tensions that followed set the empire on the road to disintegration. On the 3rd of November 1918, the Monarchy signed the Armistice of Padua, which constituted a surrender to the Entente powers, signed jointly by Austria and Hungary, who had lost the war (Ormos, 2020). However, this left several outstanding issues, notably the unresolved relationship between the Hungarian state and the Balkan Entente (Serbian-French) forces in the south of the country. To this end, on the 13th of November 1918, the Károlyi-government concluded the Belgrade Military Convention, which marked out a demarcation line that included areas already inhabited by Hungarians. This line was drawn by Barcs-Pécs-Bátaszék-Baja-Szeged-Maros, and on the same day, the

[29] The present study has a Hungarian version: Vörös, 2025.

Serbian army set out to reach it and occupied the areas south of the demarcated line (Vörös, 2024a).

Even though the convention stated that the administration of the occupied territories should remain in Hungarian hands (Hornyák, 2004), it soon became clear that to implement Serbian ambitions, which in practice meant the annexation of Baranya County to the Kingdom of Serbs, Croats and Slovenes an open change of power began at the end of 1918. The leading figures in local administration (e.g. Lord Lieutenant, subprefect, chief notary, etc.[30]) were replaced by Serbian officials. Those who did not cooperate with the invaders and the leaders of the Hungarian resistance were arrested, taken hostage and interned in Valjevo in western Serbia (Vörös, 2023, 2024b). The central character of this study, *Roman Catholic chaplain Rezső Bohuss*, was among these people.

It soon became clear that the Valjevo internment was not a succession of individual cases. It was a deliberate tool of the occupiers to crush Hungarian resistance and the uncooperative Hungarian administration. We are not talking about internment in the „classical sense"; there was no internment camp set up, and they were housed in the town. Within the administrative boundaries of Valjevo, the internees were free to move around, to work and to interact with the locals (Vörös, 2023). So, in the light of these relatively „weak" conditions, we concluded that they should not be assessed as a specific (violent) measure of punishment, but as a means of removing them from their living environment and collectively controlling persons who were dangerous to the occupiers. Of course, against the background of personal experience, it should also be emphasised that much depended on the attitude of the local population in Valjevo towards the internees who appeared there. We know from Béla Fischer's reminiscence that many of the locals were prisoners of war in Hungary during the First World War. They were not treated too cruelly there either, so they were mostly friendly towards them (Fischer, 2006). This does not allow us to generalise about the situation of prisoners of war in Hungary during the First World War. Extensive research has been carried out on the Serbian prisoners of war in Austria-Hungary in recent years (Gorcsa, 2023).

The source material for the research of the Valjevo internment consists mainly of various ego-documents (e.g. diary) left by the interned persons, administrative documents and personal bequests in the holdings of the public archives of the area. In these ego-documents, Rezső Bohuss was mentioned several times, though little information is available about him. Further sources of church history and literature, and local press sources of the period, were needed to identify him and reconstruct his life. The next two chapters describe these sources and the identification process.

[30] I translated the names of administrative officials based on the recommendations of Dániel László Kovács (Kovács, 2024).

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The appearance of Rezső Bohuss in the studied ego-documents

The figure of Rezső Bohuss appears in the diaries and letters of three people interned in Valjevo. Ferenc Vojnics (1879–1962), mayor of Baja, in a letter, László Visy (1854–1935), retired Lord Lieutenant of Pécs, and Béla Fischer (1877–1953), then second chief notary of Baranya, later vice prefect, in his memoirs. Ferenc Vojnics was interned in Valjevo in the summer of 1919 and „moved with" Rezső Bohuss from the chaplain's arrival in May 1920. László Visy and Béla Fischer were interned from Pécs on the 20th August 1920, and arrived in Valjevo on the 24th August. The Pécs residents also met with Bohuss, but they did not spend much time together there, till Bohuss and Vojnics escaped from Valjevo on the 25th August 1920 (HU-MNL-BaVL XIV. 60. 3. d. VI. k. (1920. okt. 4.)). László Visy remembers Rezső Bohuss this way:

> „(...) *two gentlemen suddenly appeared, and asked in Hungarian, are we* [László Visy, Béla Fischer, Ferenc Fischer, József Hamerli - V. Zs.] *interned? To our answer in the affirmative, one of them was the mayor of Baja, Ferenc Vojnics, and the other was the Roman Catholic chaplain there* [Rezső Bohuss – V. Zs.] *introduced themselves, and after asking our names and positions, the mayor began to talk to the clerk in Serbian, as we learned afterwards, that he would allow us to sleep in the inn today, guaranteeing us that we would report to the secretary at 8 a.m. tomorrow*"
>
> (HU-MNL-BaVL XIV. 60. 3. d. VI. k. (1920. okt. 4.)).

László Visy (and his companions in the internment) arrived in Valjevo at the time of the quoted entry and, according to him, they were able to establish better relations with the help of Ferenc Vojnics and Rezső Bohuss, mainly thanks to Vojnics' assistance in translation. Béla Fischer's reminiscence also records the moments around the meeting:

> „*Ferenc Vojnics and Rezső Bohus* [sic!], *the Roman Catholic chaplain: Vojnics is a gentleman even when he is shabby, Bohus* [sic!] *in short trousers and a sport shirt, unserious, plays the piano and violin.* (...) *The next day, the Vojnics's* [Ferenc Vojnics and Rezső Bohuss - V. Zs.] *were with us all day, informing us about local conditions. The next day, they went on an excursion, they said. We never saw them again, they ran away. A week later, they* [the Serbian authorities – V. Zs.] *found out about the escape*"
>
> (Fischer, 2006).

Béla Fischer and László Visy arrived together in Valjevo and met Rezső Bohuss together. They similarly remembered him, with similar words. The third ego-document is a personal letter from Ferenc Vojnics:

> „*I was very tired of this* [of the internment - V. Zs.] *and I escaped. It took me eight days to escape*. (...) *My companion in the escape was a Catholic priest* [Rezső Bohuss - V. Zs.] *who later quit, and I know he went debauched. He was more of a burden than a help*."
>
> (Knézy, [1940] 2009).

Ferenc Vojnics refers to Bohuss as his partner in the escape, which confirms Visy's and Fischer's claim that the two of them left. Vojnics' characterisation is also consistent with Visy's and Fischer's characterisation of Rezső Bohuss: an „easygoing" chaplain who hindered rather than helped him in his escape. However, he is also wrong; after reconstructing Bohuss' life, it turns out that he did not leave the Church, ending his life as a Catholic priest. The information from the ego-documents just quoted was the starting point for the research: Who was Rezső Bohuss?

The breakthrough – church history sources and literature

From the entries in the aforementioned ego documents, the research already had some basic information, a character profile of Rezső Bohuss. The first breakthrough came from the Archives of the Archdiocese of Kalocsa, where we found Rezső Bohuss among the diocesan personalities, but the source did not tell us much (HU-KFL Personáliák BR.). It turned out that he was born on the 7th April 1892, in Érsekújvár, attended seminary in Kalocsa and was chaplain in Nagybaracska, Kecel and Felsőszentiván until 1923 (HU-KFL Personáliák BR.). Another important fact: his first name is written as Bohuss and not Bohus. Based on these data, research on Rezső Bohuss continued, helped greatly facilitated by advances in 21st century digital technologies and public data accessibility (e.g. ADT).

Margit Beke's extensive volume on the clergy of the Esztergom(-Budapest) Archdiocese also includes a short biography of Rezső Bohuss from the second half of the 1920s, after he had already been in the service of the Esztergom Archdiocese (Beke, 2008). In the light of this, it appears that he returned to his homeland, the Felvidék, for the second half of his life. In addition, a PhD dissertation on the Hungarian Catholic clergy in the Felvidék helped to identify Bohuss more precisely (Sztyahula, 2012). Rezső Bohuss's trajectory can be geographically delineated, and by examining these sources and the local press of the places in question, it was possible to reconstruct his life's journey.

The reconstructed biography of Rezső Bohuss (1892–1955)

Rezső Bohuss was born on the 7th April 1892 in Érsekújvár, Nyitra County (Beke, 2008). He finished his secondary education at the Catholic Secondary School in Érsekújvár, where he graduated in 1910 (SzFKG Értesítője, 1911). He completed his theological studies at the seminary of the Archdiocese of Kalocsa, but the First World War intervened, and he served in the army for three years from 1914 (Beke, 2008). Bohuss was ordained in Kalocsa on the 3rd June 1917 (HU-KFL Personáliák BR.). After his ordination, he served as a chaplain in the Archdiocese of Kalocsa, from 1919 in Nagybaracska and Baja (HU-KFL Personáliák BR.). In the early period after his ordination, he is also mentioned as the chaplain of Kula, but this is not mentioned in the personnel of the diocesan archives, although the settlement belonged to the diocese. During the Serbian occupation, probably in May 1920, he was interned in Valjevo in Western Serbia, from where he escaped with Ferenc Vojnics, mayor of Baja, on the 25th August 1920 (HU-MNL-BaVL XIV. 60. 3. d. VI. k. (1920. okt. 4.)). After the occupation, he was a chaplain in Kecel from 1921 and then in Felsőszentiván from 1923 (HU-KFL Personáliák BR.). During these years, his irredentist writings and plays were regularly reported in the press of those times. In 1927, he entered the service of the Esztergom Archdiocese, and from 1928 he was chaplain in Szőgyén. (Beke, 2008) From 1929, he was chaplain in Bős for eight years. It is especially worth mentioning that during his stay in Bős, he was mentioned in the contemporary press as a boost to the cultural life of the village. Between 1937 and 1940, he was the administrator of Balony, and from 1940 until his retirement in 1953, he was the priest of Egyházkarcsa. Together with several Hungarian priests from the Felvidék, he lost his Hungarian citizenship between 1944 and 1948 (Sztyahula, 2012). Rezső Bohuss died on the 2nd of April 1955 (Beke, 2008).

In what questions does this research help to answer?

The biography reconstructed by the research can also provide clues on several larger historical issues. Research methodology, source issues: the complex use of significantly different types of sources together. Research on the life of Rezső Bohuss and, in parallel, the inquiry into his internment in Valjevo required the use of archival sources, museum sources, church history sources, personal legacies (e.g. from the museums in Baja or Mohács), ego-documents and a large number of contemporary printed sources, in addition to those that can be considered general. By spring 2025, the research had already identified 23 interned persons in Valjevo, of whom Rezső Bohuss is the only clergyman.

Bohuss' life and circumstances in the period under study can give us an insight into the situation of church actors during the collapse of the First World War and its aftermath, a picture that is diffuse and varies greatly from region to region (Tengely, 2004). The geographic mobility of a person under study is also significant; he started his life in the Nyitra County, and after working in Central Hungary and Bácska (and the internment in Serbia), he returned to his homeland, where he worked in several municipalities. In this second phase of his life, it is particularly important that his ecclesiastical activity was not much affected by the repeated changes of the border (1944–1945 inclusive), since these settlements were returned to Hungary in November 1938, in the framework of the first Vienna Award.

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Zsolt Vörös – PhD student
voroszsolt20@gmail.com
ORCID ID: 0009-0007-9301-3503

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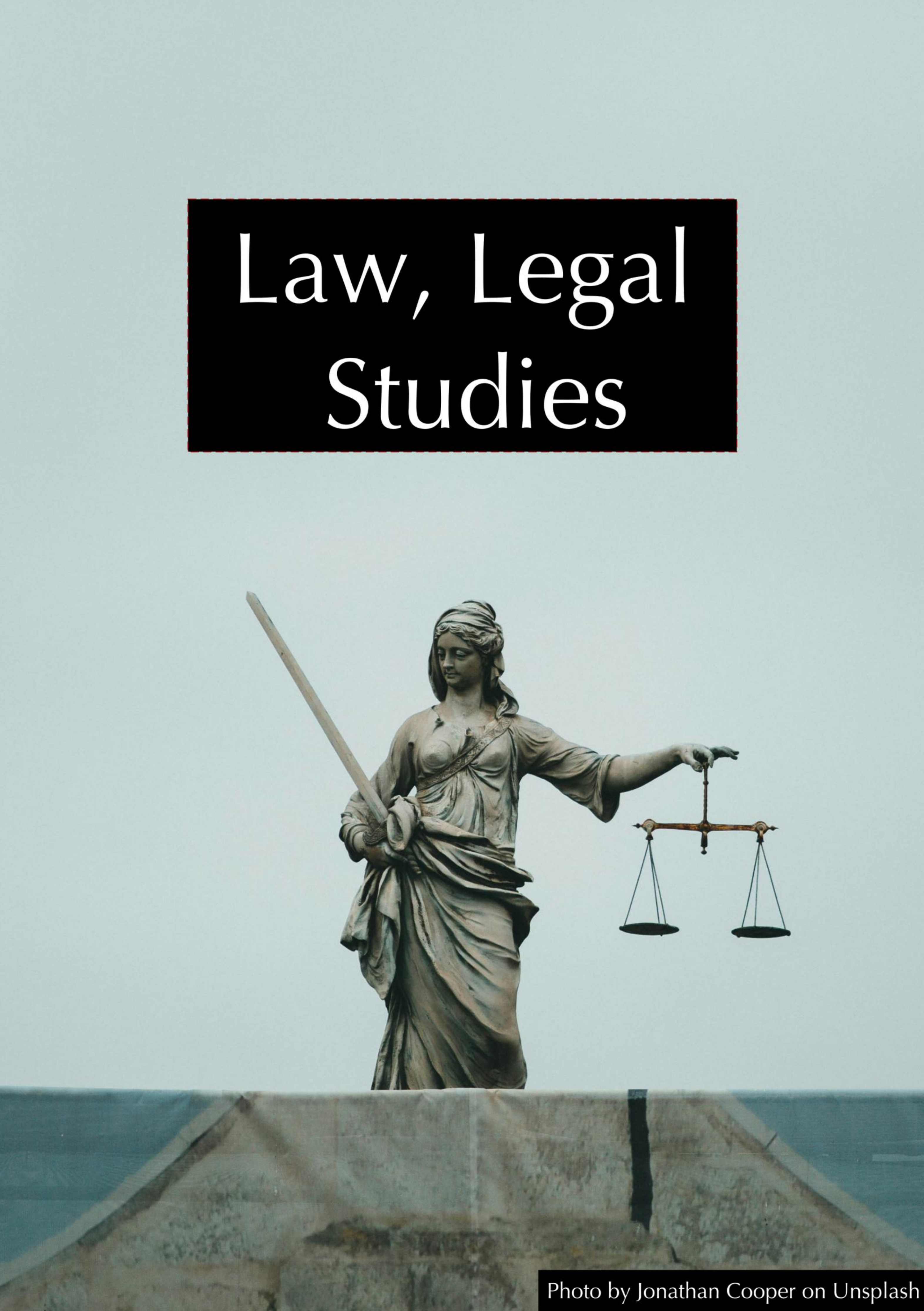

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The Issue of Judicial Remuneration in the Light of the So-Called Quadrilateral Agreement

Kristóf Benedek Fekete

Department of Constitutional Law, Faculty of Law, University of Pécs

ABSTRACT

The legislator has resolved the deficiencies previously identified in judicial independence in the context of comprehensive reforms. By the end of 2023, the European Commission considered that Hungary had implemented the measures necessary to meet the horizontal enabling condition on the European Union Charter of Fundamental Rights. However, the tensions over the salaries of judges and judicial staff have not been satisfactorily solved. Therefore, the main objective of this study is to present a complete overview of the issue of judges' salaries, which has remained unaffected since January 1, 2022, with a particular focus on the path towards a pay settlement for judicial staff.
The study methodology is based on qualitative methods: the analysis is mainly based on the interpretation and analysis of relevant (legal) documents using known interpretative techniques and exploring contexts and trends.
The study has found that financial decisions cannot be interpreted in isolation, even in the case of the judiciary, because, as the wage issues show, they are always complemented by other issues and reforms.
The study underlines that it is unfortunate to link the financing of the judiciary with other issues of different origins. As far as judicial salaries are concerned, it is advisable to give priority to automatism because at present the financial autonomy of the administration of the courts is merely symbolic in its present form, being in fact tied to the discretionary power of the government of the moment.

Keywords: judicial independence, salary base of judges, financial autonomy of the court administration

Introduction

The horizontal enabling condition on the European Union (hereinafter: the EU) Charter of Fundamental Rights requires Member States to put in place adequate mechanisms to ensure that the implementation of their programs is in line with the Charter. In this context, at the end of 2022, the European Commission expressed concerns about four aspects of judicial independence in Hungary and proposed solutions to remedy the situation. Provided that Hungary implements these proposals, it will receive approximately €10.2 billion of the total €21.9 billion in EU funds withheld (European Commission, 2023a).

The Hungarian legislator has resolved the deficiencies identified around judicial independence in the context of comprehensive reforms. Following legislative clarifications by the end of 2023, the European Commission took the view that Hungary had implemented the measures necessary to meet the above-mentioned enabling criteria (European Commission, 2023b). However, the tensions over the salaries of judges and judicial staff have not been satisfactorily solved.

Therefore, the main objective of this study is to present a complete overview of the issue of judges' salaries, which has remained unaffected since January 1, 2022, with a particular focus on the path towards a pay settlement for judicial staff. However, this also requires a brief outline of the relationship between the rule of law and judicial independence, and given the sensitivity of the issue, it is necessary to emphasize the highly descriptive nature of the analysis in some places.

The study relies on qualitative methods in terms of methodology. The analysis is mainly based on interpreting and analyzing relevant (legal) documents using known interpretative techniques and exploring contexts and trends.

Brief overview of the rule of law and judicial independence

According to the dominant view, the rule of law is a state in which the primacy of law prevails, so the concept of the rule of law in constitutional democracies typically refers to a state where the constitution/fundamental law and constitutional legislation provide the framework for orderly coexistence within the state and also give measure and form to the exercise of public power (Petrétei, 2011; Trócsányi, 2016). In Hungary, Paragraph (1) of Article B) of the Fundamental Law of Hungary constitutes and declares the rule of law and lays down several elements of this principle. In accordance with the legal policy requirements of the rule of law, legal development produces legal institutions that enforce legal values, such as the principle of judicial independence (Samu, 2008).

An independent judiciary is one of the fundamental pillars of the rule of law (Kuijer, 2004), and judicial independence – following the consistent practice of the Constitutional Court of Hungary – is the "most important" guarantee of the independence of the judiciary (Decision No. 4/2014. (I. 30.) of the Constitutional Court of Hungary). As the most important guarantee, its content is very complex and has numerous meanings due to its many components.

Regarding the crucial so-called *Portuguese Judges* case – where the European Court of Justice first began to develop its new, solid doctrine on judicial independence – "[t]he concept of independence presupposes, in particular, that the body concerned exercises its judicial functions wholly autonomously, without being subject to any hierarchical constraint or subordinated to any other body and without taking orders or instructions from any source whatsoever, and that it is thus protected against external interventions or pressure liable to impair the independent judgment of its members and to influence their decisions" (Case C-64/16, Associação Sindical dos Juízes Portugueses). Based on the above, and in line with the widely accepted view in the literature (Decision No. 34/2013 (XI. 22.) of the

Constitutional Court of Hungary), the independence in question must consist of at least three components, namely organizational, personal, and professional (or internal) independence (Dieseroth, 1993; Herzog, 1986; Redish, 1995).

The “decent” remuneration of judges – as a professional element of judicial independence – is therefore also part of ensuring the independence of the administration of justice. Financial recognition plays a central role in ensuring that judges can perform their judicial functions appropriately and free from influence (Decision No. 4/2014 (I. 30.) of the Constitutional Court of Hungary). This type of independence can be divided into two parts. On the one hand, judges’ remuneration must necessarily meet their professional needs and, in addition, provide them with financial security and respect commensurate with their status and authority. On the other hand, an objective and calculable system of requirements must be established, strengthening independence. The requirement for adequate remuneration can be approached from two perspectives. On the one hand, judges’ remuneration can be compared to the average wage in the country, and on the other hand, a comparison should be made with the competitiveness of judges’ remuneration to the private sector (Nurmi, 2001).

In this regard, it is important to highlight the requirements set out by the European Law Institute concerning the financial autonomy of courts, namely that “1. The legislature must provide sufficient financial resources for the proper administration of justice. 2. The allocation of financial resources must be based on stable, objective, and transparent criteria. 3. To ensure the separation of powers, the judiciary must be closely involved in budget determination. 4. The judiciary must be accountable for the financial management of the funds allocated to them.” (European Law Institute, 2024, p. 32). Without these, we cannot speak of real financial independence and complete judicial independence (Venice Commission, 2010).

Salaries of judges and judicial staff

In general, the management of the courts is not subject to much criticism, unlike the remuneration of judges and judicial staff. These disputes are not new, as they go back a long time, to before the 1997 reform of the judiciary, and have many aspects (Tóth, 2001) but their essence is that the downgrading of the status of judges to that of conscious civil servants has reached the point (Horváth, 2024) where “[t]he court is one of the worst-paid civil servants working in the worst conditions.” (Kulcsár, 1985, p. 332).

A plastic point of departure is the 1870 (!) writing of János Baintner, who takes the following position, which I share: “[the] right administration of justice demands that the most excellent individuals devote themselves to it. For this reason, too, such individuals must be duly rewarded. Nor is it an excuse for the state to have no money because it is also subject to the same rules as the private individual. If it wishes to take in laborers, some less skillful and cheaper, and others more skillful, who do the work more perfectly, but more expensively: it is not in its power to make him do the work at a low price.” (Baintner, 1870, p. 34).

Accordingly, the current legislation also states that “[t]he salary of judges shall reflect the gravity of their responsibilities and the dignity of their office, and it shall be sufficient to ensure their independence” (Act CLXII of 2011 on the Legal Status and Remuneration of Judges). However, there is heated debate about whether the current remuneration situation is commensurate with this requirement. Erika Farkas’ view seems to be correct that “[the] current method of determining judges’ salaries does not meet the requirements of the rule of law, since in a state governed by the rule of law it cannot be a budgetary issue that the material conditions determining the basic functioning of the judiciary are provided” (ATV Magyarország, 2024). Former Minister of Justice Péter Bárándy also emphasizes “[a]ny change that moves judicial regulation not towards a set of automatisms, but towards a set of decisions, towards a set of decisions made by someone, is against judicial independence and violates or endangers it” (ATV Magyarország, 2025). Tamás Matusik, former President of the National Judicial Council (hereinafter: NJC or OBT) points out that “[the] settlement of judges’ salaries is a cardinal issue in itself, from the point of view of the independence of the judiciary. It cannot be linked to any other condition, it cannot be negotiated, it cannot be bargained. [...] There can, therefore, be no bundling for good reforms.” (Partizán, 2024).

Under the law, “[t]he salary base of judges shall be established by the act on the central budget, with the proviso that it may not be less than the sum established for the previous year.” In addition, “[t]he basic salary of a judge shall be determined on the basis of the judge’s service time as calculated in accordance with this Act, by multiplying the judge’s salary base with the index numbers specified for each pay grade in Annex 2” (Act CLXII of 2011 on the Legal Status and Remuneration of Judges). The determination of the salaries of judges is therefore subject to the periodic decision of the Hungarian National Assembly (the Hungarian Parliament) and not to a predictable automatism, as in the case of Members of Parliament, where the monthly salary of a Member of Parliament, determined for the period from March 1, of the year in question to the end of February of the following year, is three times the average monthly gross earnings of the national economy for the preceding year, as officially published by the Hungarian Central Statistical Office (Act XXXVI of 2012 on the National Assembly). It would be advisable to introduce similar automatism in the judiciary, as in Estonia (ENCJ, 2024a), for judges and other judicial staff, as such a system would better serve the long-term interest of the judiciary (e.g., the number of people entering the court system would not decrease, which might justify reorganizations) and the requirement of judicial independence. For example, at the time of the 1997 judicial reform, a form of automatic inflation-linked judicial remuneration was already being considered (ATV Magyarország, 2024).

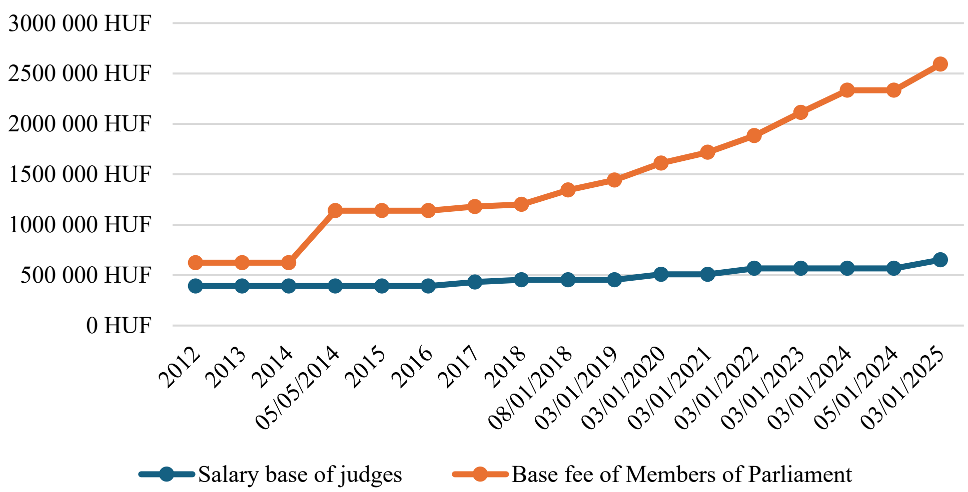
Table 1
The base fee of Members of Parliament and the salary base of judges, based on the annual reports of the President of the National Office for the Judiciary (hereinafter: NOJ) and the data of the Hungarian National Assembly, by period

Period	Salary base of judges	Period	Base fee of Members of Parliament
01/01/2012 – 12/31/2016	HUF 391 600	01/01/2008 – 05/04/2014	HUF 231 900
01/01/2017 – 12/31/2017	HUF 431 740	05/05/2014 – 07/31/2018	HUF 747 878
01/01/2018 – 12/31/2019	HUF 453 330	08/01/2018 – 02/28/2019	HUF 891 000
01/01/2020 – 12/31/2021	HUF 507 730	03/01/2019 – 02/29/2020	HUF 989 700
01/01/2022 – 12/31/2024	HUF 566 660	03/01/2020 – 02/28/2021	HUF 1 103 400
01/01/2025 –	HUF 651 660	03/01/2021 – 02/28/2022	HUF 1 210 800
		03/01/2022 – 02/28/2023	HUF 1 316 400
		03/01/2023 – 02/29/2024	HUF 1 547 298
		03/01/2024 – 04/30/2024	HUF 1 767 342
		05/01/2024 – 02/28/2025	HUF 1 767 342
		03/01/2025 –	HUF 1 940 400

Source: Own compilation (NOJ, n. d.; Fee of Members of Parliament, n. d.-a & n. d.-b).

The figures for the salary base of judges are always calculated from January 1 of the current year. However, they are shown next to the basic salary of Members of Parliament for a better and clearer comparison. It should also be added that in 2020, it is not the judges' salary base that has increased but the multipliers.

Figure 1.
The base fee of Members of Parliament and the salary base of judges, based on the annual reports of the President of the NOJ and the data of the Hungarian National Assembly, by period



Source: Own compilation (NOJ, n. d.; Fee of Members of Parliament, n. d.-a & n. d.-b).

According to the latest 2024 findings of the European Commission for the Efficiency of Justice (hereinafter: CEPEJ) in 2022, "[a] [judge's] gross salary is 2.5 times the average national salary at the beginning of their career and 4.9 times for the Supreme court. At the start of their careers, judges' salaries vary between 1.5 and 3.5 times the average national salary in 61% of states and entities. At the Supreme Court level, it varies between 2.5 times and 6.5 times the average national salary in 74% of them" (CEPEJ, 2024, p. 76). As for Hungarian judges, according to this report, they earn 1.9 times the national average salary at the beginning of their career and 4.3 times at the top, with an end-to-start ratio of 1.3; between 2012 and 2022, the change (increase) in salary was 70.9% (CEPEJ, 2024). The absolute value at the beginning of a career is €30 157 and €69 818 at the top in Hungary, compared to averages of €60 750 and €115 733 in the countries studied, and median values of €46 812 and €100 367. In median value, the average gross salary at the beginning of their career is 2.1 times the national average salary, while for the highest instance, it is 4.3 times (the latter value coincides with the Hungarian value). Considering the data, Hungary is significantly below the average. Moreover, our current figures are even worse due to turbulent inflationary trends. Regarding this, in its press release of May 3, 2024, the NJC states: "The salary base of judges has remained unchanged since January 1, 2022, and is already lagging behind the average gross national salary by a considerable margin. Since 2010, the minimum wage has risen four and a half times, the average gross national salary three times, while the salary base of judges has increased by only one and a half times. The actual level of remuneration is now persistently out of proportion with the dignity of the judiciary and far from commensurate with the responsibilities of judicial staff. The NJC considers that this situation is jeopardizing the functioning of the courts. Therefore, the NJC expresses in this communication the urgent need for a settlement of the remuneration of judges and judicial staff and calls on the legislator to take the necessary measures without delay" (OBT, 2024a). This is made worse by the fact that a Hungarian judge has submitted a complaint to the European Commission in connection with the judicial remuneration system (OBT, 2024b).

We cannot overlook the recent tense debates surrounding the issue of judicial remuneration. In this context, organizing and evaluating what has been said is appropriate.

Considering the above, on June 28, 2024, the NJC addressed a request to the President of the Republic to take up the demand of judges and judicial employees and submit a draft law as an independent legislative initiative (OBT, 2024c).

On July 24, 2024, the European Networks of Councils for the Judiciary (hereinafter: ENCJ) published a statement on the situation of the remuneration of Hungarian judges, in which the ENCJ called on all relevant actors, including other branches of state power, to take the necessary steps to resolve the situation. The ENCJ underlined that "[e]arlier salary increases of judges and prosecutors have been adversely affected by high inflation. Consequently, the financial situation of judges and of court staff has deteriorated significantly in the last number of years. This issue is further exacerbated by substantial salary increases in other sectors of the labour market, including legislative and executive branches of the public sector, which leads to significant disparity among different state entities. Recalling the ENCJ Statements of May 25, 2023, and June 12, 2024, on the issue of adequate judicial remuneration as an important component of judicial independence, the European Network of Councils for the Judiciary takes this opportunity to reiterate the importance of an independent judicial system in ensuring the fundamental values of Article 2 TEU on which the European Union is founded. Insufficient funding hampers the ability of the judiciary to carry out its functions effectively and independently. It also creates real difficulties in hiring and retaining qualified court staff, who assist judges in the administration of justice" (ENCJ, 2024b).

On September 11, 2024, the President of the NOJ, with the agreement of the NJC, wrote to the Minister of Justice to negotiate a settlement of the remuneration of judges and judicial staff (OBT, 2024d). The Minister of Justice replied on October 1, 2024 (OBT, 2024e), and on October 16, 2024, a joint statement was adopted, in which they declared their common intention "[t]o improve the Hungarian judicial system in order to ensure that the courts of Hungary provide citizens seeking justice with the highest possible quality of timely and professional judgments, while fully respecting the independence of the judiciary. They express their intention to pursue a complex series of negotiations. They state that a crucial element of this is to increase the financial dignity of judges and judicial staff. The President [of the NJC] stresses the need to prioritize the settlement of fair remuneration regarding the timetable. He considers it important that the government's dialogue with the actors of the judicial system should be intensified. The Minister of Justice underlines that the aim is to ensure that Hungary's judicial system serves the interests of the Hungarian people even better and that those who go to court receive predictable and swift decisions. The government intends for judges and judicial staff to be properly appreciated. The government intends for judges and judicial staff to be properly appreciated. The President of the NJC and the Minister of Justice will agree on a timetable for a series of hearings covering access to justice, facilitating access to justice, and the efficient functioning of the judicial system." (OBT, 2024f).

At an extraordinary sitting on November 20, 2024, the NJC discussed a draft proposal for concluding a quadrilateral agreement initiated by the Ministry of Justice. It is important to note that the President of the NJC called the extraordinary sitting on November 19, 2024, i.e., 1 day before the sitting, in the banquet hall of the Gyula Regional Court, where a maximum of 50 pre-registered listeners are expected on a first-come, first-served basis (OBT, 2024g); online broadcasting was not provided at. The NJC adopted the agreement initiative by a "narrow majority." In the vote on the presentation of the draft quadripartite agreement, there were seven votes for and seven votes against, so the ex officio member, the President of the Curia, voted in favor of the conclusion of the agreement (OBT, 2024h). The result would have been the same if he had not been present at the meeting since the NJC takes its decisions by majority vote. However, in a tie, the President's vote was decisive, and he favored the agreement (Act CLXII of 2011 on the Legal Status and Remuneration of Judges). On November 22, 2024, the Minister of Justice, the President of the Curia (the Hungarian Supreme Court), the President of the NOJ, and the President of the NJC signed the quadrilateral agreement between the bodies.

According to the agreement regarding the "financial appreciation of the professions", "[t]he Parties agree to implement salary increases for judges and judicial staff in three steps from 1 January 2025 to 1 January 2027, so that the average salary in 2027 compared to the 2024 base will be a) for judges, an increase of 48% to reach a gross monthly amount of HUF 2,250,000,- per month, b) for court secretaries and clerks, an increase of 82% to reach 50% of the judges' income, i.e. a gross amount of HUF 1,125,000,-, c) increase by 100% for additional judicial officials, reaching 38% of the judges' remuneration, i.e. HUF 850,000 gross. […] in order to achieve the above objective, the budget of Hungary will provide an additional HUF 212 billion over three years for the increasing of remuneration of judges, prosecutors, judicial and prosecution staff, 135 billion of which will be used exclusively to increase the salaries of judges and court employees, with the increase in the hourly rate being approximately equal to the previous year" (OBT, 2024i). However, beyond the settlement of primary substantive issues, the agreement included several parts that go beyond purely financial issues, and rather concern structural and organizational issues (e.g. extending the retirement age of judges to 70, raising the current age of 30 to 35, or extending the function of district judge to the whole jurisdiction of the regional court) under the headword of "improving the efficiency of the judiciary" (OBT, 2024i). For me, the most bizarre points of the quadripartite agreement are, on the one hand, point III.4. c), which states that „[i]n order to standardize the workload of the district courts, the district judge's function should cover the entire jurisdiction of the regional court, while maintaining the local district courts within its organizational framework" (which is essentially in collision with the right to a lawful judge); on the other hand point III.4 e), which provides that "[i]n order to reduce unnecessary administrative burdens and increase the time available for substantive work, to introduce a rule that in civil cases a detailed statement of reasons is only required if the parties are likely to exercise their right of appeal" (which may in fact cause confusion in the context of the requirement of a fair trial, including the duty to state reasons, if only due because of its rubber-rule nature; OBT, 2024i).

Following the agreement, protests and petitions for judicial independence were launched (Res Iudicata, 2024), as the NJC's decision, according to some, "[s]aid yes to the question of whether judicial independence can be bought", thus making the pay rise conditional on a deal that threatens judicial independence (Nagy & Mizsur, 2024).

In its December 2, 2024, letter the ENCJ also draws attention to the fact that "[t]he text of the agreement is drafted in a broad manner. This leaves a wide margin of appreciation regarding the exact commitments and undertakings of the signatories, foreseen changes in the court system with regard to its efficiency and the implementation of all these provisions. We are therefore hopeful that the proposed legislative changes will be drafted and adopted under a regular legislative procedure, including proper consultation with the stakeholders, especially – the [NJC]" (ENCJ, 2024c).

On December 3, 2024, the President of the NJC, who signed the quadrilateral agreement, resigned as President, and the NJC issued the following statement: "[…] The [NJC], in the light of the published opinions of the judiciary and judicial staff, records the following. The functions and powers of the [NJC] are defined by law, which the [NJC] may not exceed, and the [NJC] shall act solely in accordance with these rules. In exercising its right to legislate, the [NJC] acts in the interests of judges, judicial staff, and the judiciary, bearing in mind judicial independence, judicial self-government, and professionalism. The [NJC] fulfills its mission by acting as a body" (OBT, 2024j).

On December 11, 2024, the new President of the NJC summarized the position of the body and drew attention to the fact that "[t]he remuneration of judges and judicial staff, the preparation of legislation on the organization of the judiciary and the giving of opinions on it are matters for the administration of the courts, and therefore the legal basis for the conclusion of the agreement existed under the Fundamental Law of Hungary and the Act CLXI of 2011 on the Organization and Administration of the Courts. The agreement does not in itself infringe judicial independence, but the legislation resulting from the legislative process leading to its objectives potentially risks infringing judicial independence. [...] the legislature and the executive have the right to determine the framework of the organization of the judiciary. However, in the light of the principle of separation of powers, it is essential to obtain the opinion of the courts when establishing the organization of the judiciary, one of the ways of doing so being to involve judicial organizations, including the NJC, in the drafting of legislation. The NJC participates in preparing legislation, for which it obtains the opinion of the judiciary's representative bodies. The NJC participates in preparing legislation, for which it obtains the opinion of the judiciary's representative bodies. As a constitutional body, we aim to focus on the legislative consultation tasks ahead and the NJC will channel the judiciary's views in developing its opinion" (OBT, 2024k).

A day later, however, the committee on legislation adopted the draft law on the central budget for 2025 and the fourteenth amendment to the Fundamental Law of Hungary. The President of the NJC also approached the Minister of Justice to allow him to comment on what had been recorded (OBT, 2024l). Later, on December 16, 2024, the President of the NJC met with the Minister of Justice in a working meeting (OBT, 2024m), where he informed him in detail about the concerns of the judiciary and the reasons for the protests related to the previously signed quadrilateral agreement, and expressed his concern that, in his view, the judiciary was not involved in the process leading to the drafting of the legislation on the change of the judiciary. The Minister of Justice underlined that his Ministry intends to closely cooperate with the NJC in the elaboration of the details of the objectives of the agreement, and stressed that the proposals for legislative amendments so far have been formulated primarily in the context of the wage settlement; he also stated that his Ministry has acted and continues to act in the present legislative process in respect of the independence of the judiciary. "They noted that expert-level discussions on how the legislation should be consulted have started to discuss the different positions and will continue throughout next year" (OBT, 2024n). The NJC has sought to review the quadrilateral agreement (OBT, 2024o), while the ENCJ has expressed further concerns about legislation affecting the courts (ENCJ, 2024d).

At its sitting on January 15, 2025, the OBT, for its part, considered the concluded quadrilateral agreement invalid, and the OBT is therefore not bound by the terms of the agreement (OBT, 2024p). The Minister of Justice reacted to the decision as follows: "It is with regret and deep shock that I have taken note of the decision of the National Council of the Judiciary (NJC) today on the quadrilateral agreement signed by the parties to improve the efficiency of the judiciary and to settle the remuneration of judicial staff. This agreement would have been a historic commitment to increase the salaries of judges by an average of 48%, court secretaries and clerks by 82% and court officials by 100% by 2027. The agreement is about respect for the judiciary and the more efficient functioning of the judiciary as a whole. I have great respect for the President and members of the body. Yet, today's decision by the NJC not only contradicts its previous position but also suggests a profound inconsistency that calls into question the body's credibility. This situation calls for reflection by all of us, as the conflicting decisions reflect a lack of seriousness, making it difficult to achieve proper cooperation on issues affecting the future of justice. Nevertheless, on the government side, the agreement is still in force. While we regret that the NJC does not wish to play an active role in the legislative work to improve the efficiency of the court system, our commitment remains undiminished. The Ministry of Justice will continue its work with the utmost respect for constitutionality, judicial independence, and the rule of law. Our responsibility to ensure the smooth functioning of the judiciary and to serve society remains unchanged, and we will continue to fulfill all our legal obligations" (Jogászvilág, 2025).

The overall picture is significantly influenced by the fact that on November 22, 2024, the President of the Curia "[o]ut of his responsibility for his colleagues, in the interests of the administration of justice in Hungary and the interests of the Curia [...] signed a[n bilateral] agreement with the Ministry of Justice on the salary settlement" (Kúria Kommunikációs Osztálya, 2024). The reason for the special agreement with the government is that "[a] sufficient level of income is essential for the judges of the Curia to be able to make decisions solely based on law and legality, free from any financial dependence and influence, as representatives of the legal order that shapes the unity of the profession. Therefore, it is necessary to establish a completely new basis for the career and salary system of the Curia, as the supreme judicial body, to ensure that the judges receive a higher salary for their work" (Kúria, 2024).

Given the controversial agreement, in line with a last-minute committee amendment proposed by the governing party (Hazafi, 2025), no longer uses the judicial salary base as the starting point for the remuneration of Curia judges, but the monthly salary of the President of the Curia, which is 7 times the salary base of judges (Act CLXII of 2011 on the Legal Status and Remuneration of Judges). Under the law, applicable retroactively to January 1, 2025, 60% of the monthly salary of the President of the Curia is paid to the Curia judge, 70% of the monthly salary of the President of the Curia is paid to the Curia judge if he/she also functioning as the president of chamber of the Curia, 80% of the monthly salary of the President of the Curia is paid to the head and vice-head of college of the Curia, and 90% of the monthly salary of the President of the Curia is paid to the secretary-general of the Curia.

As the Hungarian Association of Judges has drawn attention to "[t]his distinction disproportionately opened the gap even wider between the incomes of curia judges and those of judges in lower courts. Such a disparity eliminates proportionality within the court system, undermines public confidence in the courts, and creates enormous internal tensions" (MABIE, 2024). It should be noted that Decision No. 189/2024. (X. 16.) of the NJC supported these figures in principle. However, with the 35% increase in the salary base of judges from January 1, 2025, as is known, only about 13% was achieved (Act XC of 2024 on the 2025 central budget of Hungary). Thus, it can be said that there is currently no harmony within the judiciary, and what is more, there is a very tangible discord between the various actors, think of the sometimes completely contradictory opinions and ambitions of the President of the Curia, the President of NOJ and the President of NJC.

Summary

In conclusion, financial decisions cannot be interpreted in isolation (even in the case of the judiciary), since, as the detailed discussion of remuneration issues shows, they are always complemented by other issues and reforms. However, linking the judiciary's financing with other issues with different origins is unfortunate. I recommend that the above-mentioned automatisms be given priority because the financial autonomy of the administration of the courts in its present form is merely symbolic, not accurate since it is ultimately tied to the discretionary power of the (parliamentary) governing powers (Madai, 2009). Unfortunately, the problems of this subject have not changed in more than 20 years (Tilk, 2002). However, such a system does not guarantee the long-term value of judges' salaries (Szabó, 2001). I believe that slower, more deliberate legislation that more explicitly seeks and takes into account the stakeholders' opinions would be more appropriate.

I know and accept the position of the Ministry of Justice regarding the fact that according to the law, the opinion of the NJC on draft legislation affecting the judicial system, as provided for in Point (b) of Subsection (1) of Section 103 of the Act CLXI of 2011 on the Organization and Administration of the Courts does not conceptually extend to the Fundamental Law of Hungary, and that the bill does not qualify as a law of the given act (OBT, 2024q). Thus, December 12, 2024, and beyond processes have complied with the law but lack effective and constructive cooperation. Hence, with a view to the future, it can be recorded that if the Minister of Justice (the Government) shows a similar attitude and if there is discord within the judicial organization, it may be an obstacle to a future dialogue based on compromise and progress and ultimately undermine judicial independence.

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Kristóf Benedek Fekete – PhD student
fekete.kristof@ajk.pte.hu
ORCID ID: 0009-0002-1536-8409

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Competing digitally

The implementation of digital goals and member state challenges in the Digital Decade 2030 Strategy

Emese Hargita Vörös[1,2,3]
1: Faculty of Law, Eötvös Loránd University
2: Bibó István College
3: Modern Legal Studies Workshop, Mathias Corvinus Collegium

ABSTRACT

In the European Union's digital vision, „eGovernment" plays a key role. Its goal is to use information technologies and the internet to make public services more efficient, transparent and accessible. This study focuses on the four main goals of the EU's Digital Decade 2030 strategy: digital skills, business digitalisation, digital infrastructure and digital public services. The research uses both quantitative and qualitative methods. It is based on the European Commission's DESI (Digital Economy and Society Index) as well as the Digital Decade 2024: Country Reports. Special attention is given to five EU Member States that are in the "Watch out" category: Hungary, Greece, Slovakia, Slovenia and Spain. These countries show similar performance levels but face different challenges in digital development. The study analyses how these countries perform in key areas of the Digital Decade. It shows that their common strengths include the development of broadband internet and digital public services. Overall, the study presents the structure of the EU's digital strategy and explores how Member States can adapt it to their national systems. It also highlights the limits of these adaptations. While there are still many challenges, the goals of the Digital Decade 2030 are achievable, offering opportunities for improvement and progress.

Keywords: service-oriented public administration, digital state, DESI, Digital Decade

Introduction

The EU and related documents from the Member States consistently avoid the term digital citizen, referring to the digitisation of „the European Union", „certain systems", „territories" and „digital skills development" (Commission (EU): Second Report; Digital Decade 2024: Special Eurobarometer Report). Digital citizenship, according to the literature, refers to the possibility of universal access to the Internet and the acquisition of appropriate digital skills (Codagnone et al., 2021, pp. 15–16). This approach is in line with the European Union's (EU) understanding of digital transformation as a way to benefit people, ensuring that technology respects fundamental rights and improves the quality of life for all. This requires, for example, that the transformation takes place within a democratic framework, that EU values and rights are applied both online and offline, as well as that the EU promotes responsible behaviour by public and private actors in the digital environment. In short, this is the vision that the EU has set itself as its direction (Parliament, Council and Commission (EU): European Declaration).

The aim of this study is to explore and understand EU policies on digital citizenship, with a particular focus on their advantages, disadvantages and areas for development, as well as to analyse some international and Hungarian practices, in order to provide a realistic picture of the state of digitalisation.

This study covers three main sections. First, it clarifies the relationship between digitalisation and the EU, identifying the disadvantages as well as areas for improvement. The next part looks at EU policy for the Digital Decade, the documents that can guide both the policy framework and the practical reflection. Finally, part three, as a complement to the frameworks clarified in units one and two, presents the author's own analysis and findings on the level of digitisation in five EU Member States, with a view to the direction the EU vision should take.

Digitisation

Digitalisation is the transformation of analogue or offline products, processes and structures into digitally processable form, resulting in more efficient, accessible and optimised solutions (Budai et al., 2018, p. 17).

Possible vision: eGovernment

Technological developments are redefining traditional public functions (automation replacing the role of administrators, control of information by experts and decision-makers, etc.) (Gyekitzky, 2022, pp. 99–100).

This is what the literature calls eGovernment: the use of information and communication technologies (ICT) and the internet to deliver government services, with the aim of making public processes more efficient, transparent and accessible, thus facilitating the involvement of citizens and businesses (Turi, 2020, p. 190).

For the EU, digitisation – and thus the development of eGovernment – is central. This is reflected in the promises it has made to deliver on digital promises by 2030, such as: „the development of the Internet of Things and Artificial Intelligence (AI) to improve health, transport, industry and smart city systems", „energy savings and better supply systems through digital technologies", „by 2025, 5.8% of EU GDP will be data-driven and data-driven economy", but also such promises that digitalisation will result in „transport safety, sustainable agriculture, competitive industry and efficient public administration" (Codagnone et al., 2021, p. 13).

All these processes could ultimately lead to explosive economic growth within the EU. For example, just think of the value creation of AI – the use of AI could create between \$2.6 trillion and \$4.4 trillion in each industry by 2023, according to a McKinsey & Co. study of 63 cases (Chui et al., 2023, p. 6).

Difficulties and challenges

Digitalisation – and hence „digital identities" – poses a number of challenges as well as difficulties, only some of which are highlighted in this paper for illustrative purposes.

The following main challenges are certain to be faced in the process of digitisation:
- *Data protection:* This implies that electronic data management and the protection of personal data may face difficulties, especially in the context of digital profiling (Budai et al., 2018, pp. 382–384; Turi, 2020, p. 145).
- *Cybersecurity risks:* Public sector systems are not always prepared for digital attacks, and the lack of adequate security systems can pose a serious risk.[31]
- *Information asymmetry:* In the digital economy, we are striving for interoperability, i.e. the „interoperability" of different systems. However, centralised databases can lead to misuse – especially by market actors (Turi, 2020, p. 145).
- *Technology dependency:* The EU's lack of technological independence and foreign dominance in the cloud services market can hamper local development and create overdependence.
- *Technology gap:* Access to digitisation is not equally available to all. Differences in the uptake of digital technologies across the EU (due to age groups, social classes, gender, etc.) and the low digitalisation of small and medium-sized enterprises are slowing down progress.
- *Risks of AI:* The use of AI can lead to various prejudices and discriminatory effects – e.g. in the context of workplace surveillance – and thus to violations of fundamental human rights (Codagnone et al., 2021, p. 14).
- *E-bullying and other online behavioural distortions*: The lack of e-etiquette and online norms may increase the risk of harassment and overall „digital conflict" (Ollé et al., 2013, pp. 87–90).

In the light of the above, it is understandable that when deciding on the direction of digital development, both the positive benefits and the negative drawbacks need to be weighed together to ensure a balanced and thorough assessment.

Framing our Digital Decade

In the following, the study seeks to answer the question of how to develop efficient, accessible and user-centred digital systems at the EU and national level in a period of increased dependence on technology.

Background

The present study does not aim to review the evolution of the EU's approach to digitisation over time, as there are many relevant summaries in the literature (Csáki, 2010, pp. 32–38).[32] The EU has always had a positive attitude towards digital technologies because of their long-term benefits, and has seen them as a „motor" for transforming society and the economy. According to the European Commission, advanced digital technologies not only make business processes more cost-effective and efficient, but also foster the development of innovative economic models, the digital economy, while contributing to economic growth and improving quality of life. This view is in line with the OECD's approach, which sees

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32 Detailed discussion includes: Bibliography.

digital transformation as a key tool for achieving more sustainable and inclusive prosperity (Karnitis et al., 2019, p. 70).

Digitalisation today: Where to look for it?

Today we are living in the „second Digital Agenda for Europe" (2020–2030), which focuses directly on the changes brought about by digital technologies and sets the EU's technological and geopolitical objectives. The principles are set out in a policy paper on shaping Europe's digital future (hereafter: *Digital Decade 2030*; Commission (EU): Shaping Europe's Digital Future; Council (EU): Policy Programme 2022/2481).· The European Parliament and the Council put forward „digital principles for the benefit of all European citizens" and set out guidelines for these principles, such as „putting people at the heart of the Digital Agenda, solidarity and inclusiveness, freedom of choice, participation in the digital public space, security, safety and responsibility, and sustainability". The principles of the policy are set out in the European Declaration on Digital Rights and Principles for the Digital Decade (*European Declaration*), complemented by the *Commission Communication* (Commission (EU): On the Drafting of the European Declaration).

Under this „Digital Agenda", the EU should achieve four main goals by 2030 (along defined key performance indicators, known as „sub-goals"):

1. developing digital skills
2. digital transformation of businesses
3. secure and sustainable digital infrastructures
4. digitisation of public services (Commission (EU): Europe's Digital Decade).

In essence, a Europe built around these goals can be the platform for „digital governance". Formal reflections on the goals and their implementation will be produced from 2021 onwards to provide a more comprehensive picture of the current state of EU policy.[33] The following three are discussed below:

- The second *Digital Decade 2024: Special Eurobarometer*, reflecting the changes since the early 2020s (Commission (EU): Report on the State of the Digital Decade).
- Changes to The Digital Economy and Society Index (*DESI*) in the form of the *Digital Decade Methodological Note 2024*.
- Finally, *Staff Working Documents* summarising the progress made by individual EU Member States towards the Digital Decade objectives as well as targets over the past year (Commission (EU): Digital Decade 2024: Country reports).

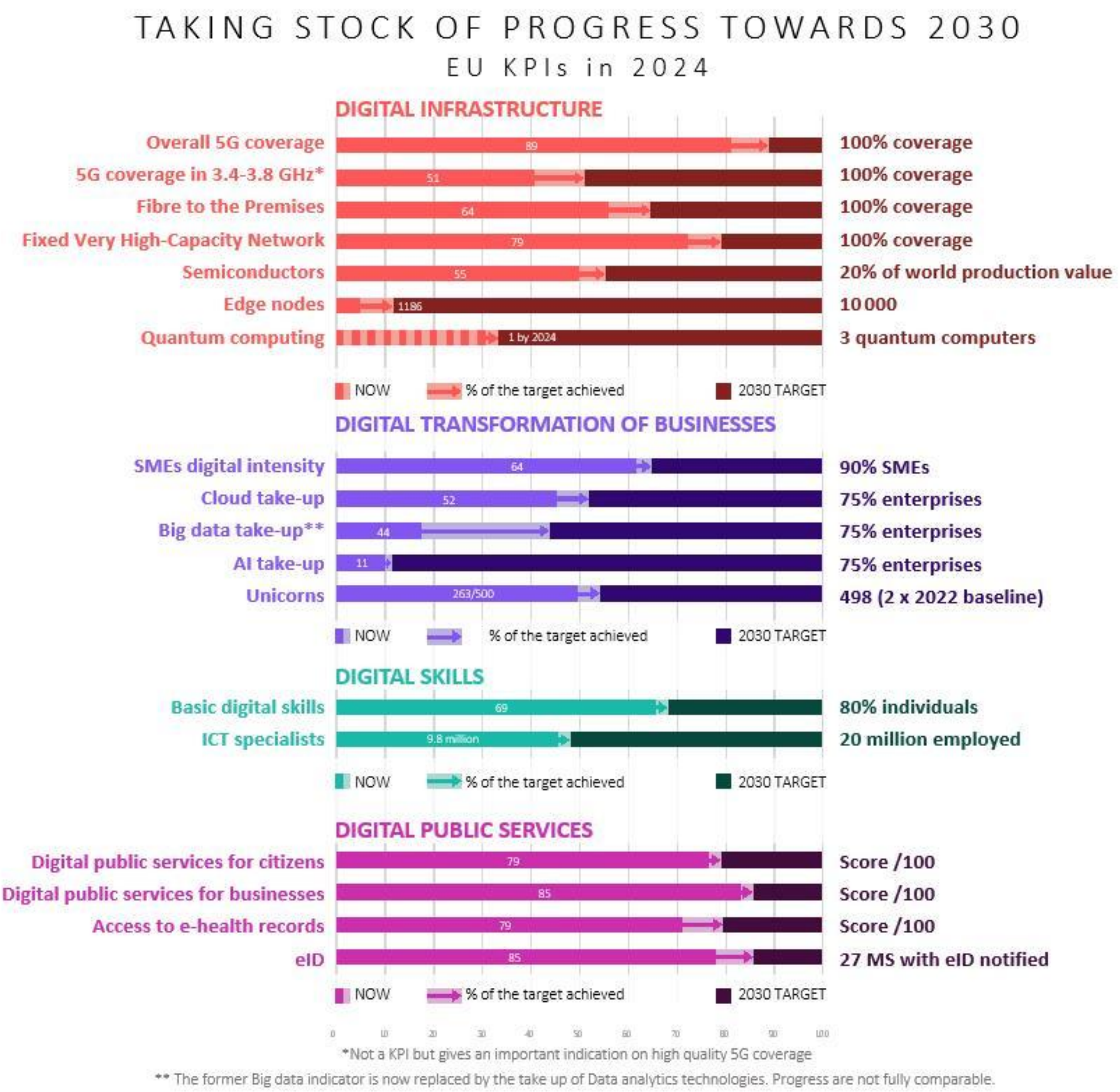
Special Eurobarometer report (2024)

The European Commission will publish a report on the state of play of the Digital Decade from 2023 onwards to monitor Member States' actions, the second results of which were

[33] Such documents include: Digital Decade 2024: Implementation and Perspectives; and its 4 annexes: (‘List of relevant policy initiatives'; ‘Update on MCPs / EDICs'; ‘Analysis of national Digital Decade strategic roadmaps'; 'Monitoring of the European Declaration on Digital Rights and Principles'), The International benchmarking study; Study: Monitoring of the Implementation of the Declaration on Digital Rights and Principles; The Broadband coverage study; The eGovernment study; The eHealth study ; 5G Observatory Report etc.

published in July 2024. The 2024 report will give an overview of their digitisation efforts, make recommendations for improvement and monitor the implementation of the European Declaration on Digital Rights and Principles. If we want to make digital governance a reality, it is worth looking at EU policies in the light of the above-mentioned objectives. The following summary graph at the beginning of the second report outlines this evolution:

Figure 1.
Taking stock of progress towards 2030



Source: 4 pillars, Commission (EU): Digital Decade 2024: Special Eurobarometer Report
For a more detailed understanding of the objectives, it is essential to clarify the precise meaning of the related concepts, technologies and terms which follow.

Digital skills

[1] Basic digital skills refer to operational, formal, information, communication, content creation and strategic skills (e.g. internet search and information management, use of applications and software, digital security and privacy; Dijk & Deursen, 2014). The

number of individuals with these skills covers 69% of EU citizens, but there is still much work to be done to reach the expected target (80%), presumably achievable by 2030.

[2] ICT professionals have a broad knowledge of computing, network communication, data management and internet systems and are therefore essential actors in the digitalisation process (Karnitis et al., 2019). As the scale shows (20%), there is a surprising shortage of them, and we are unlikely to reach the 20 million jobs target.

Digital transformation of enterprises

[1] The digital intensity of small and medium-sized enterprises, which is essentially the extent and frequency of digital device use by these private economic actors, can be put at 64%, based on the report, in addition to the target of 90%.

[2] Cloud services are services available online that allow data to be stored, processed and applications to be used over the Internet without users having to maintain their own physical infrastructure (Schaper, 2010). Their use in the EU stands at 52%, but the dependence of technology on other aspects means that the 75% target is unlikely to be reached. And this point will also make it difficult to achieve big data, which is why this indicator stands at 44% of the 75% target.

[3] The use of AI as a set of computational systems and algorithms that require human intelligence is only 11% (Chui et al., 2023, p. 6). Perhaps most striking is the lack of progress in this aspect, especially given the recent EU legislative trends in its use (e.g. AI Act)

[4] Finally, the current number of unicorns (startups worth up to $1 billion) is 53%, with a target of 498 (double the then current number in 2022).

Digital infrastructure

[1] 5G, the fifth-generation mobile network, is key to the future of digital development, including: very fast data speeds, low latency, more device connectivity, better network connectivity, economic growth and innovation (Yang et al., 2018). Current EU 5G coverage is at 89% of the 100% target, while coverage in the 3.4-3.8 GHz band is only 51%, meaning that despite high-bandwidth coverage, the (frequency) speed of networks is far from the ideal and is not expected to be fully achieved by 2030.

[2] Optical networks, which represent data transmitted along glass-plastic optical fibres in the form of pulses of light, also have statistics far from 100%, with a current coverage of 64%.

[3] As a prominent player in fixed, very high-capacity networks (communication systems capable of transmitting large amounts of data at high speeds) and the IT and electronics industries that enable them to operate, the market penetration of semiconductors can be considered as a single area of investigation (Yu et al., 2024). Here, the 79% position for networks makes it realistic to reach the target by 2030, while 20% of world production (EU target of 100%) is unlikely to be reached by the target date.

[4] Finally, the diffusion of two technological tools. Edge nodes refer to devices that do not perform data processing on a central server or data centre, but are closer to the users or the data source, on the so-called edge network (Rahman et al., 2019). A quantum computer is a computer that works on quantum mechanical principles, unlike traditional computers. While conventional computers work using bits, which can only ever take a value of 0 or 1, quantum computers use units called qubits (quantum bits). The special feature of the qubit is that it can be in both 0 and 1 states, resulting in a so-called superposition. In addition, qubits can be entangled so that they can interact with each other's

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states, even remotely. This allows quantum computers to perform parallel calculations faster than conventional machines (Alexeev et al., 2021). While the EU figure in the edge nodes data is below the target, 1 of the 3 quantum computers has already been deployed (so it is expected that this target will be met).

Digital public services

[1] Digital public services are public services provided by the state or other public institutions to individuals electronically via the internet, and have seen a surprising evolution in recent times (Alexeev et al., 2021). Although the current level is 79%, it is not illusory to reach this target (100%) given the current trend of development. Related to this, the level of digital public services available to businesses is also progressing well (85%).

[2] eHealth data accessibility means that health information is available digitally, online and accessible to those with the right rights, such as patients and healthcare providers (e.g. medical records, laboratory results, treatment plans, other patient care related data). This currently stands at 79% of 100% (Lányi, 2020, pp. 37–38).

[3] An eID (electronic identity document) is a digital system that securely stores and authenticates a person's virtual identity using personal data and, in some cases, biometric data. It is essentially the digital equivalent of a traditional tangible identity document, allowing online identification as well as secure electronic administration (Turi, 2020, pp. 146, 189). In essence, it is now almost common in all 27 Member States.

Conclusions

As the report points out, over the last 5 years, the EU has made a strategic shift towards a more robust digital policy framework, recognising the urgent need to shape the digital space (Commission (EU): Digital Decade 2024: Special Eurobarometer Report). This approach represents a major breakthrough, isolating the key drivers and challenges by clusters:

1. A competitive, sovereign and flexible EU,
2. protecting and empowering people,
3. harnessing digital transformation for a smart environment, and
4. harmonising digital policies and spending.

The success of the Digital Decade is key to Europe's prosperity and competitiveness. The 2024 State of the Digital Decade report raises concerns about the EU's performance in digital transformation. Urgent action is needed to accelerate progress and ensure a coordinated approach. The EU has not yet fully achieved convergence on most goals and targets, and the pace of progress on some is slower than expected. This is particularly the case in the areas of skills, high levels of connectivity, business adoption of AI and data analytics, semiconductors and start-up ecosystems.

Not enough progress has been made at the national and EU level, and there is still considerable fragmentation at the national level. The report underlines the need for Member States to work together and maintain the commitments they have made in their strategic agendas.

DESI (2024)

The DESI is a set of indicators used by the European Union to assess the development of the digital economy and society in the Member States. The index monitors countries' progress through indicators (KPI's) organised in different dimensions and sub-dimensions, with a particular focus on the EU Digital Decade objectives.

The indicators have been modified in response to the Second Report 2024 and further feedback. The DESI 2024 dashboard contains a total of 36 indicators, only some of which are considered official EU Digital Decade KPI's under the new methodology. This is important as Member States are required to report on the status of these indicators. These are:

Table 1
DESI 2024 dashboard only for DD KPI's

Dimension	Sub-dimension	Indicator	
Digital Infrasctructures	*Fixed broadband*	1.	Fixed Very High Capacity Network (VHCN) coverage
		2.	Fibre to the Premises (FTTP) coverage
	Mobile broadband	3.	Overall 5G coverage
		4.	Edge Nodes
Digital Transformation of Business	*Digital intensity*	5.	SMEs with at least a basic level of digital intensity (DII)
	Digital technologies for businesses	6.	Cloud
		7.	Data Analytics – former Big Data
		8.	Artificial Intelligence (AI)
		9.	Unicorns
Digital Skills	*Internet user skills*	10.	At least basic digital skills (Basic Skills)
	Advanced skills and development	11.	ICT Specialist perc.
Digitalisation of Public Services	*e-Government*	12.	Digital public services for citizens (DPS Citizens)
		13.	Digital public services for businesses (DPS Businesses)
	e-Health	14.	Access to e-health records (eHealth)

Source: Digital Decade 2024: DESI Methodological Note

A detailed description of the indicators is available in the methodological note and on the European Commission website. So, if we want to assess the digital status of a country, we currently have to take into account the status of these indicators, which are developed in line with EU policy objectives.

Analysis: situation in the Member States

The sample

Digital competitiveness is one of the aspects of the evaluation of the Member States, and Magdolna Csath's reflections on this issue from the Hungarian literature will be the guiding principle in this study. Based on the Digital Planet 5 research, she has classified countries into four groups, examining the two dimensions of digital competitiveness (static-dynamic) (Csath, 2019, p. 110):

1. stand out: those countries that are currently achieving excellent digital results and are making dynamic progress.
2. stall out: countries that are currently in a good position but whose progress has slowed down and appears to have stalled.
3. break out: countries with low levels of development that are catching up quickly and are making dynamic progress.

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4. watch out: countries that are currently performing poorly and lacking momentum, i.e. have weak dynamism.

The aim of this research was to better understand which countries are successfully on the digital development path by looking at static and dynamic competitiveness together. In the following, I will focus on the 5 EU Member States classified as „Watch out", which are currently classified as weakly developed as well as slow to change. These are: Hungary, Greece, Slovakia, Slovenia and Spain (Csath, 2019, pp. 111–112).

The reason for this narrowing down is not the lack of need for a complete picture, but with regard to the content and format of the framework, I wanted to examine the digital situation in countries like Hungary, which share common characteristics in certain KPI's.

Methodology

Among the Staff Working Documents, the Digital Decade 2024: Country reports contain detailed information on the situation in the Member States with regard to the DESI KPI's mentioned above (Commission (EU): Digital Decade 2024: Country reports). These longer reports have also been published by the European Commission in the form of the country fact pages, which allow us to make a clear, logical analysis (Commission (EU): Digital Decade 2024: Country fact pages). In the following, I will first analyse the data in the fact pages reflecting the situation of each indicator, and then, based on the same short summaries and the Country reports, highlight some common characteristics as well as differences of the 5 countries in the light of the Digital Decade objectives.

Data analysis

This part of the analysis consists of data filtering and sorting. I wanted to identify how the selected countries can be ranked in terms of digital level from „top" to „bottom". To do this, I used a quantitative methodology.
After reviewing the data sheets of the five countries and filtering the data, I have prepared the following table:

Table 2
Overall ranking

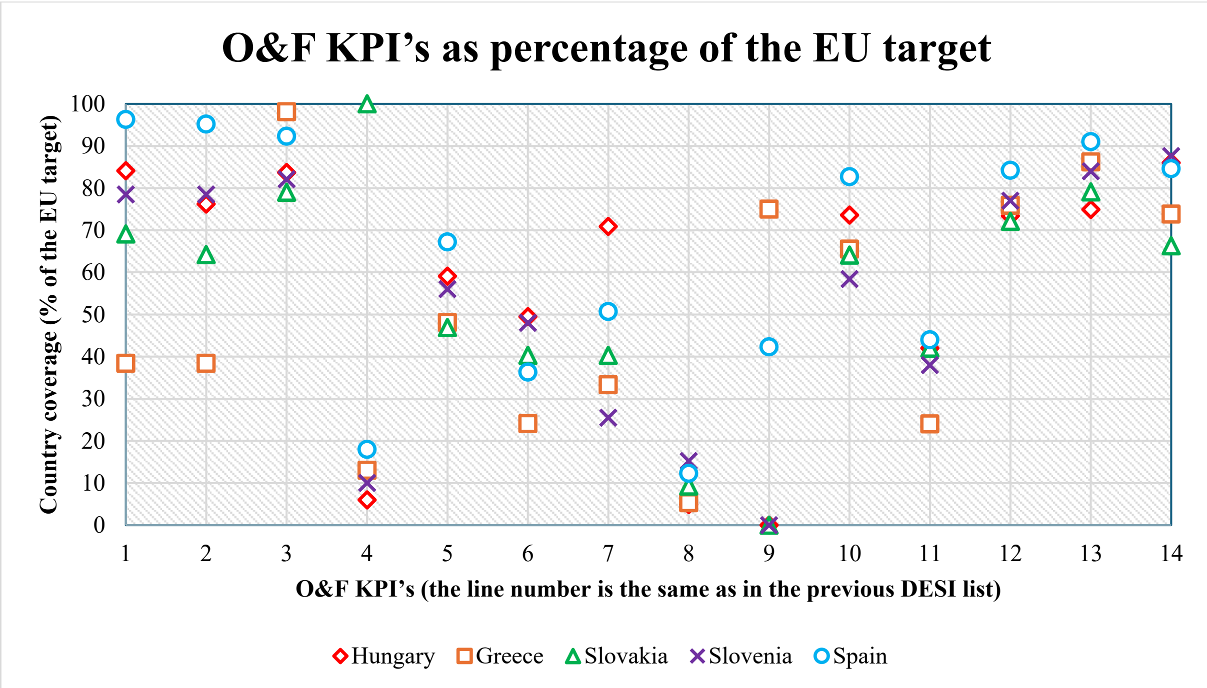
	Digital Infrasctructures				Digital Transformation of Business					Digital Skills		Digitalisation of Public Services			
	VHCN	FTTP	Overall 5G	Edge Nodes	DII	Cloud	Data Analytics	AI	Unicorns	Basic Skills	ICT Specialist perc.	DPS Citizens	DPS Businesses	eHealth	**Overall ranking**
Hungary	84,1	76,2	83,7	6	59,1	49,5	70,9	4,9	0	73,6	42	73,4	74,9	86	**2.**
Greece	38,4	38,4	98,1	13	48,1	24,1	33,3	5,3	75	65,5	24	75,9	86,2	73,8	**4.**
Slovakia	69,1	64,2	79	100	46,9	40,3	40,3	9,3	0	64,1	42	72,1	79,1	66,3	**5.**
Slovenia	78,5	78,5	82,1	10	56	48	25,5	15,2	0	58,4	38	77	84	87,6	**3.**
Spain	96,3	95,2	92,3	18	67,2	36,3	50,7	12,3	42,3	82,7	44	84,2	91	84,6	**1.**
KPI's serial number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

Source: Based on the country fact sheets available on the Internet, my calculations have been carried out in the following Excel spreadsheet: research_cal_excel_2024.xlsx (last edit December 19, 2024).

The columns in the table show the results already achieved by each country for each KPI, row by row, out of 100% Country coverage (% of the EU target).

Based on this, I have created the following illustrative graph, which shows more clearly which countries have a „high” or „low” level of digital competitiveness development in each KPI:

Figure 1.
O&F KPI’s as percentage of the EU target



Source: Own editing, Digital Economy and Society Index; Commission (EU): Member States’ trajectories

I have based the final ranking of the 5 countries on the results of the table for each indicator, using ascending ordering within the columns. In this way, the rankings for each indicator can be easily tracked by the colour code associated with the country cell:

Table 3
Final ranking

Hungary
Greece
Slovakia
Slovenia
Spain

Digital Infrasctructures				Digital Transformation of Business					Digital Skills		Digitalisation of Public Services		
VHCN	FTTP	Overall 5G	Edge Nodes	DII	Cloud	Data Analytics	AI	Unicorns	Basic Skills	ICT Specialist perc.	DPS Citizens	DPS Businesses	eHealth
38,4	38,4	79	6	46,9	24,1	25,5	4,9	0	58,4	24	72,1	74,9	66,3
69,1	64,2	82,1	10	48,1	36,3	33,3	5,3	0	64,1	38	73,4	79,1	73,8
78,5	76,2	83,7	13	56	40,3	40,3	9,3	0	65,5	42	75,9	84	84,6
84,1	78,5	92,3	18	59,1	48	50,7	12,3	42,3	73,6	42	77	86,2	86
96,3	95,2	98,1	100	67,2	49,5	70,9	15,2	75	82,7	44	84,2	91	87,6

Summarising the data from the tables and graph, I conclude that the five countries can be ranked according to their performance on each KPI, and can be ranked overall on all 14 KPI’s. As a result, from the best performing country (1st) to the worst (5th):

1. Spain
2. Hungary
3. Sovenia
4. Greece
5. Slovakia

(Of course, this ranking is not exhaustive and only reflects the overall results – see Excel table mentioned earlier).

Text test

In the following, I will carry out a content analysis of the countries' fact pages: qualitative and quantitative analysis.

Brief characterisation

For each country, a brief description is first presented in the fact sheet, highlighting the main positive and negative results in terms of digital advances.[34]
Moving forward:

1. Developing broadband connectivity: Hungary, Greece, Slovakia and Slovenia have made significant progress in deploying infrastructures such as 5G, FTTP and gigabit networks.
2. Developing digital public services: Slovakia, Slovenia and Greece are particularly well advanced in the digitisation of e-government, e-health and other public services.
3 Digitisation of SMEs: SMEs in Hungary and Greece have made progress in adopting cloud-based solutions and data analytics.

Backward steps:

1. Lack of basic digital skills: there are still significant gaps in the digital skills of the population in Hungary, Slovakia, Slovenia and Spain.
2. Digital skills of the older generation: Hungary is particularly lagging behind among the older generations.
3 Low ICT skills: Greece and Spain are struggling to increase the proportion of ICT professionals.
4 Digital intensity of SMEs: SMEs in Greece and Slovenia lag behind in the use of basic digital solutions and advanced technologies (e.g. data analytics).

Two main strengths or areas for development

Common development points can be observed between countries.
[1] The development of connectivity [fibre-to-the-premise (FTTP); very high capacity network (VHCN) coverage] has been identified as a strength by Hungary, Slovenia and Greece.
[2] The development of digital public services [public services for businesses, electronic communications] is observed in Greece, Slovakia and Slovenia.

34 Excel worksheet 4: short descriptions.

[3] e-Health [access to electronic health records, communication, etc.] is also an area of development for Slovenia and Slovakia.

In addition to common points, specific areas have been identified by the countries, such as:

Hungary has a strength in the use of advanced technologies: 53.2% of enterprises use data analytics (EU average: 33.2%).

Spain's strength lies in its growth in the use of AI, already at 9.2% (EU average: 8%).

Common strengths include improving connectivity infrastructure and improving digital public services. Countries' different strengths include the uptake of advanced technologies such as AI and data analytics, and different levels of digital skills among the population. While some countries are excelling in infrastructure or technologies, others have made significant progress in the digitisation of public services.

Two main weaknesses or areas for improvement

There are also common weaknesses between countries.

[1] All five countries have identified the lack of ICT professionals as a common weakness, and indeed, they are all below the EU average in terms of the employment rate of ICT professionals. And while there is some improvement in some of the five countries, the pace of growth is likely to be insufficient to reach the 2030 targets.

[2] Digital skills gaps were identified in the remaining four countries, with the exception of Hungary. In these countries, the basic digital skills of the population are below the EU average. Although Hungary is above average, there are serious gaps for the older generations.

[3] The digital intensity of SMEs and the use of advanced technologies such as artificial intelligence, cloud services and data analytics is below the EU average in Greece, Slovenia and Spain.

In addition to the common points, specific areas have been identified by countries, such as:

Hungary is significantly below the EU average in the use of AI in enterprises (3.7%).

Slovakia's VHCN coverage – 69% – is significantly below the EU average (78.8%), especially in rural areas where it is only 35%.

In Spain, the growth rate of cloud services (0.4%) is well below the EU average (7%).

In summary, among the weaknesses/areas for improvement, the low share of ICT professionals, the lack of digital skills of the population and the digital maturity of SMEs were the main cosmopolitan points for the countries. Specific problems can be found, for example, in Slovakia's rural infrastructure, Hungary's adoption of artificial intelligence, and Slovenia and Spain's weak development in cloud technologies.

Strategic roadmap

In response to both the strengths and weaknesses identified, the five countries have also published their strategic roadmap for the Digital Decade, which includes (1) the degree of focus on the development of each area, (2) the number of KPI targets to be met, (3) the level of targets relative to the EU average and (4) the budget (in GDP terms) required.

(1) Greece, Slovakia, Slovenia and Spain have specified that they are making a significant effort to achieve the Digital Decade targets, while Hungary has opted for a limited level of effort. (2) The level of effort is also partly related to the number of KPI targets set. Hungary and Slovakia set 12 targets, Spain 13, Slovenia and Greece 13 each. (3) Hungary is half and half in line with the EU targets measured at the digital level, and the other countries are also mostly in line with the EU. (4) Spain received the largest funding of the five countries, €26.7 billion, equivalent to 1.8% of GDP. Hungary comes second with €17 billion, but this

is only 0.9% of GDP. Greece received €5.1 billion, or 2.3% of GDP, and Slovakia €2.3 billion, or 1.8%. Slovenia received the smallest amount of aid, €946 million, or 1.5% of GDP

Overall, Greece and Spain are the most ambitious, thanks to their high budgets and KPI's aligned with EU targets. Slovenia is the most balanced, planning its budget efficiently while exceeding EU targets in some areas. And the report also shows that Slovakia and Hungary are the least ambitious, with limited targets and some below EU levels, although the former would have a particularly large budget available.

Digital rights and principles

The views of citizens in the countries on digital rights and principles are summarised in the table below:

Table 4
Digital rights and principles

Country	EU protects digital rights (EU average: 47%)	Main concerns	Positives	Trends
Hungary	60%	Online freedom of assembly, child protection	Affordable internet (68%), green services	Confident in EU protection
Greece	33%	Child protection (62%), data protection (51%)	Keeping in touch with friends (85%)	Low confidence in EU, growing concerns
Slovakia	47%	Child protection (57%), data protection (39%)	Access to public services (84%), keeping in touch (89%)	EU level confidence, positive trends
Slovenia	46%	Child protection (62%), data protection (47%)	Privacy-friendly technologies (57%)	Confidence in EU declining
Spain	36%	Child protection (61%), Data protection (53%)	Digital skills (62%), Affordable internet (60%)	Significant decline in trust in EU

Source: Excel 8 worksheet, rights and principles.

(1) This shows that Hungary leads the field in confidence in the EU's protection of digital rights (60%), well above the EU average. Greece has the lowest level of trust (33%).
(2) Countries all see child protection as one of the most important concerns in digitalisation, which is coupled with data protection concerns outside Hungary.
(3) Citizens in other countries see different benefits of the Digital Decade, ranging from affordable internet, connectivity, privacy, digital skills development, to environmentally friendly services.
(4) The most positive assessment and confidence in EU policy is in Hungary (despite the challenges mentioned), despite challenges in the area of child online protection and privacy. The most critical situations are Greece and Spain, where EU trust is weak and concerns are growing rapidly. Slovakia and Slovenia, on the other hand, can be seen as balanced countries, with trust levels in line with the EU average and significant progress in digitisation.

Recommendations

Country-specific recommendations are included at the end of the published summaries. These are summarised in the table below.

All countries have a role to play in the digitisation of SMEs. Hungary, Greece and Slovenia are pushing for the introduction of targeted policies to support smaller businesses.

In addition, Hungary and Spain have prioritised the promotion of innovative technologies (AI, cloud, data analytics).

In the area of basic digital skills, Slovakia and Slovenia focus on improving educational programmes and reducing gender gaps. Hungary and Greece focus on social inclusion and support for vulnerable groups.

Increasing the ICT workforce is a priority everywhere, with Hungary and Greece placing particular emphasis on attracting and retaining talent.

In the connectivity infrastructure target area, Greece, Slovenia and Slovakia focus on developing gigabit and 5G networks to meet the 2030 targets.

Finally, a recommendation for Hungary is the implementation of eIDAS-based electronic identification systems.

Table 5
Identified KPI's to improve

Country	Enterprise application of advanced technologies	Digital skills	ICT professionals	e-ID	Connectivity infrastructure
Hungary	Support for the implementation of artificial intelligence, cloud, data analytics.	Reducing the digital divide through inclusion policies, with a special focus on vulnerable groups.	Increase the number of women working in STEM fields, increase the number of ICT professionals in the long term.	eIDAS-based e-ID system.	
Greece	Support for less digitally mature SMEs to adopt advanced technologies.	Targeted development of digital competences among the population.	Increase the share of ICT professionals, retain talent		Develop gigabit network, identify investment gaps.
Slovakia	Accelerate the uptake of innovative solutions and technologies by SMEs.	Developing more flexible and broader ICT learning at different levels of education			Supporting the development of Gigabit and 5G networks
Slovenia	Targeted measures to promote artificial intelligence and data analysis.	Promote ICT studies, with a special focus on the involvement of women.	Develop digital training programmes, tailored to labour market needs		Promote the rapid take-up of digital technologies
Spain	Further support the uptake of advanced technologies (AI, cloud)		Increase the number of ICT professionals, promote training and retraining		

Summary

The eGovernment is one of its visions, using information technologies and the internet to make public services more efficient, transparent and accessible. The EU's objectives include the introduction of artificial intelligence, IoT and other digital technologies to improve health, transport, industry and smart city systems, and the creation of a data-driven economy. While these developments promise economic growth and innovation, they also raise a number of challenges, such as data protection, cybersecurity, technological dependency and the digital divide.

The „Second Digital Agenda for Europe 2020–2030" sets out the EU's digital technology and geopolitical objectives. The European Parliament and the Council will guide Europe's digital future through the „Digital Agenda", setting out principles such as inclusiveness, security, sustainability and people-centredness. The Digital Decade 2030 aims to achieve the goals of increasing digital skills, digital transformation of businesses, building secure digital infrastructures and digitising public services.

The study first conducted a general analysis of the four objectives. 69% of the EU population has basic digital skills, but more needs to be done to reach the 80% target. The lack of ICT professionals is a major barrier (Digital skills). Although the use of digital devices is improving, technologies such as artificial intelligence and big data are still in their infancy (Digitalisation of enterprises). Edge computing and quantum computing applications are slowly developing (Digital infrastructure). Finally, eGovernment and eHealth availability is at 79–85% and approaching the target (Digitisation of public services).

However, such a broad analysis of the four headline targets can inevitably lead to distortions from the overall reality, which is why the analysis of Member States' practices was of particular importance. The DESI 2024 indicators show that the digital development of EU Member States is uneven across the objectives, with a number of areas lagging behind, particularly in AI, data management and start-up ecosystems. The Special Eurobarometer 2024 report urges the need to coordinate action at EU and national levels and to accelerate the implementation of the digital objectives.

In order to map the pathways to achieving the digital goals at the Member State level, I conducted a study focusing on 5 countries below the national level, which are in the Digital Planet 5 „Watch out" category, showing poor performance and slow progress. I analysed the situation of Hungary, Greece, Slovakia, Slovenia and Spain, and the reason for this choice is that these countries are at similar KPI levels.

The methodology of the research is based on the Digital Decade 2024: Country reports and DESI KPI indicators published by the European Commission. The data was analysed quantitatively, and countries were ranked according to their digital performance. The aim of the analysis was to compare the digital development of the selected countries. On the other hand, I used qualitative content analysis alongside the quantitative methodology to analyse the digital datasheets of these countries for 2024.

It shows that the common strengths of the selected countries include the development of broadband internet and digital public services, while the main weaknesses are the low share of ICT professionals, the lack of digital skills and the digitalisation of SMEs. Countries also differ in specific areas, with Hungary lagging behind in the use of advanced technologies and Slovakia in rural infrastructure. Among the strategic objectives, all countries have set Digital Decade targets, but the budgetary effort and pace of achievement of the targets differ, with Spain and Greece being the most ambitious. Hungary leads the field in EU trust as well as digital rights protection, while Greece faces the biggest challenges. The recommendations suggest specific actions for each country in digitising SMEs, developing basic digital skills, boosting the ICT workforce and improving connectivity infrastructure. Hungary is recommended to introduce eIDAS-based electronic identification.

The resulting summary shows the EU's strategy for developing digital systems at EU and national level, while also highlighting the difficulties in putting these policies into practice. There are still many steps to be taken by the EU and the Member States to achieve the objectives of the Digital Decade 2030, but the achievability of this vision is rather a reason for optimism as well as a sense of ambition.

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Emese Hargita Vörös – Law student (Undivided, Master's Programme)
veh@student.elte.hu
https://orcid.org/0009-0000-0143-1900

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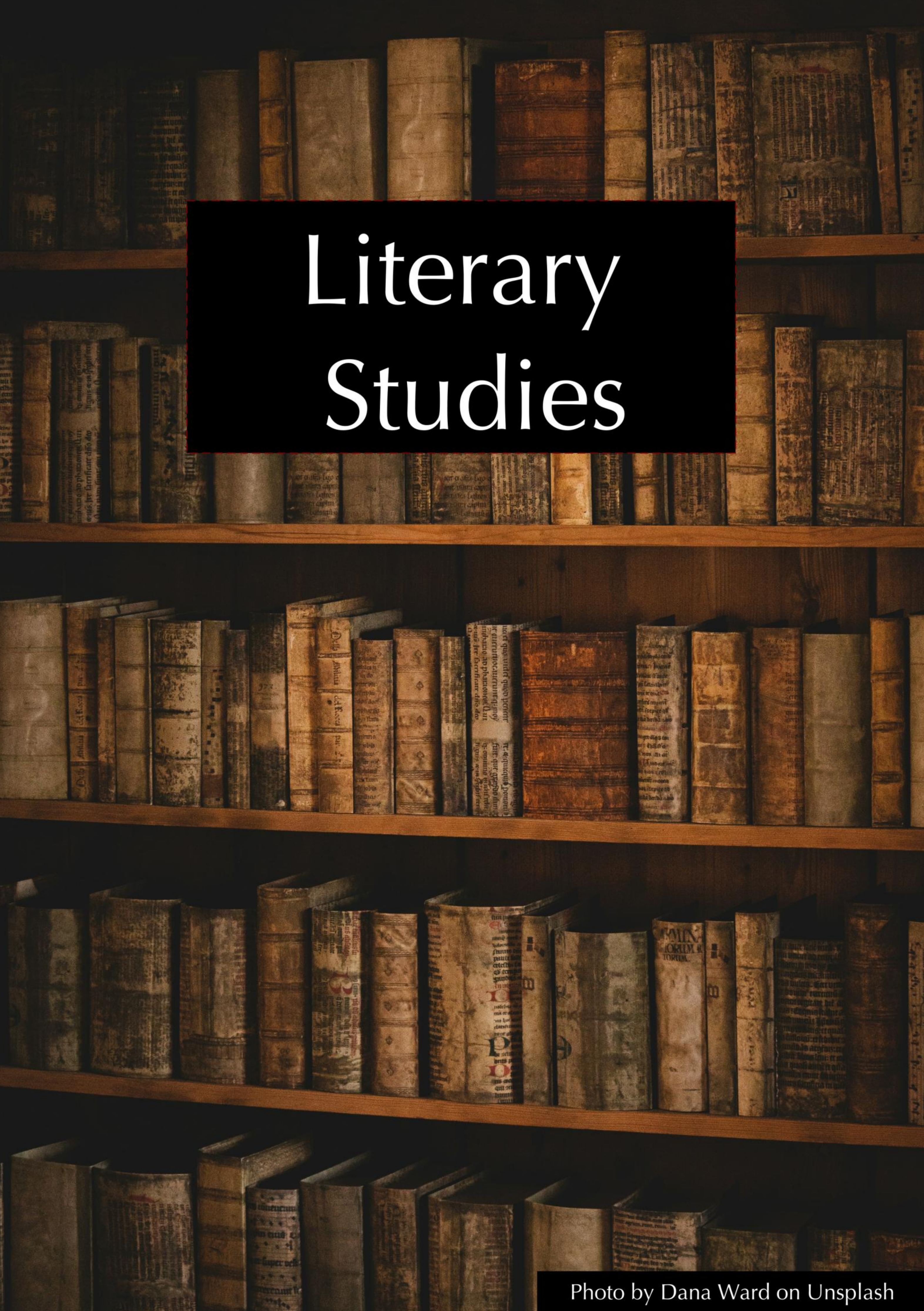

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The Debut Author Madách

Zsófia P. Rétfalvi

Doctoral School of Literary and Cultural Studies, University of Pécs

ABSTRACT

Despite the boom of monographs in recent years, since Ferenc Kerényi's 2006 book, no comprehensive, evaluative scholarly work on Imre Madách and his oeuvre has been published. The anniversary of the poet's birth - an occasion that often (also for publishing reasons) encourages the publication of monographs - has also not inspired a renewed examination of Madách's oeuvre. Several fundamental problems remain in the narration of the events of his life.

A common phenomenon in late 19th and early 20th century biographies is the use of a teleological approach, which presents the subject's life story as directed towards a single goal. In Madách's case, this goal is the creation of his main work, The Tragedy of Man. The paper focuses on the young poet's early career and the specificities of his first collection of poems, Lant-virágok [Lyre-flowers]. The primary aim is to demonstrate the place of the collection within Madách's biographies and to highlight the unsoundness of the biographical interpretations surrounding it.

Keywords: Imre Madách, biography, Lant-virágok [Lyre-flowers]

Imre Madách is often discussed as a one-work author, as his cultic magnum opus, *The Tragedy of Man*, largely overshadows the distinctive features of his other works. This study continues my earlier research on Madách's early career, in which I examined the problems posed by the idea of being a one-work author in the teleological narratives of biographies, and how biographers attempt to circumvent or obscure this issue through various strategies. In that earlier piece, I focused on interpretations of Madách's childhood manuscript magazine *Litteraturai Kevercs*, which – despite not having been physically seen since the early 1900s – was still regarded by many biographers as a precursor to *The Tragedy of Man* (Rétfalvi, 2021). In what follows, I first aim to show how the notion of Madách's one-work authorship shaped the reception of his early poetry collection *Lant-virágok* [hereinafter: *Lyre-Flowers*] from the 1840s. I will then attempt to highlight the problems inherent in the biographical interpretation traditions associated with this poetry collection.

The *Lyre-flowers* and the literary establishment

In recounting the beginnings of Imre Madách's literary career, biographers have attributed great significance to his first poetry collection, *Lyre-flowers*. Menyhért Palágyi, for instance, viewed its uniqueness in the fact that it was the author's only work published before his magnum opus: "Its particular literary interest lies in the fact that for more than 20 years following its publication, no poem, drama, or any literary work of Madách appeared. The next work to follow *Lyre-flowers* in print was *The Tragedy of Man*. The works of the intervening years remained in the author's desk and were only published posthumously. From *Lyre-flowers* to *The Tragedy of Man*, there is not a trace of Madách's presence in Hungarian poetry. He disappears as a young man humming his first verses and re-emerges before a surprised audience as the creator of a magnificent world poem." (Palágyi, 1900, pp. 69–70.).

However, Károly Bérczy and later biographers pointed out that the poetry collection was distributed only among family and friends (Bérczy, 1880, p. XXI.). Little is known about the circumstances of its publication, despite the fact that Csaba Andor, as president of the Madách Society, dedicated several writings to the subject (Andor, 1997; 2018). According to its title page, it was printed by Lajos Landerer of Füstkút, and copies submitted to the censors later resurfaced, which Gábor Halász described in the 1942 edition of Madách's *Collected Works*. He described the manuscript as consisting of two booklets, one of 21 sheets and the other of 4 sheets. Both had the title *Lyre-flowers* and were signed with the pseudonym Zaránd. The thinner booklet was marked as a "continuation" by the poet, so – according to the dates on them – the poems in it were written to replace those removed by the censor (Antal Ottmayer; Halász, 1942, pp. 1201–1203.). In 1878, Lajos Abafi found another manuscript of the work in the legacy of Gábor Kazinczy, titled *Lyre-sparks for my friends*, also under the pseudonym Zaránd (Abafi, 1878, pp. 1–2.). Later, in 1922, these omitted poems were published together with the material from the 1840 collection, edited by Jenő Sugár (Madách, 1922). In his introduction to the 1985 facsimile edition, Ferenc Kerényi noted that we do not know the number of copies printed or who received them (Kerényi, 1985, p. 3.). However, the small number of known copies – today only a few survive, housed in the National Széchényi Library and the Palóc Museum in Balassagyarmat – suggests a limited circulation.

Thus – as Kerényi also suggests (Kerényi, 1985, p. 3) – the collection remained invisible to the contemporary literary establishment, and unfortunately, no surviving comments from family or friends have been found discussing the volume or its poems. The poet himself only mentioned the collection a few times – in correspondence with Menyhért Lónyay – mainly expressing his desire to prevent the poems from falling into other hands: "I have here selected and polished my poems. Once again I beg you not to show my copied poems to anyone; when we meet again, I will give you all the corrected versions, with which you may do as you please." (Andor–Gréczi-Zsoldos, 2014, p. 62). And: "If you grant me one request, make it that you bury the poems you have in eternal darkness, showing them to no one. I will try once more, and you may be certain that if anyone, it will be I who will not be ashamed to show good work to anyone." (Andor–Gréczi-Zsoldos, 2014, p. 73.). Madách refers to the collection's contents only in a letter in which – according to biographers – he confesses his feelings for Etelka Lónyay to her brother, Menyhért: "I often thought to myself that I would have the strength to defy, that this thought would follow me to the grave [...] I wrote a *Swansong* – because I longed to leave this world, to leave everything – and nature did not provide the means for us to end everything in one stroke. [...] She was my dream, she was the spirit in my lyre." (Andor–Gréczi-Zsoldos, 2014, pp. 84–85.).

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Interpretations of *Lyre-flowers* and the biographical context

Very little attention has been given in reception to interpreting the works included in the collection. Pál Gyulai's edition of Madách Imre's collected works did not even include them (Gyulai, 1880). A more detailed examination of the material and the aesthetic evaluation of the poems was only undertaken in Mária Schéda's 1973 study (Schéda, 1973). In addition to this study, the volume by Zsuzsanna Máté and Kálmán Bene, which deals more broadly with Madách's poetry, deserves mention, though it pays little attention to the poems in *Lyre-flowers* (Máté & Bene, 2008). Schéda mainly examines how Biedermeier poetry influenced Madách's early poems and how the outlines of his later creative profile can be discerned in these works. Schéda's study highlights the young poet's wide reading and the key poetic themes of the *Athenaeum* journal through the mottos of the poems. However, it also criticizes his epigonism and literary taste, noting that, in addition to references to Kisfaludy, Vörösmarty, and Kölcsey, not only the „greats" influenced young Madách. For example, considering his poems *Édes kín* [*Sweet pain*] and Szép szebb [*Nice nicer*], he was also influenced by a poet named Zorányi, who published a sonnet titled *Sweet pain* in an 1840 issue of the *Athenaeum* (Schéda, 1973, p. 418).

Instead of interpreting the works, greater emphasis was placed on the biographical element that Madách wrote the collection for his first love, Etelka Lónyay. The story of this love was first mentioned in Károly Bérczy's memorial speech, though he did not reveal the name of the muse who inspired the poetry collection and did not attribute much significance to this youthful romance. In his interpretation, more importance is given to Madách's devotion to his mother, which led him to renounce his love (Bérczy, 1880, pp. XXI–XXII). It should be noted that the same prodigal son narrative appears in Bérczy's account when describing Madách's later marriage and divorce, as Madách once again – according to Bérczy, rightly – chooses his mother over his wife: "Dark days followed, years darker than the prison nights. Home, family, faith, hope, love: all lost, gone! Where can the shipwrecked man flee among the crashing waves over his head? Everywhere emptiness, whirlpool, desert. But no, is it not so? There is still an oasis, the ever-faithful, ever-loving breast of the mother!" (Bérczy, 1880, pp. XXVIII). In the friend's memorial speech, it is already suggested that the poems written about this "purely idealized figure" later became fond memories (Bérczy, 1880, p. XXII).

In his biography of Madách, Menyhért Palágyi also seems to follow this perspective, viewing *Lyre-flowers* as a love memento. In his cultic reading, this argument supports the idea that there is no point in focusing on the quality of the texts, since they merely contain love confessions and descriptions of Etelka's figure and activities: "It is impossible to approach this first budding of tender poetic talent with serious criticism, but the devoted biographer turns the pages of Madách's first poetry collection with inner emotion. [...] However, to give some idea of the booklet's contents, I will say that it is dedicated from beginning to end to Etelka. Etelka is portrayed in the church, in her everyday surroundings." (Palágyi, 1900, p. 70).

In Palágyi's description, an important role is played by one of the reminiscences, by Béla Kálmánházy, who he claims "hints at the latent drama of hearts" in his writings about Etelka (Palágyi, 1900, p. 74). Around the same time as Palágyi's volume, Hugó Becker's series of articles on Madách's life also placed dramatic emphasis on the significance of love in the poet's oeuvre. According to Becker: "It is characteristic, and it also affected [Madách's] future, that his first youthful love was also his first tragedy." (Becker, [1899], 2004, p. 19).

In his monograph on Madách, Géza Voinovich – apparently building on all these insights – elaborates on the experience of the Etelka-love in relation to the poet's development: "However, Madách's passion did not fade with the usual suddenness of youth; it left an eternal mark on his sensitive soul. This feeling made him a poet; [...] His first disappointment made him distrustful for his entire life: he attached disenchantment to every hope with a logical chain. The memory of this pain never healed in his soul. After his great disappointment, Etelka's image seemed to him the figure of his unattainable happiness. When he had his poems transcribed, he placed a few addressed to her at the forefront of the 'Love Group'. Even in the revolutionary scene of *The Tragedy of Man*, the virginal marquise seems to evoke the memory of Etelka. This susceptibility to gloomy moods, the excessive sensitivity, and this internal conflict between imagined and real worlds are constant features of his poetry." (Voinovich, 1914, p. 20).

Thus, the biographer believes that the *Lyre-flowers* collection is primarily a document of Madách's becoming a poet. His love for Etelka is not merely a fond memory, but an event of dramatic force that made him a poet. Additionally, according to Voinovich, the fundamental concept of *The Tragedy of Man* also stems from this experience, since in the dramatic poem, each era's hopeful initial situation is generally followed by Adam's disillusionment at the end of the scene.

In the reception of *Lyre-flowers*, then, the interpretation of the text is replaced by a biographical event – the story of the Etelka-love. The dramatic interpretation of this love story contributes to biographers – similar to the case of *Litteraturai Kevercs* – seeing in it the seed of *The Tragedy of Man*'s basic concept.

Dedications

Various mentions of the *Lyre-flowers'* dedications can be found in Madách's biographies. Surprisingly, the collection begins with three dedications and two poems that can be interpreted as such. The first is from Ferenc Kölcsey: "Let this lyre be sacred to you: Amor, Gratia, Phoebus / Aetherial fire, pain, and voice flow from you to it." (Madách, 1985, p. 2.). This excerpt was written by Kölcsey as an internal dedication in his 1832 poetry volume, preceding his Greek translations. Although two versions of the dedication existed (from 1817 and 1832), Madách used the later version in his collection (Kölcsey, 1832, p. 25). The phrase "Aetherial fire" suggests that the dedication might have originally been connected to the collection's earlier title *Lyre-sparks*. The second dedication is addressed to Madách's mother: "Dedicated to my mother, with filial respect." The third, a French quotation from Victor Hugo, also functions as a dedication for his play *Cromwell*: "Que le livre lui soit dédié; / Comme l'auteur lui est dévoué." ["Let the book be dedicated to him; just as the author is devoted to him."] (Hugo, 1836, p. 2).

In biographies by Bérczy and Becker, this latter dedication is also interpreted as being addressed to his mother: "Because of Imre's sickbay and still student status, the age difference, and perhaps religious differences, the match did not seem desirable; he renounced, and dedicated his *Lyre-flowers* to his mother with a motto borrowed from Victor Hugo." (Bérczy, 1880, pp. XXI–XXII.). "The booklet was dedicated to his mother, for whose sake he renounced his first love, as indicated by the borrowed motto from Victor Hugo." (Becker, 1899, p. 19). However, the biographers overlook the fact that in Hugo's work, these lines were addressed to the author's father: "A mon Père / Que le livre lui soit dédié; / Comme l'auteur lui est dévoué." (Hugo, 1836, p. 2). The volume, incidentally, is listed in József Szücsi's catalog of Madách's library (Szücsi, 1915, p. 15).

Biographies provide little information about the recipient of the poem titled Ajánlat [*Dedication*]. Ferenc Kerényi, in his introduction to the facsimile edition of *Lyre-flowers*, discusses the differences between the manuscript and the printed volume. In the former, after the omitted lines, it simply states "recommend by the author," and only on the back of the page appears "To the mother." (Kerényi, 1985, p. 4). Based on this, the other two dedications, and the opening poem of the collection, Kerényi concludes: "The poem opening the collection, titled *Dedication*, and the overarching theme of love throughout the entire poetry collection clearly suggest that the author intended to insert the name Etelka Lónyay in the omitted space." (Kerényi, 1985, p. 4).

This interpretation might be justified by the fact that the poem's motto is from Ferenc Verseghy's 1806 work *Julis at the dance*: "I strum my lyre for my fair Julis, / while I live, her charms." (Madách, 1985, p. 5). Although Madách's poem is not about a dance but a natural scene, through Verseghy's poem, it may connect with the description in Madách's letter to his sister, Mária, about a house ball at the Lónyay family's residence, where the young Madách danced with Etelka (Andor–Gréczi-Zsoldos, 2014, pp. 76–80). However, the omitted lines might also indicate that, due to the small number of printed copies, the author intended to personally inscribe the recipient's name on the distributed copies.

Is Adeline the Same as Etelka?

In the next poem, *Adeline*, Madách's biographers clearly identify the person named in the title with Etelka. Menyhért Palágyi writes: "In July 1840, Madách Imre's melancholy, hopeless love poems addressed to Etelka (to Adeline) were published under the title *Lyre-flowers*." (Palágyi, 1900, p. 69). Furthermore, Béla Kálmánházy, cited by Palágyi, and Géza Voinovich also do not question this identification. Kálmánházy wrote: "Adeline (Etelka) might have suspected that her father, one of the powerful men of the era, an inner secret councillor and the mighty governor (administrator) of the Gödöllő estate, would not permit her, his family's blossoming rose, Adeline, to be attached to Madách's heart, especially due to the religious differences between them and the heated public debates over mixed marriages in 1840." (Kálmánházy, 1880, cited in Palágyi, 1900, p. 74). The later interpreter of the collection, Csaba Andor, also did not question the identification of the names. In his 2018 essay, he raises the question of how Madách's mother, Anna Majthényi, might have reacted when she discovered from the *Adeline* poem that her Catholic son was watching Etelka in the Reformed church: "There remains one more psychological riddle: what could the lady [Anna Majthényi] have thought when she saw the book dedicated to her? Perhaps she only skimmed it and put it aside indifferently. But what if she didn't? What if she happened upon the second poem (*Adeline*), which begins: 'If in the sound of the church hymn, / Glorified to burn, in holy prayer / I see her face [...]'? In that case, she would have had to ask her son: how could he, as a Catholic, have spied on his Reformed beloved in a church? (I do not wish to get lost in the details of literary topography, but the likely location was the Calvin Square church.) For if she got that far in reading, she would not have found it flattering but rather directly insulting that the dedication was addressed to her. This could have led to a serious exchange between them." (Andor, 2018, p. 131). Although the Hungarian name Etelka originates from András Dugonics's 1788 novel *Etelka, a very rare little Hungarian lady at Világos castle, during the time of our princes Árpád and Zoltán*, it was later used as a replacement for the Germanic-rooted Adelheid. The related names Adeline and Etelka both mean "noble." (Fercsik & Raátz, 2009, pp. 367–368). Thus, the identification may seem justified. However, interpreters consistently ignored the note following the title: "Fragment, after Bürger." (Madách, 1985, p. 6). According to József Szücsi's catalog, Gottfried August Bürger's 1789 volume *Gedichte* was part of the Madách family library (Szücsi, 1915, p. 13). This volume contains Bürger's own poem titled *Adeline*. The original poem consists of three stanzas, of which the seventeen-year-old Madách translated the first two (see appendix for the original).

Gottfried August Bürger

Adeline

„Seh' ich, bei des Tempels Harmonieen,
Ihr Gesicht von Seelenandacht glühen,
Ach! so wähnt mein hochgetäuschter Blick,
Eine Himmelsbraut in ihr zu schauen.
Mir entsinket alle mein Vertrauen,
Und die Liebe bebt vor ihr zurück.

Aber seh' ich, wie im Alltagskreise,
Frei und fröhlich, doch nach Sitt' und Weise,
Sie so mädchenhaft sich haben kann;
Wie sie Scherz und Ernst so lieblich kleidet,
Und um ihre Huld sich alles neidet:
Dann wagt Liebe wieder sich heran."

Imre Madách

Adeline

"If in the sound of the church harmonies,
Glorified to burn, in holy prayer
I see her face, my foolish fancy
Sees in her the bride of heaven,
And my trust then flies away:
My feeling recoils from her.

But if then I see her in her everyday world,
Charming in shy simplicity,
Living plainly, like a woman:
How sweetly she moves amid sorrow and joy:
If everyone sacrifices for her,
Ah, then I dare feel again."

The formal similarity can be seen in the number of lines, and the speech position is also the same. In the first stanza, the image of the girl praying in the temple is presented, whom the speaker imagines as the bride of heaven [“Eine Himmelsbraut”] (Bürger, 1790, p. 22). The lyrical self’s “feeling” – in Bürger’s version, “love” [“die Liebe”] – recoils due to this divine image and dares not approach her. However, in the second stanza, when he sees the woman “in her everyday world” [“im Alltagskreise”], “like a woman” [“mädchenhaft”], engaged in simple activities, he dares to “feel again” [“Dann wagt Liebe wieder sich heran.”].

Conclusions

Based on all this, the tradition of interpretation that unequivocally associates the poem and the figure of Adeline with the experience of Madách’s love for Etelka Lónyay seems highly questionable. Of course, it is possible that the young Madách chose to translate Bürger’s poem precisely so that his beloved’s name could still appear in the collection. However, there is no evidence in the sources that Etelka was ever called Adeline in her family, and Madách himself refers to her as Etelka or Etelke in his letters and poems. Although it is not known exactly when these poems (*In the Garden to Etelke*, *On the Memorial Pages: Etelke*) were written, as they were not included in the *Lyre-flowers* collection, the author later included them in the planned edition of his poems in the cycles *Love* and *Epigrams* (Madách, 1942, pp. 11; 372).

Thus, instead of an interpretation focusing on biographical events, it would be more fruitful to approach Madách’s youthful love poems through their linguistic constructions. This approach is similar to Szilárd Borbély’s reading in his essay *The Lilla-love as Text*, where he argues that in both the poetry collection and the letters, it is better to approach the Lilla-love as text rather than as an experience (Borbély, 2023).

In summary, the study has shown how biographers construct narratives around the creation of Madách’s magnum opus. The examination of *Lyre-flowers* indicates that when it is impossible to deduce connections to the great work from the poems’ texts or themes, the uncertain biographical narrative – the story of youthful heartbreak – takes the place of textual interpretation, ultimately leading interpreters to the underlying structure of *The Tragedy of Man*.

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Appendix

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Adeline

(Töredék, Bürger után.)

Ha szentegyházi ének hangzatában,
Dücsőülve égni, szent imában
Latom arczát, dőre képzetem
Az ég menyasszonyát sejditi benne,
És bizalmam ekkor elrepülve;
Vissza döbben tőle érzetem.
Am ‘s ha ekkor köznapi körében
Látom őtet bájlo szendeségben
Élni egyszerün, ‘s oly nőileg;
Mi édesen leng, bú ‘s öröm körébe;
Hogy ha minden áldozik feléje,
Ah akkor újra érzeni merek.


Adeline.

(Töredék, Bürger után.)

Ha szentegyházi ének hangzatában,
Dücsöülve égni, szent imában
Latom arczát, döre képzetem
Az ég menyasszonyát sejditi benne,
És bizalmam ekkor elrepülve;
Vissza döbben töle érzetem.

Am 's ha ekkor köznapi körében
Látom ötet bájlo szendeségben
Élni egyszerün, 's oly nöileg;
Mi édesen leng, bú, 's öröm körébe;
Hogy ha minden áldozik feléje,
Ah akkor újra érzeni merek.

Zsófia P. Rétfalvi – PhD student
zsofi200@gmail.com
ORCID ID: 0000-0001-7832-8426

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Cardiac Function and Carotid Intima-Media Thickness in Obese and Normal Weight Hungarian Adolescents and Their Association with Serum Folic Acid and Vitamin B12 Levels

Preliminary Results

Anna Hajdú[1], Péter Nagy[2], Noémi Szabó[2], Regina Felső[2,3],
György Masszi[2], Szilvia Bokor[2,3], Dénes Molnár[2,3]

1. Faculty of Medicine, University of Pécs, Pécs
2. Department of Paediatrics, Medical School, University of Pécs, Pécs
3. National Laboratory of Human Reproduction, University of Pécs, Pécs

ABSTRACT

Childhood obesity has become a global epidemic, with rising prevalence worldwide contributing to increased cardiovascular morbidity and mortality risks in adulthood. Despite growing awareness of its effects, the relationship between obesity, cardiac function, and vascular health, particularly in relation to micronutrients such as folate and vitamin B12, remains insufficiently explored in adolescents.

This study aimed to investigate the association between obesity, cardiac function, carotid intima-media thickness (CIMT), and serum folate and vitamin B12 levels in adolescents.

In 31 obese and overweight adolescents (O group, BMI 35.2 ± 7.2 kg/m²; mean age: 14.9 ± 1.7 years) and 17 normal-weight adolescents (K group, BMI 19.7 ± 1.7 kg/m²; mean age: 15.2 ± 1.6 years), anthropometric parameters, blood pressure, and serum folate and vitamin B12 levels were measured. Echocardiography and CIMT measurement using neck ultrasound were performed. Statistical analysis was conducted using an independent samples t-test or a Mann-Whitney test, depending on the distribution. Pearson correlation test was used to assess correlations, with a significance level set at $p<0.05$.

Significant differences were observed between groups K and O in epicardial fat volume (K: 3.86±0.10, O: 5.73 ± 1.50 mm, p= 0.001), left CIMT (K: 0.34 ± 0.05, O: 0.38 ± 0.04 mm, p = 0.001), right CIMT (K: 0.34 ± 0.04, O: 0.37 ± 0.04 mm, p = 0.001), systolic blood pressure (K: 117.53 ± 15.9, O: 127.53 ± 6.46 mmHg, p: 0.005), diastolic blood pressure (K: 66.00 ± 7.59, O: 71.40±6.50 mmHg, p: 0.02), and serum folic acid (K: 5.39 ± 2.42, O: 4.07±1.61 ng/l, p = 0.033). Correlations were found between serum folic acid and body fat percentage (R = -0.315, p = 0.035), serum folic acid and CIMT (R = -0.315, p = 0.035), vitamin B12 and CIMT (R = -0.311, p = 0.035), body fat percentage and ejection fraction (R = -0.302, p = 0.017), and body fat percentage and CIMT (R = -0.302, p = 0.017).

These preliminary results demonstrate that obesity is associated with less favorable cardiovascular status and increased CIMT in adolescents. Serum folate and vitamin B12 status may play a role in these associations. The findings suggest that cardiovascular disease prevention should begin in pre-adolescence, before cardiac and arterial changes become evident.

Keywords: adolescent obesity, cardiac function, carotid intima-media thickness, folic acid, vitamin B12

Introduction

Childhood obesity has become a major global public health issue, with its prevalence rising dramatically over the past four decades. According to the World Health Organization, around 340 million adolescents and 39 million children are affected (WHO, 2022).

The increasing prevalence of childhood obesity is strongly associated with elevated cardiovascular morbidity and mortality in adulthood (Bendor et al., 2020; Genovesi & Pieruzzi, 2006). Early cardiovascular structural changes, including left ventricular enlargement, diastolic dysfunction, increased carotid intima-media thickness (CIMT), endothelial dysfunction, and early vascular aging, are already detectable in obese children (Anderson, 2006; Cabeza et al., 2022; Côté et al., 2013; Moretti et al., 2024; Reinehr et al., 2006); however, the underlying mechanisms require further investigation.

Diet plays a key role in obesity and cardiovascular health. Obese children often consume calorie-dense, nutrient-poor diets, leading to deficiencies in essential micronutrients like folate and vitamin B12 (Calcaterra et al., 2023). These water-soluble vitamins are essential in one-carbon metabolism, cellular function, biosynthesis of proteins and lipids, and epigenetic regulation of gene expression (Clare et al., 2019). Therefore, deficiencies in these vitamins may impair metabolic function, elevate homocysteine levels, and contribute to endothelial dysfunction, thereby promoting cardiovascular disease (Ashok et al., 2021). Despite the growing recognition of cardiovascular consequences in childhood obesity, there remains a lack of comprehensive research on the role of nutritional deficiencies (particularly folate and vitamin B12) as underlying contributors to these alterations in the pediatric populations. A deeper understanding of these associations may yield valuable insights into the early pathophysiological mechanisms of cardiovascular disease and lead to the development of targeted, evidence-based interventions.

Therefore, this study aims to examine the relationship between obesity, cardiac function, carotid intima-media thickness (CIMT), and serum levels of folate and vitamin B12 in adolescents.

Research design and methods

The study population consisted of obese and overweight adolescents (age 12-18 years, n=29 obese: 15 boy, 14 girl, n=2 overweight: 1 boy, 1 girl) who attended the Metabolic Clinic at the Department of Pediatrics, University of Pécs, as well as normal weight adolescents (age 12-18 years, n=17: 6 boy, 11 girl) from primary and secondary schools in Pécs who voluntarily agreed to participate. Data collection was carried out between July and December 2024. At the clinic, both children and their parents received detailed oral information about the study, after which written informed consent was obtained from both parties. For participants recruited from schools, comprehensive written information was provided to both the parents and the children. Participation was confirmed by returning a signed consent form to the school, upon which the date of the examination was scheduled.

Children with chronic illnesses or secondary forms of obesity were excluded from the study.

The study was conducted in accordance with the Declaration of Helsinki. The study had the permission of the Regional Ethical Committee (ID:9278-PTE 2022).

Anthropometric measurements

Weight was determined with a digital scale with an accuracy of 0.1 kg, in loose clothing, without shoes. Height was measured barefoot with a Holtain stadiometer with an accuracy of 0.1 cm. BMI (Body Mass Index) was calculated based on the formula body weight (kg)/body height x body height (m) (kg/m2). Waist and hip circumferences were measured with a SECA 200 type measuring tape. Body Fat percentage (BF%) was measured by bio-electrical impedance (Tanita Inner Scan BC-543, Tanita, Tokyo, Japan).

Children were considered obese, overweight, and normal weight by their body mass index (BMI) according to the age- and gender-specific national limits given by Joubert (2006). Blood pressure was measured under standard conditions, using an automatic sphygmomanometer (Omron M6) and an appropriate cuff, at rest on the left bare upper arm. Measurements were taken twice consecutively, with two-minute intervals, and the results were recorded on the test sheet. High blood pressure was diagnosed if systolic or diastolic blood pressure was equal to or higher than the age and gender specific 95th percentile according to an international and a national reference standard (Dionne, 2017; Hidvégi et al., 2024).

Echocardiography and Ultrasound of the carotid intima media thickness

Carotid artery ultrasound was conducted using high-resolution B-mode and Doppler imaging to assess carotid intima-media thickness (CIMT) as recommended by international consensus guidelines (Touboul et al., 2004). Transthoracic echocardiography was performed using standard two-dimensional (2D), M-mode, and Doppler imaging protocols in accordance with the American Society of Echocardiography guidelines (Lang et al., 2015). Ejection fraction (EF), epicardial fat mass, fractional shortening (FS), left ventricular end-diastolic diameter (LVEDD), and left ventricular end-systolic diameter (LVESD) were measured.

Laboratory tests

For the laboratory test, venous blood was taken into empty vacuum tubes after an overnight fast. The vitamin B12 and folic acid values were determined from the blood samples by immunochemical testing.

Statistical methods

The statistical processing of our data was performed using the SPSS Windows 25 program. During the analysis, the independent variable T-test or Mann-Whitey test was used, depending on the distribution. In order to find the correlation between the values, the Pearson correlation test was used. The significance level was defined as $p<0.05$.

Results

A total of 31 obese and overweight children (O group: n=29 obese + n=2 overweight) (BMI: 35.2 ± 7.2 kg/m²; mean age: 14.9 ± 1.7 years, 16 boy, 15 girl) and 17 children with normal body weight (K group) (BMI: 19.7 ± 1.7 kg/m²; mean age: 15.7 ± 1.5 years, 6 boy, 11 girl) have been included in the study to date.

Anthropometric parameters, serum folate, and vitamin B12 levels for both groups are presented in Table 1. The O group exhibited significantly higher body weight, BMI, waist and hip circumference, and body fat percentage compared to the K group. All the adolescents in the O group had central obesity (waist/hip ratio > 95th percentile according to the reference values of Kułaga et al. (Kułaga et al., 2023). Serum folate levels were significantly lower in the O group than in the K group. However, no statistically significant difference was observed in serum vitamin B12 levels between the two groups.

Cardiovascular examination results for both the O and K groups are summarized in Table 2. Both systolic and diastolic blood pressure values were elevated in children from the O group. In the O group, the prevalence of hypertension was 22.6% according to the reference values of Dionne (2017), and 25.8% according to the Hungarian reference values (Hidvégi et al., 2024). In the control group, the corresponding prevalences were 5.9% and 11.8%, respectively.

Epicardial fat thickness was significantly higher in the O group compared to the K group. In contrast, the O group exhibited significantly lower ejection fraction values compared to the K group. Carotid intima-media thickness, assessed by Doppler ultrasound, was significantly greater on both the left and right sides in the O group. No significant differences were found between the groups in terms of fractional shortening, left ventricular end-diastolic diameter, or left ventricular end-systolic diameter.

In the analysis of the relationship between anthropometric and cardiovascular parameters, significant correlations were identified. A negative correlation was found between body fat percentage and ejection fraction ($R = -0.302$, $p = 0.017$; Figure 1.a). A strong positive correlation was also demonstrated between body fat percentage and mean carotid intima-media thickness ($R = 0.453$, $p = 0.001$; Figure 1.b).

Table 1
Anthropometric Characteristics, Serum Folate, and Vitamin B12 Levels in investigated adolescents Children

Variables	Non-obese (mean ± SD) n=17	Obese (mean ± SD) n=31	P-value
Age	15.69 ± 1.52	14.94 ± 1.68	0.06
Weight (kg)	57.45 ± 9.6	102.33 ± 21.86	*0.001
Height (cm)	160.28 ± 1.38	169.32 ± 8.9	0.09
Waist circumference (cm)	68.95 ± 5.98	105.69 ± 15.2	*0.001
Hip circumference (cm)	88.65 ± 8.43	115.032 ± 13.66	*0.001
Waist- hip ratio	0.78 ± 0.08	0.92 ± 0.08	*0.001
BMI (kg/m2)	19.68 ± 1.7	35.17 ± 7.15	*0.004
Body Fat (%)	17.87 ± 6.16	40.41 ± 10.08	*0.001
Folic acid (ng/ml)	5.39 ± 2.42	4.071 ± 1.61	*0.03
Vitamin B12 (pg/ml)	429.5 ± 117.96	377.1 ± 127.24	0.08

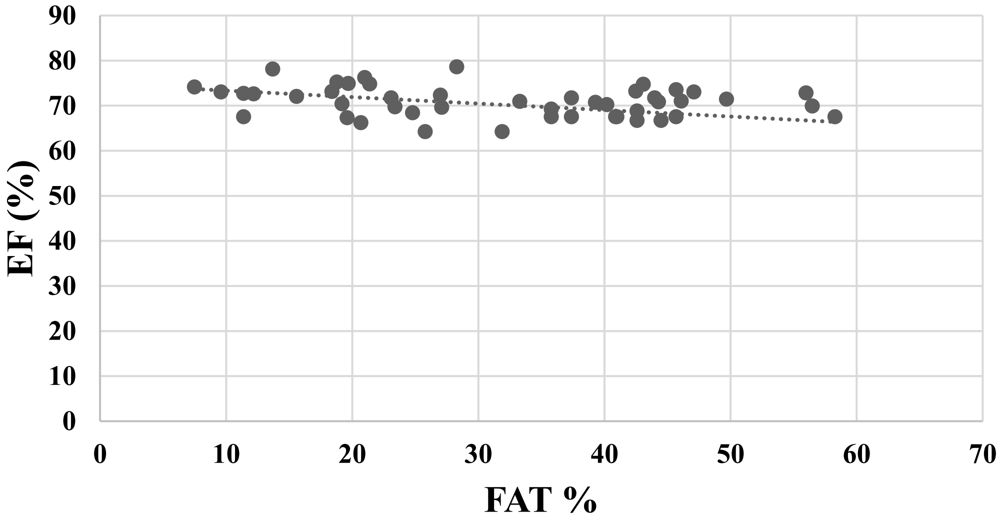
BMI: Body Weight Index, *Significance Level P <0.05
Source: Own compilation.

Table 2
Cardiovascular parameters in Obese and Non-Obese Children.

Variable	Non-obese (mean ± SD) n=17	Obese (mean ± SD) n=31	P-value
EF %	72.05 ± 3.8	69.06 ± 6.6	*0.05
FS%	41.94 ± 3.6	40.42 ± 3.1	0.07
LVEDD (mm)	45.71 ± 3.7	47.06 ± 7.2	0.68
LVESD (mm)	26.35 ± 1.9	29.29 ± 4.7	0.19
Right CIMT (mm)	0.34 ± 0.05	0.38 ± 0.04	*0.001
Left CIMT (mm)	0.34 ± 0.04	0.37 ± 0.04	*0.001
Epicardial fat mass (mm)	3.86 ± 0.1	5.73 ± 1.5	*0.001
Systolic RR (mmHg)	117.53 ± 15.9	127.37 ± 6.5	*0.005
Diastolic RR (mmHg)	66.0 ± 7.6	71.4 ± 6.5	*0.02

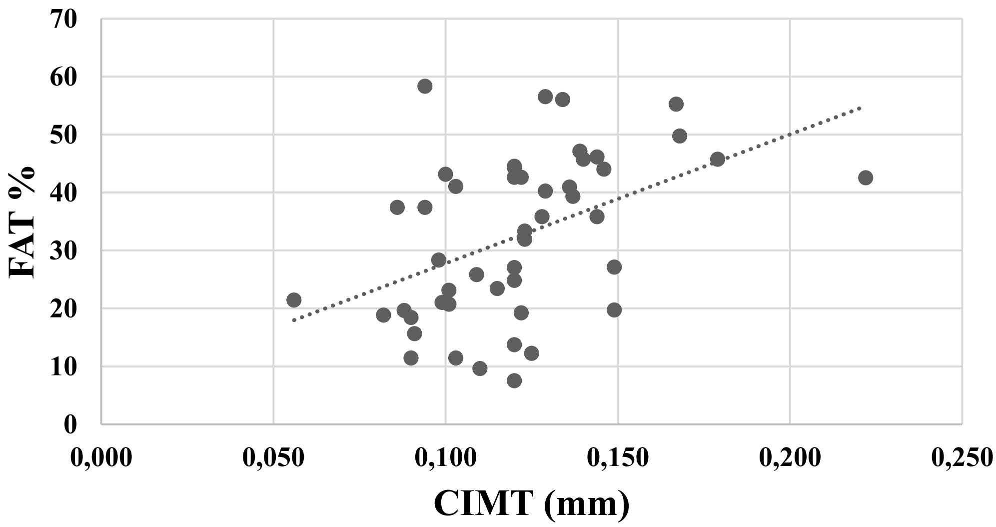
EF- ejection fraction, FS-fractionated fiber shortening, LVEDD- left ventricular end-diastolic diameter, LVESD- left ventricular end-systolic diameter, CIMT- carotid intima-media thickness; *Significance level p<0.05
Source: Own compilation.

Figure 1.a.
Correlation Between Body Fat Percentage and Ejection Fraction.



EF: Ejection Fraction, FAT %: Body Fat %. p = 0.017
Source: Own compilation.

Figure 1.b.
Correlation Between Body Fat Percentage and Mean Carotid Intima-Media Thickness.

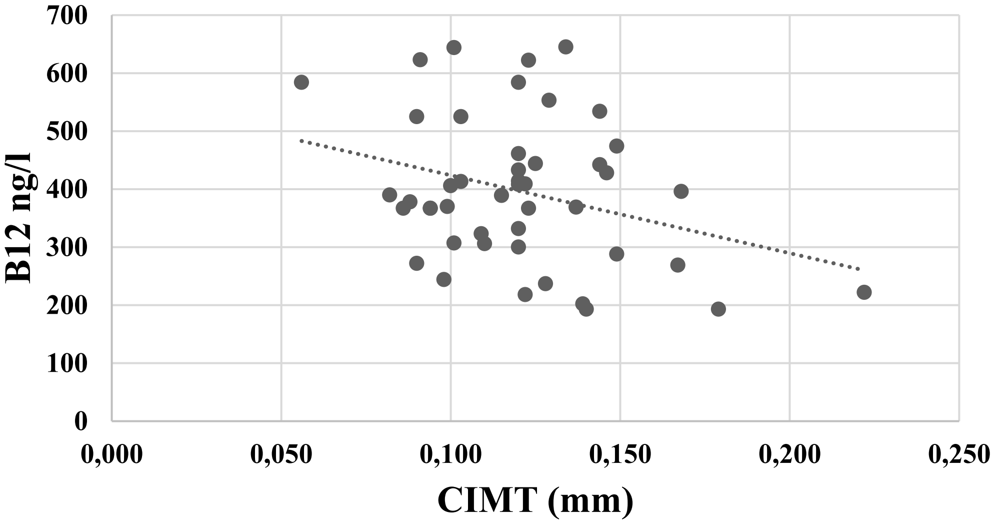


CIMT: carotid intimal- media thickness, FAT%: Body Fat %, p=0.001
Source: Own compilation.

We examined the correlations between serum folate and vitamin B12 levels with anthropometric and cardiovascular outcomes. A significant negative correlation was found between serum vitamin B12 levels and mean carotid intima-media thickness (R = –0.311, p = 0.035; Figure 2.a), as well as between serum folate levels and mean carotid intima-media thickness (R = –0.355, p = 0.017; Figure 2.b). Additionally, a negative correlation was observed between body fat percentage and serum folic acid levels (R = –0.315, p = 0.035; Figure 3).

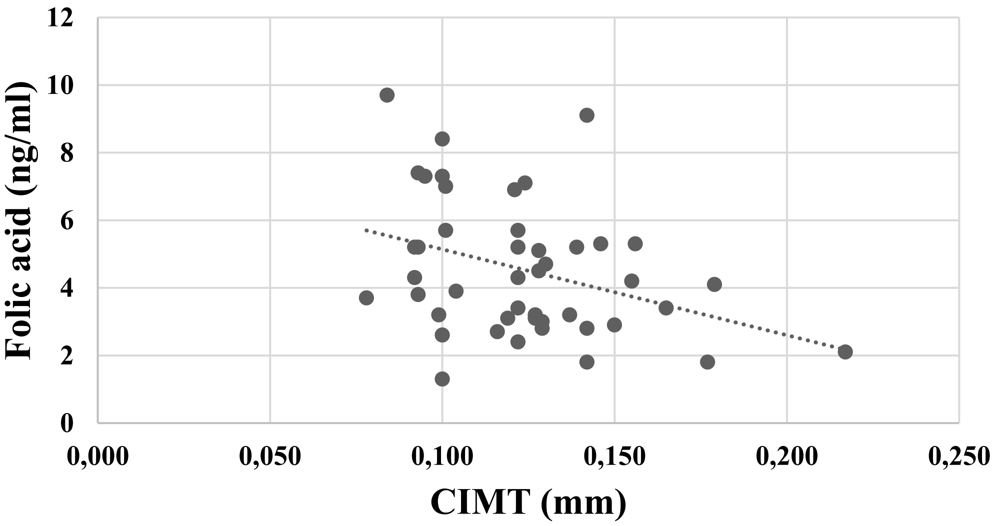
We also analyzed the relationship between systolic and diastolic blood pressure and serum vitamin B12 and folic acid levels, but no significant associations were found.

Figure 2.a.
Correlation Between Serum B12 Vitamin Level, and Carotid Intima-Media Thickness.



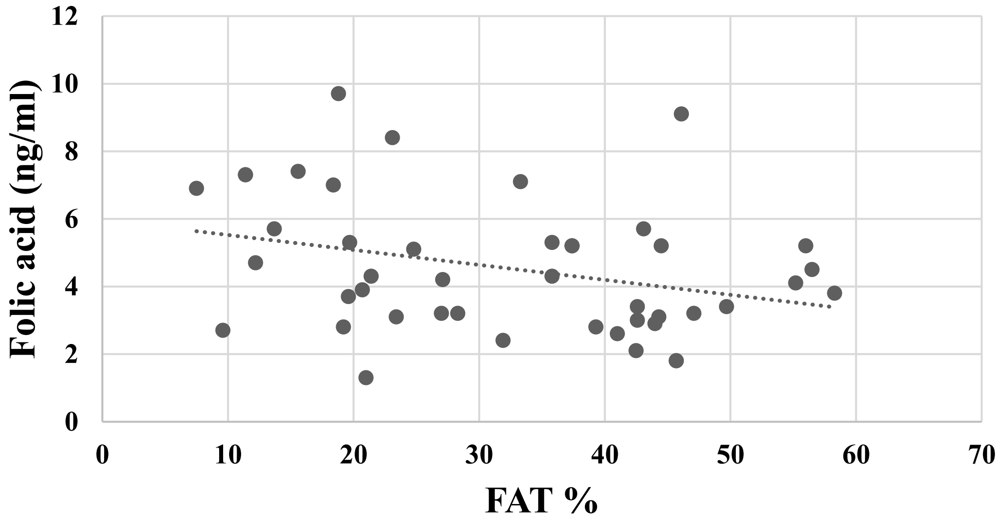
CIMT: carotid intima- media thickness, p=0.017
Source: Own compilation.

Figure 2.b.
Correlation Between Serum Folic Acid Level, and Carotid Intima-Media Thickness.



CIMT: carotid intima- media thickness, p=0.035
Source: Own compilation.

Figure 3.
Correlation Between Body Fat Percentage and Serum Folic Acid Levels.



FAT%: Body Fat %, p=0.035
Source: Own compilation.

Discussion

This study provides new insights into the early cardiovascular consequences of adolescent obesity by exploring the associations between obesity, cardiac function, carotid intima-media thickness, and serum levels of folate and vitamin B12. Our findings indicate that obesity during adolescence is already associated with significant alterations in cardiac function, epicardial fat mass, as well as increased carotid intima-media thickness, which appear to correlate with lower circulating levels of folate and vitamin B12.

Consistent with previous literature, we observed that obese adolescents exhibited significantly higher epicardial fat mass volume, which is a known marker of increased cardiovascular risk (Reyes et al., 2016). Elevated epicardial fat mass has been associated with subclinical changes in cardiac morphology and function, and in the pediatric population, it is linked to insulin resistance, dyslipidemia, and systemic low-grade inflammation—factors that collectively increase cardiovascular risk even at a young age (Mietus-Snyder et al., 2023).

Moreover, we identified a significant negative correlation between body fat percentage and ejection fraction, suggesting that increased adiposity may be associated with early myocardial functional impairment. This observation aligns with previous studies reporting subtle systolic and diastolic dysfunction among obese children and adolescents in the absence of overt heart disease (Di Salvo et al., 2001). These early functional alterations may reflect the impact of adiposity-induced metabolic and hemodynamic stress on myocardial performance.

A positive association between body fat percentage and CIMT was also observed, supporting existing evidence that childhood obesity contributes to increased arterial wall thickness, a well-established early marker of atherosclerosis (Côté et al., 2013; Doyon et al., 2013). When compared to other pediatric studies, our results show that the CIMT values in our obese adolescent group fall within the upper-normal range, roughly between the 60th and 75th percentiles. This corresponds with earlier research linking higher CIMT values to obesity-related metabolic risk in children (Doyon et al., 2013).

Blood pressure measurements further reinforced the association between obesity and cardiovascular risk, with both systolic and diastolic values being significantly higher in obese adolescents compared to their non-obese peers, an observation consistent with existing data (Falkner et al., 2023; Genovesi & Pieruzzi, 2006).

Laboratory analyses revealed lower serum levels of folate in the obese group. Importantly, adolescents with higher vitamin levels exhibited lower body fat percentages and thinner CIMT values. These findings support the hypothesis that reduced levels of folate are linked to cardiovascular alterations in obese youth. One potential mechanism involves impaired homocysteine metabolism: both folate and B12 act as cofactors in the remethylation of homocysteine to methionine. Their deficiency may lead to hyperhomocysteinemia, a state associated with endothelial dysfunction, oxidative stress, vascular stiffness, and ultimately atherogenesis and hypertension (Smulders & Stehouwer, 2005). Additionally, folate and vitamin B12 may modulate cardiovascular function through their involvement in methylation processes, including the synthesis of serotonin—a neurotransmitter that influences endothelial nitric oxide synthase (eNOS) activity. Reduced serotonin synthesis due to vitamin B deficiency may impair nitric oxide (NO) production, leading to increased arterial stiffness and elevated blood pressure (Aflyatumova et al., 2018). Folic acid supplementation has also been shown to directly increase NO bioavailability, thereby supporting endothelial function and vascular homeostasis. Vitamin B12 deficiency may further promote systemic inflammation and metabolic dysregulation via pathways involving adipokine imbalance and cytokine overproduction, contributing to insulin resistance and oxidative stress (Simonenko et al., 2024).

Taken together, these findings suggest that suboptimal folate and B12 status may contribute to the pathophysiological link between obesity and early cardiovascular risk in adolescents, reinforcing the importance of adequate micronutrient intake during this critical developmental period. Our findings are consistent with earlier studies indicating that even in the absence of overt cardiovascular events, obesity in adolescence is associated with early subclinical cardiovascular alterations. Since major cardiovascular outcomes are rare in youth, subclinical markers such as echocardiographic changes and increased CIMT offer valuable insight into disease progression and long-term risk. The use of non-invasive imaging and vascular assessment tools has improved our ability to detect these early abnormalities.

Conclusion

In conclusion, our study demonstrates a significant association between obesity, impaired cardiac function, increased CIMT, and reduced folate and vitamin B12 levels in adolescents. These findings underscore the importance of early identification and intervention in at-risk youth to prevent the progression of obesity-related cardiovascular complications. Preventive strategies should be initiated early, ideally before adolescence, and should include nutritional interventions to correct potential micronutrient deficiencies in addition to addressing metabolic risk.

Limitations

It is important to emphasize that the current study represents a preliminary investigation. We are actively expanding our sample size to enhance statistical power and generalizability. Furthermore, additional laboratory assessments (regarding metabolic risk factors) are planned to allow a more comprehensive evaluation of metabolic risk. These future analyses aim to clarify the complex interplay between obesity, micronutrient status, and cardiovascular health in adolescents. We also intend to adjust future analyses for sex and other relevant confounding variables to improve the clinical interpretability and robustness of our findings.

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Anna Hajdú – MD/PhD student
hajdu.anna2001@gmail.com
ORCID ID: 0009-0004-4449-7175

Péter Nagy MD – Paediatric cardiologist
nagy.peter@pte.hu

Noémi Szabó – PhD student
noemi.fogl@gmail.com

Regina Felső – Assistant research fellow
felso.regina@pte.hu
ORCID ID: 0000-0001-5646-2093

György Masszi MD – Paediatrician, Head of the Department of Paediatric Cardiology
masszi.gyorgy@pte.hu
ORCID ID: 0009-0002-7077-2244

Szilvia Bokor MD, PhD – Senior lecturer
bokor.szilvia@pte.hu

Dénes Molnár MD, PhD, DSc – Professor emeritus
denes.molnar@pte.hu
ORCID ID: 0000-0002-3675-7019

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Do lipid rafts exist?

Specialized microdomains and where to find them – a systematic review

Ivona Hlaj[1]
Sara Bonet[2]
Marija Heffer[2]
1: Department of Biology, J. J. Strossmayer University of Osijek
2: Faculty of Medicine, J. J. Strossmayer University of Osijek

ABSTRACT

Lipid rafts are nanoscale, cholesterol and sphingolipid-enriched domains within the dynamic phospholipid bilayer that organize signaling platforms and influence membrane trafficking. We conducted a systematic review of 56 peer-reviewed studies published between 2015 and 2024 to quantify prevailing methodologies across three dimensions: visualization techniques, experimental models, and isolation protocols. Biochemical and immunoassay approaches (48.2 %) and classical detergent-resistant membrane (DRM) fractionation (80.4 %) dominate the field, reflecting reliance on Western blots, ELISAs, and cold Triton X-100 extraction coupled with sucrose-gradient ultracentrifugation. Fluorescence-based super-resolution and FRET microscopy (21.4 %), analytical-chemistry lipid profiling (12.5 %), and computational omics analyses (8.9 %) remain underutilized, indicating opportunities for spatial–molecular integration. Central nervous system-derived models prevail (89 %), whereas peripheral tissues, including blood, immune, vascular, and endothelial systems, account for < 10 % of studies, underscoring a narrow experimental focus. These findings highlight methodological biases, particularly the potential for detergent artifacts, and suggest that adopting detergent-free fractionation, enzyme-mediated proximity labeling (e.g., EMARS), correlative light-electron microscopy, and multi-modal lipidomics paired with live-cell imaging will enhance native preservation and resolution of raft assemblies. Expanding tissue contexts beyond the CNS and standardizing reporting metrics for raft yield, purity, and functional controls are critical for reproducibility and translational impact. Embracing these holistic, quantitative strategies will advance our understanding of raft-mediated signaling in health and disease and accelerate the development of targeted membrane-modulating therapeutics.

Keywords: gangliosides; immunohistochemistry; lipid rafts; methodology

Introduction

Cell-Membrane Structure

The cell membrane is a dynamic, selectively permeable boundary composed primarily of a bilayer of amphipathic phospholipids, interspersed with cholesterol, glycolipids, and membrane proteins (Casares et al., 2019; Yan et al., 2024). Phospholipid molecules with hydrophilic "head" groups (e.g., phosphatidylcholine, phosphatidylethanolamine) and hydrophobic acyl chains self-assemble so that the heads face the aqueous environment, while the tails are sequestered within the bilayer interior. This arrangement was first inferred by Ernest Overton in 1899 based on the lipid solubility of cell surfaces and was formally proposed as a bilayer by Gorter and Grendel in 1925. Electron microscopy (EM) and X-ray diffraction studies in the mid-20th century later provided direct visualization of a ~4–6 nm thick double layer (Honigmann & Pralle, 2016; Raghunathan & Kenworthy, 2018). Cholesterol, which constitutes up to 30–50 mol% of animal plasma membranes, intercalates between phospholipid tails via its small hydroxyl “head” and rigid sterol ring. This arrangement reduces membrane permeability to water and small solutes while preventing gel–liquid crystalline phase transitions at physiological temperatures (Honigmann & Pralle, 2016; Rafieiolhosseini & Ejtehadi, 2020). Membrane stability further arises from van der Waals forces between fatty-acid chains, hydrogen bonding among head groups, and cytoskeletal tethering via peripheral proteins (Cohen & Shi, 2020). The insertion of lipids and proteins occurs either co-translationally through the Sec translocon (for many integral proteins) or post-translationally via lipid-transfer proteins and vesicular trafficking (Casares et al., 2019; Kalappurakkal et al., 2020). Membrane composition varies markedly among organ systems: neuronal membranes are enriched in polyunsaturated phospholipids to maintain fluidity for rapid ion-channel gating, whereas hepatic and renal epithelia incorporate more sphingomyelin and cholesterol to support barrier functions (Djakbarova et al., 2021; Raghunathan & Kenworthy, 2018). Beyond these major lipids, cells incorporate specialized molecules—such as glycosylphosphatidylinositol (GPI) anchors for protein tethering, glycolipids for cell–cell recognition, and lipid-modified signaling proteins (e.g., Ras, Src family kinases)—to modulate signaling, adhesion, and trafficking in a tissue-specific manner (Honigmann & Pralle, 2016; Kalappurakkal et al., 2020).

Intercellular Signalization

Cells relay information via membrane-bound receptors that convert extracellular cues into intracellular responses. Ligand binding to receptor tyrosine kinases, G protein–coupled receptors (GPCRs), or ion channels triggers conformational changes and downstream cascades controlling proliferation, differentiation, and apoptosis (Azan et al., 2017; Togo, 2019). These receptors are predominantly located in the plasma membrane but can reside on endosomal membranes during trafficking; their precise lateral organization, often clustering into nanodomains or microclusters, modulates signal strength and duration (Janssen & Huveneers, 2024; Voeltz et al., 2024). Common signaling ions include Ca^{2+}, Na^{+}, and K^{+} Ca^{2+} influx through voltage-gated or store-operated channels near endoplasmic reticulum (ER)–plasma membrane contact sites generates localized “sparks” that regulate processes from gene expression to motility (Azan et al., 2017; Triller et al., 2020). Recent super-resolution imaging reveals that many receptors and ion channels preferentially partition into cholesterol-rich lipid rafts (Janssen & Huveneers, 2024; Voeltz et al., 2024), where high local cholesterol and sphingolipid content creates a distinct biophysical environment favoring signalosome assembly. Indeed, detergent-resistant membrane (DRM) preparations, the biochemical hallmark of lipid rafts, are enriched for many GPCRs and tyrosine kinases, suggesting that membranes contain subregions with elevated receptor density to facilitate rapid, localized signaling (Nishimura & Matsumori, 2020; Vizurraga et al., 2020).

Lipid Rafts

Lipid rafts are nanoscale (10–200 nm), dynamic domains enriched in cholesterol, sphingomyelin, and glycosphingolipids that float in a disordered phospholipid sea (Sezgin et al., 2017; Sonnino et al., 2018). Initially inferred in the early 1990s via their resistance to cold non-ionic detergents, Simons and Ikonen coined the term "raft" (1997); subsequent developments in single molecule tracking and super-resolution microscopy have visualized rafts in live cells (Sevcsik & Schütz, 2016; Shaw et al., 2021). Rafts serve as platforms for concentrating signaling proteins (e.g., Src family kinases, glycosylphosphatidylinositol [GPI]-anchored proteins), organizing endocytic pits, and mediating pathogen entry (Sezgin et al., 2017; Sonnino et al., 2018). While most mammalian cells harbor rafts, their lipid and protein composition can differ. Neuronal rafts are ganglioside-rich and support synaptic signaling, whereas immune-cell rafts contain distinct sphingolipid species essential for immunoreceptor clustering (Levental & Veatch, 2016; Nieto-Garai et al., 2022). Proteomic screens of detergent-resistant membranes (DRMs) have identified hundreds of raft-associated proteins, revealing that raft composition changes in response to stimuli such as oxidative stress or ligand binding (Sevcsik & Schütz, 2016; Shaw et al., 2021). Investigating rafts employs biochemical fractionation, detergent-free methods (e.g., density-gradient centrifugation), and advanced imaging: fluorescence resonance energy transfer (FRET), stimulated emission depletion (STED) microscopy, and single-particle tracking reveal raft dynamics in live cells (Nieto-Garai et al., 2022; Sezgin et al., 2017). Understanding rafts is critical because their dysregulation underlies diseases—from Alzheimer's to viral infections—and offers targets for therapeutic modulation of membrane organization (Shaw et al., 2021; Sonnino et al., 2018).

Visualizing Cell Membranes and Rafts

The ~4–6 nm thickness of the lipid bilayer can be measured by transmission electron microscopy (TEM) following cryo-fixation and metal shadowing, which preserves native membrane architecture (Shi et al., 2018; Yano & Matsuzaki, 2019). High-resolution methods such as atomic force microscopy (AFM) and STED microscopy achieve sub-10 nm resolution, permitting visualization of cholesterol-enriched domains and protein clusters on supported bilayers or live-cell surfaces (Kageler et al., 2024; Liu & Afshar, 2020). Sample preparation often involves the generation of plasma-membrane sheets or giant unilamellar vesicles, labeling with fluorescent lipid analogs (e.g., BODIPY-cholesterol, alkyl-chain-regulated dyes), and mild crosslinking to stabilize domains (Yano & Matsuzaki, 2019; Yao et al., 2024). Cholera toxin B subunit conjugated to fluorophores binds GM1 gangliosides to mark rafts, while detergent extraction at 4 °C separates raft from non-raft fractions biochemically (Sezgin et al., 2017; Yao et al., 2024). Correlative light and electron microscopy (CLEM) further maps raft-associated proteins with nanometer precision. Together, these approaches enable quantitative measurement of raft size, lifetime, and protein composition in situ—a foundation for elucidating how membrane organization governs cellular function and pathology (Kageler et al., 2024; Shi et al., 2018).

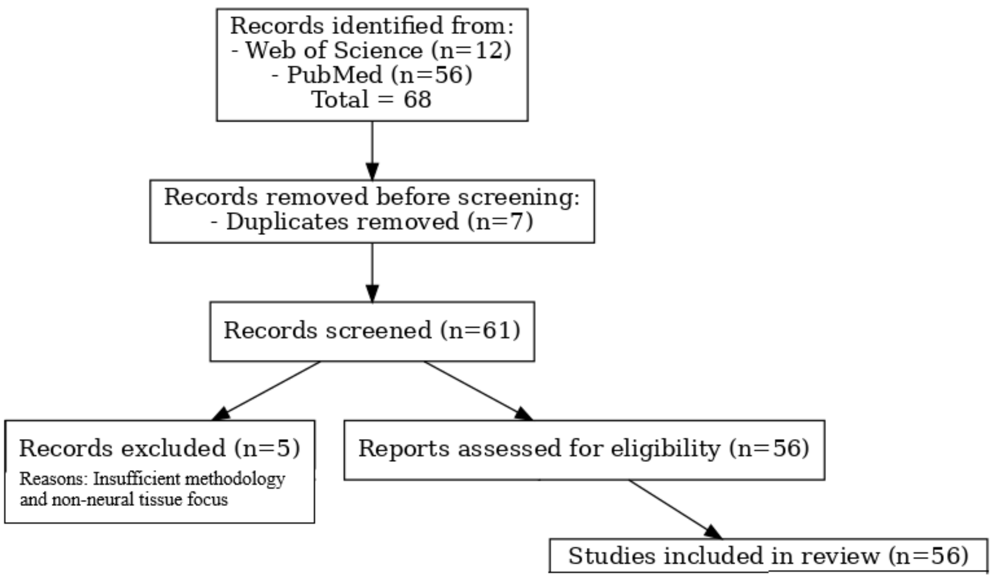
Materials and methods

We conducted a systematic literature review using Web of Science and PubMed to identify full-text, peer-reviewed articles published between January 1, 2015, and May 23, 2025, focusing on the intersection of "lipid rafts," "brain," and "methodology." The search strategy followed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-

Analyses) guidelines and was limited to English-language records. The search query was designed based on a PICO strategy P (Population): In vitro and ex vivo models derived from the central nervous system (neuronal, glial, or brain tissue) and other mammalian cell or tissue systems investigated for lipid raft composition, structure, or function. I (Intervention / Exposure): Application of specific experimental approaches for the visualization, detection, or isolation of lipid rafts, including biochemical fractionation, imaging modalities (e.g., fluorescence microscopy, super-resolution, electron microscopy), analytical chemistry (e.g., mass spectrometry), and in situ labeling methods. C (Comparator): Alternative methodological approaches for lipid raft study (e.g., detergent-resistant membrane isolation vs. detergent-free methods; biochemical vs. imaging-based techniques; CNS-derived vs. peripheral tissue models). O (Outcome): Prevalence and distribution of methodological choices in lipid raft research, identification of methodological biases or gaps, and recommendations for optimizing study design to improve reproducibility, resolution, and translational relevance.

A total of 68 unique records were retrieved. After the removal of 7 duplicates, 61 records were screened. Five studies were excluded at this stage for reasons including insufficient methodology and non-neural tissue focus, resulting in 56 studies included in the final review. Two independent reviewers conducted the screening process (titles, abstracts, and full texts), resolving disagreements through consensus.

Figure 1. Flow diagram of the review process, adapted from the PRISMA guidelines.



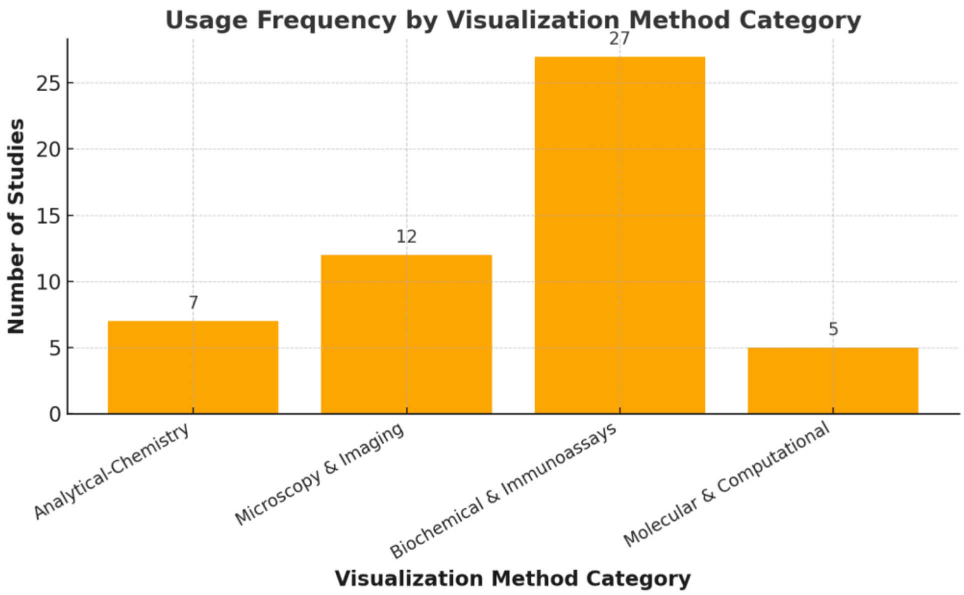
Due to the uniformity of experimental conditions—restricted to standardized in vitro models—a formal risk-of-bias assessment was not conducted. For each study, we extracted data on the biological system (cell line or brain-derived tissue), the visualization or detection technique employed (e.g., detergent-resistant membrane [DRM] fractionation, fluorescence or electron microscopy, Förster resonance energy transfer [FRET], or mass spectrometry), and any explicitly reported methodological limitations. Studies were categorized into eight distinct cell/tissue-type groups (e.g., neurons, astrocytes, microglia, glioblastoma models) and stratified by four dominant methodological classes. Extracted data were synthesized using descriptive statistics and visualized through simplified schematic representations. Narrative synthesis was employed to evaluate trends, convergence in methodological preferences, and recurrent technical constraints. This approach facilitates a comprehensive appraisal of current practices in the visualization of lipid rafts in neural in vitro systems and highlights critical gaps warranting further methodological refinement.

Results

Across 56 peer-reviewed publications spanning 2015–2024, we performed a systematic review. Our analysis extracted three core methodological dimensions: (1) visualization techniques employed to detect and characterize membrane microdomains, (2) the cellular and tissue models used as experimental systems, and (3) the biochemical and biophysical isolation protocols applied to enrich raft fractions. In Sections 3.1–3.3, we present frequency distributions for each category—visualization methods (Figure 1), tissue types (Figure 2), and isolation techniques (Figure 3)—thereby illuminating prevailing practices, methodological biases, and under-explored opportunities in lipid-raft research.

Visualization Methods

Figure 2. Frequency of Visualization Method Categories Across Lipid-Raft Studies. This bar chart depicts the number of published studies (total n = 56) employing each of four major visualization method categories in lipid-raft research.



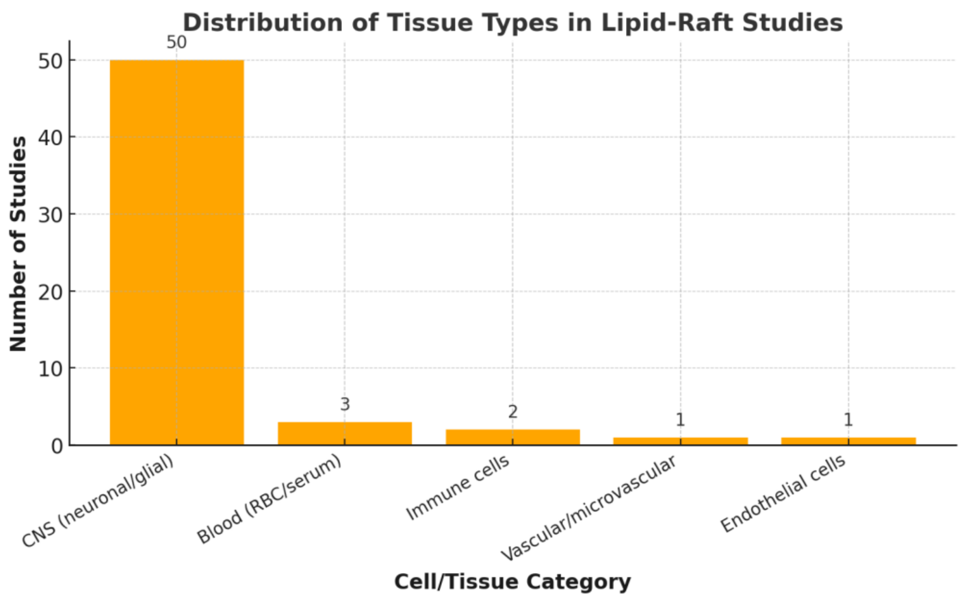
As seen in Figure 2, biochemical and immunoassay methods dominate lipid-raft research, accounting for nearly half of all studies (48.2%). This reflects the field's emphasis on targeted detection of raft-associated proteins and lipids via Western and dot blots, enzyme-linked immunosorbent assays (ELISAs), co-immunoprecipitation, and enzyme activity assays. Microscopy and imaging approaches rank second (21.4%), leveraging fluorescence-based super-resolution and Förster resonance energy transfer (FRET) techniques, transmission electron microscopy (TEM), and matrix-assisted laser desorption/ionization imaging mass spectrometry (MALDI-IMS) to resolve the spatial organization of membrane microdomains. Analytical-chemistry techniques (12.5%), including liquid chromatography–tandem mass spectrometry (LC-MS/MS), gas chromatography–mass spectrometry (GC-MS), ultra-performance liquid chromatography–tandem mass spectrometry (UPLC-MS/MS), and deuterium solid-state nuclear magnetic resonance (NMR), provide high-sensitivity, molecular-level lipid profiling but remain underutilized relative to biochemical assays.

Finally, molecular and computational methods (8.9%)—such as RNA sequencing (RNA-seq) differential-expression analyses, genome-wide association study (GWAS) Manhattan and Q–Q plots, Kaplan–Meier survival curves, and Gene Ontology (GO)/Kyoto Encyclopedia of Genes and Genomes (KEGG) enrichment visualizations—are the least common, suggesting an opportunity to expand integrative omics and systems-level approaches in future work. This distribution highlights the prevailing reliance on biochemical assays while underscoring the potential for broader adoption of high-content omics and spatially resolved imaging to deepen our understanding of lipid-raft–mediated signaling and disease mechanisms.

Tissue Types

As seen in Figure 3, central nervous system (CNS)-derived samples overwhelmingly predominate lipid-raft research, with 50 out of 56 studies (89%) using neuronal or glial tissues. Peripheral and non-CNS systems are far less common: blood (red blood cells [RBC]/serum) accounts for 3 studies (5%), immune cells for 2 studies (4%), and both vascular/microvascular and endothelial cell models appear in only a single study each (2%). This stark disparity underscores a strong focus on brain-related models in lipid-raft investigations and highlights an opportunity to broaden experimental contexts by incorporating more diverse tissue types—particularly vascular, immune, and blood components—to fully elucidate lipid-raft functions across different biological systems.

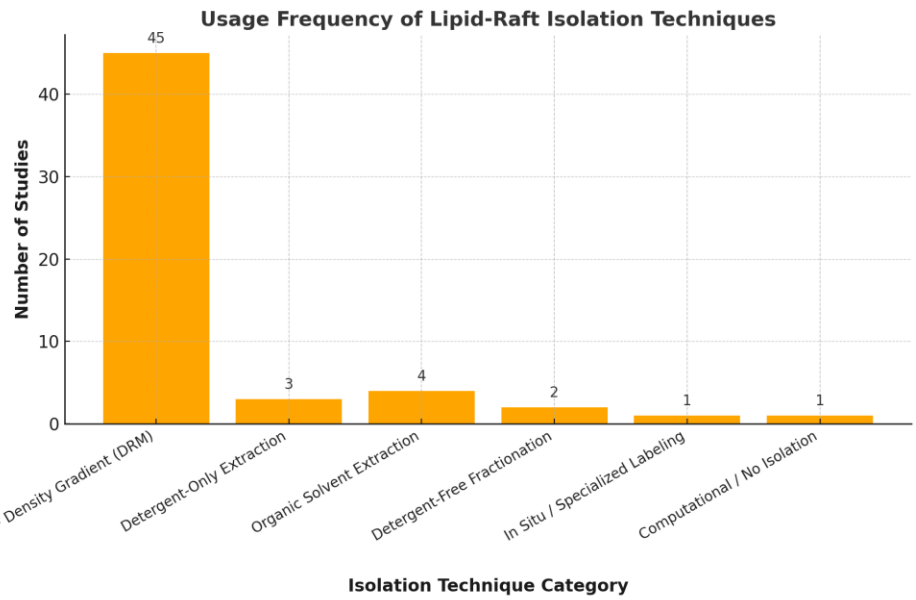
Figure 3. Distribution of Tissue Types in Lipid-Raft Studies. Bar heights indicate the number of published studies (total n = 56) employing each cell or tissue category to investigate lipid-raft biology.



Isolation Techniques

As seen in Figure 4, the predominance of the classic detergent-resistant membrane (DRM) approach—cold non-ionic detergent extraction followed by sucrose-density gradient ultracentrifugation—is striking, with 45 of 56 studies (80.4%) utilizing this method. In contrast, simpler detergent-only extractions (5.4%) and organic solvent (Folch/Bligh-and-Dyer) lipid extractions (7.1%) are far less common. Detergent-free fractionation techniques, designed to preserve native lipid–protein interactions, appear in only 3.6% of studies. Novel in situ or specialized labeling methods (e.g., enzyme-mediated activation of radical sources [EMARS], printed raft microarrays) and purely computational or non-isolation workflows each account for under 2% of the literature. This distribution underscores the field's heavy reliance on DRM protocols despite ongoing concerns about detergent artifacts, and it highlights opportunities to broaden methodological diversity by integrating detergent-free and in situ fractionation strategies.

Figure 4. Usage Frequency of Lipid-Raft Isolation Techniques. Bar heights represent the number of studies (total n = 56) employing each isolation strategy to enrich or analyze membrane microdomains.



Discussion

In this systematic review of 56 lipid-raft studies published between 2015 and 2024, three methodological dimensions—visualization techniques, tissue models, and isolation protocols—were quantified to reveal prevailing practices and under-explored avenues in the field.

Dominance of Biochemical Assays and DRM Isolation

Our analysis confirms a heavy reliance on biochemical and immunoassay approaches (48.2% of studies) and classical detergent-resistant membrane (DRM) protocols (80.4%). These methods offer robust, well-established workflows for detecting raft-associated proteins and lipids (e.g., Western blot, enzyme-linked immunosorbent assay [ELISA]) and for enriching raft fractions via cold Triton X-100 extraction followed by sucrose-gradient ultracentrifugation (Isolation Methods Mol Biol, 2021; Sezgin et al., 2017). However, the field's dependence on DRM raises concerns about detergent artifacts and the potential misclassification of non-raft components as rafts (Nishimura & Matsumori, 2020). Detergent-only extractions (5.4%) and organic solvent protocols (7.1%), while simpler, lack the fractionation specificity of gradient steps and are thus less informative for discrete raft analyses (Folch extraction; Casares et al., 2019).

Underuse of Detergent-Free and In Situ Techniques

Detergent-free fractionation (3.6%) and in situ labeling or microarray approaches (1.8%) remain rare despite offering more native preservation of lipid–protein interactions (emerging enzyme-mediated activation of radical sources [EMARS] labeling; Sezgin et al., 2017). Such methods circumvent the disruptive effects of detergents on membrane structure (Cohen & Shi, 2020) and could yield insights into raft size, lifetime, and dynamics in live cells (Sezgin et al., 2017; Yao et al., 2024). Expanding the use of detergent-free ultracentrifugation and proximity-based labeling (e.g., EMARS, correlative light and electron microscopy [CLEM]) would address long-standing questions about the true biophysical nature of rafts (Levental & Veatch, 2016; Nieto-Garai et al., 2022).

Visualization Method Biases and Opportunities

Biochemical assays also dominate visualization methods, yet offer only endpoint snapshots of raft composition. Microscopy and imaging techniques (21.4%), including super-resolution fluorescence, Förster resonance energy transfer (FRET), and matrix-assisted laser desorption/ionization imaging mass spectrometry (MALDI-IMS), provide spatial and temporal resolution critical for understanding raft dynamics (Shaw et al., 2021; Shi et al., 2018). Analytical-chemistry approaches (12.5%), such as liquid chromatography–tandem mass spectrometry (LC-MS/MS) and deuterium nuclear magnetic resonance (NMR), deliver detailed molecular profiles of raft lipids but often lack spatial context (Rafieiolhosseini & Ejtehadi, 2020; Raghunathan & Kenworthy, 2018). Integrating high-content lipidomics with live-cell imaging through correlative workflows could bridge molecular specificity with nanoscopic localization (Kageler et al., 2024; Liu & Afshar, 2020).

Predominance of CNS Models

An overwhelming 86.2% of studies employ central nervous system (CNS) tissues or neuronal/glial cultures, reflecting the high interest in raft roles in synaptic signaling and neurodegeneration (Raghunathan & Kenworthy, 2018; Sezgin et al., 2017). However, peripheral and non-neuronal systems—blood, immune, vascular, and endothelial models—are scarcely represented (<10% combined). Given that lipid rafts modulate immune-receptor clustering (Nieto-Garai et al., 2022), endothelial barrier function (Shenmai injection study, 2019), and viral entry (Front Cell Infect Microbiol, 2020), broadening tissue contexts will deepen our understanding of raft contributions across physiology and pathology.

By addressing these gaps, future lipid-raft research can overcome methodological biases, achieve a more holistic understanding of membrane microdomains, and harness raft biology for therapeutic innovation.

Table 1: Future Directions and Recommendations

Recommendation	Description	Key References
Adopt Detergent-Free & Correlative Methods	Employ detergent-free fractionation and in situ labeling (e.g., EMARS, microarray printing) combined with advanced imaging (CLEM, super-resolution) to validate raft identity under native conditions and avoid DRM artifacts.	Cohen & Shi, 2020; Dragvold et al., 2021; Honigmann & Pralle, 2016; Levental & Veatch, 2016; Sezgin et al., 2017
Integrate Multi-Modal Analyses	Pair MS-based lipidomics (LC-MS/MS, MALDI-IMS) with live-cell super-resolution imaging and proximity labeling (BioID, APEX) to link molecular composition with spatial and temporal raft dynamics.	Kageler et al., 2024; Raghunathan & Kenworthy, 2018; Sezgin et al., 2017; Shaw et al., 2021; Zhang et al., 2022
Diversify Tissue Models	Expand beyond CNS tissues to systematically include immune cells, vascular/endothelial systems, and blood (serum/RBC) models to uncover cell-type-specific raft functions and translational applications.	Levental & Veatch 2016; Liu et al. 2020; Miller et al. 2018; Nieto-Garai et al. 2022; Togo 2019
Standardized Reporting & Quantification	Develop community guidelines for isolation protocols (detergent vs. detergent-free), require reporting of raft yield/purity metrics, and include functional controls (e.g., cholesterol depletion) for reproducibility.	Honigmann & Pralle 2016; IUPAC Lipidomics Task Force 2022; Luk et al. 2021; Sezgin et al. 2017

Conclusion

This systematic analysis of 56 lipid-raft studies reveals a methodological landscape dominated by central nervous system (CNS)–derived models (86.2%) and classical detergent-resistant membrane (DRM) isolation (80.4%), with nearly half of all investigations relying on biochemical and immunoassay readouts. While these approaches have been instrumental in uncovering the roles of lipid rafts in synaptic transmission, receptor clustering, and signal transduction, their heavy reliance on detergents and narrow tissue contexts constrains our understanding of microdomain structure and dynamics—particularly in the diseased brain.

Neurodegenerative disorders such as Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis feature prominently in raft research, with alterations in amyloid-β processing, α-synuclein aggregation, and neuroinflammatory signaling documented across multiple studies. However, detergent artifacts may disrupt the native lipid–protein interactions that drive pathological oligomerization and mislocalization of critical proteins in these diseases. Moreover, the predominant use of neuronal and glial cultures, as well as post-mortem CNS tissues, leaves unaddressed the contributions of peripheral immune cells, vascular endothelium, and circulating lipoproteins to neurodegenerative cascades.

Embracing detergent-free fractionation and correlative imaging approaches—such as enzyme-mediated proximity labeling and correlative light and electron microscopy (CLEM) will be essential for capturing native raft assemblies that influence amyloid precursor protein processing and tau phosphorylation. Integrating mass spectrometry (MS)–based lipidomics with live-cell super-resolution microscopy and proximity-labeling techniques stands to map how shifts in lipid composition facilitate α-synuclein seed formation and inflammatory activation in microglia. Diversifying experimental models to include blood-derived immune cells and brain-barrier endothelial systems will illuminate how systemic lipid alterations and vascular dysfunction contribute to blood–brain barrier breakdown in Alzheimer's and Parkinson's pathology.

Finally, standardizing isolation protocols and reporting through quantitative metrics of raft yield, purity, and cholesterol dependency will enable reproducible, cross-study comparisons in both healthy and diseased tissues. By moving beyond detergent artifacts and expanding tissue contexts, lipid-raft research can achieve a more faithful, systems-level understanding of membrane microdomains. These advances will be critical for elucidating the biophysical and biochemical mechanisms that underlie neurodegenerative disease progression and for identifying raft-targeted strategies with therapeutic potential.

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Ivona Hlaj – Biology student
ivonahlaj@gmail.com
ORCID ID: 0009-0008-5515-5102

Sara Bonet – Medical student
sarabonet06@gmail.com
ORCID ID: 0009-0006-1686-5318

Prof.dr.sc. Marija Heffer – Full Professor
marija.heffer@gmail.com
ORCID ID: 0000-0001-6770-7359

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Functional Health Benefits of Spa Rehabilitation in Paediatric Asthma Patients

A Pilot Observational Study

Natália Plunárová
Faculty of Health Sciences,
University of Ss. Cyril and Methodius in Trnava

ABSTRACT

Bronchial asthma is a disease of civilization, the prevalence of which is increasing every year worldwide. For the long-term improvement of patients' quality of life, it is important to pay attention to rehabilitation, which brings a wide range of benefits.

The aim of the pilot study was to investigate the effect of a comprehensive 2-week spa rehabilitation including kinesiotherapy, respiratory physiotherapy, inhalation, physical therapy and climatotherapy on specific parameters representing the functional health status of 10 paediatric patients aged 6-9 years in the form of an observational study.

The results of spirometry show an improvement in vital lung capacity (FVC) by an average of 0.05 L (2.3%), $p < 0.05$ and forced expiratory volume in 1 second (Fev1) by 0.04 L (2.5%), $p < 0.05$. By measuring chest development, we demonstrated an increase in respiratory amplitude by an average of 0.4 cm ($p < 0.05$), the value of the lateral deviation of the chest during respiration decreased by 0.3 cm ($p < 0.05$), and the respiratory rate decreased by 0.8/min ($p < 0.05$). The mean score on the Asthma Control Test increased by 2.1 points ($p < 0.05$). When assessing overall physical fitness with the 6-min walk test, we observed an increase in distance walked by an average of 33.8 m ($p < 0.05$) and saturation increased by 0.8% ($p < 0.05$). Even the heart rate decreased by 0.3 bpm, but this measurement was statistically insignificant ($p > 0.05$).

The results of the measurements showed a positive effect of spa rehabilitation; therefore, we recommend spa rehabilitation for paediatric patients with asthma.

Keywords: Bronchial asthma, Children, Rehabilitation, Spa treatment

Introduction

Bronchial asthma is among the most common chronic non-communicable diseases worldwide. According to the Global Initiative for Asthma (2022), the condition affects approximately 300 million people globally, with an estimated average prevalence of clinical asthma in Europe of 18.2% (Weerakkody, 2023). Given that the incidence of this disease peaks before the age of five and continues to rise significantly each year on a global scale, it represents a substantial burden not only for the affected children but also for their families and healthcare systems. From a long-term perspective, it is essential to focus not only on pharmacological treatment but also on rehabilitation, which can extend beyond symptomatic relief to improve physical, psychological, and social aspects of health, thereby contributing to an overall enhancement of quality of life in paediatric patients (Mattiuzzi et al., 2019).

Rehabilitation in children with bronchial asthma generally involves a wide range of possible interventions, implemented either on an outpatient or inpatient basis. When selecting appropriate rehabilitative methods, it is important to consider the individual needs and characteristics of each child, as well as the context of their family environment.

A significant percentage of patients undergo rehabilitation on an outpatient basis, which is practical due to its proximity to the patient's home and the possibility of integrating therapy into everyday life. However, a notable drawback of this approach is the limited availability of rehabilitative methods and interventions. Since bronchial asthma is a lifelong condition, it is essential to prioritize approaches that amplify the positive effects of rehabilitation—such as spa-based therapy, which offers a combination of multiple proven methods.

Spa-based therapeutic rehabilitation is a set of healthcare interventions delivered in an inpatient setting, providing comprehensive rehabilitative care. It utilizes natural healing resources and favourable climatic conditions to restore lost or impaired functions resulting from illness, and to stabilize and support the recovery of the patient. This form of treatment has proven to be highly effective for patients with bronchial asthma, particularly due to its integrative nature and the possibility to apply a broad range of therapeutic interventions, including climatotherapy, kinesiotherapy, respiratory physiotherapy, physical therapy, and inhalation therapy (Jakubíková, 2019; Jandová, 2014). Research has demonstrated a direct link between reduced corticosteroid dosage required for asthma control and a decrease in cortisol levels associated with adrenal cortical suppression following spa treatment (Yokota et al., 2022).

A defining characteristic of spa rehabilitation, in addition to its comprehensive approach, is the incorporation of climatotherapy, which leverages natural climatic conditions to benefit the patient. In the context of Central Europe's geographic features, the primary modalities are aerotherapy (air therapy) and heliotherapy (sunlight therapy). For asthmatic patients, moderate cold air exposure under professional supervision is particularly suitable. This includes air baths, therapeutic outdoor physical exercise, terrain walking, outdoor sports activities, and sleeping in adapted outdoor environments. During climatotherapy, the organism is affected by changes in atmospheric pressure, air temperature, humidity, aerosol composition, and increased oxygen concentration, combined with physical activity in fresh air. This leads to enhanced alveolar ventilation and partial pressure of oxygen in the alveoli, thereby improving oxygen absorption into the bloodstream and enhancing internal respiration, ultimately optimizing breathing efficiency (Fieten et al., 2022; Hloušková & Spišák, 2021).

Halotherapy (salt room therapy) serves as a valuable adjunct treatment by reducing bronchial hyperresponsiveness and increasing the provocation threshold dose required to decrease FEV_1 (Hedman et al., 2006).

The rehabilitation plan also incorporates physical activity-based interventions, which reduce serum levels of inflammatory markers. Regular exercise contributes to increased resistance to IgE-mediated mechanisms, lowering levels of antigen-specific IgE in the bloodstream, which is one of the primary pathways toward improved pulmonary function (Panagiotou et al., 2020). The most common form of kinesiotherapy among paediatric asthma patients (58.3%) is aerobic endurance exercise, which improves cardiorespiratory fitness, enhances glucocorticoid receptor sensitivity, increases levels of anti-inflammatory cytokines, suppresses pro-inflammatory mediators, reduces ventilatory demand, and lowers muscle fatigue (Jiang et al., 2022, pp. 2915–2927). According to ATS/ERS guidelines for pulmonary rehabilitation, resistance training with emphasis on postural muscles is also recommended (Stanojevic et al., 2021).

A core component of spa rehabilitation for paediatric asthma patients is respiratory physiotherapy. This targets the airways therapeutically and primarily supports correct thoracic expansion during breathing across all chest segments, linking breathing to postural function (Máček & Smolíková, 2010). A significant positive effect on bronchial asthma has been documented with conditioning breathing exercises, inspiratory/expiratory muscle resistance training, respiratory gymnastics, airway drainage techniques, and the use of resistance-based breathing aids (Kolář et al., 2009). In spa rehabilitation settings, group-based conditioning, breathing gymnastics are frequently utilized (Neumannová et al., 2012). A notable technique is the pursed-lip breathing, involving a prolonged, intermittent exhalation through partially closed lips to generate resistance. This increases intrabronchial pressure, maintaining airway patency and helping prevent airway collapse during cough episodes, while also aiding in controlling dry, irritating cough (Máček & Smolíková, 2010). The huffing technique, which consists of forced exhalation through an open mouth, supports training of prolonged expiration and helps alleviate exertional dyspnoea. It includes two to three forceful expirations followed by relaxation of the respiratory muscles and controlled breathing. Manual chest stimulation may be applied concurrently to further promote maximal air expulsion and mucus mobilization (Felicio-Júnior et al., 2020; Lewis et al., 2012). The use of resistance devices contributes to the mobilization of both central and peripheral airways and facilitates mucus expectoration (Jendrichovský et al., 2020; Zdařilová et al., 2005). In asthma care, expiratory resistance trainers such as the Threshold PEP device—with adjustable resistance levels ranging from 5–20 cm H_2O (representing 30% of the patient's maximal oral pressure)—are commonly employed (Neumannová & Zatloukal, 2011).

Inhalation therapy is another essential part of spa rehabilitation, based on the direct inhalation of isotonic or hypotonic solutions. Inhaling mineral water one to two times daily for 15 minutes has demonstrated beneficial effects on bronchial hyperreactivity, alleviation of dry irritative cough, reduction of inflammatory parameters, and improvement in forced expiratory volume, as confirmed in a comprehensive meta-analysis by Fesyun et al. (2023). Oxygen therapy, which involves inhaling air enriched with a higher concentration of oxygen via oxygen masks or nasal cannula, improves oxygen delivery to body tissues. The humidified air from oxygenators moistens mucosal surfaces, reducing symptoms of dry cough and aiding mucus clearance (Bónová et al., 2021). However, oxygen therapy should only be used outside acute exacerbation phases of asthma and acute viral infections of the upper respiratory tract (Martinéz et al., 2019).

Electromagnetic therapy, a form of physical therapy, may be additionally integrated into the rehabilitation program for its anti-inflammatory, muscle-relaxing, vasodilatory, and secretolytic effects (Sadlonova et al., 2003). Infrared sauna sessions lasting 15 minutes have been shown to not only provide psychorelaxation but also reduce oxidative stress, a key pathogenic mechanism in inflammatory lung diseases. They also lower pulmonary congestion, thereby directly supporting improved pulmonary and tissue function (Kunutsor et al., 2021).

The vision of this study was to assess the impact of a comprehensive approach to paediatric patients, combining several proven and commonly used rehabilitation methods with the aim of enhancing their positive effect on the patient's health parameters and highlighting the potential of spa treatment in a mountainous environment as the most effective rehabilitation option due to its multifaceted nature.

The aim of this pilot study is to provide a complex overview of effective methods and The primary objective of this study was to evaluate the impact of a comprehensive two-week spa rehabilitation program on pulmonary function parameters, respiratory amplitude, lateral thoracic deviation during breathing, and respiratory rate in paediatric patients with bronchial asthma. Secondary objectives included assessing the effect of spa rehabilitation on asthma control and the overall physical fitness of the children.

Methods

The pilot study was conducted in the form of a prospective observational design, utilizing methods of measurement, evaluation, testing, and comparison.

Characteristics of the Study Sample

The sample consisted of 10 paediatric patients aged 6 to 9 years with a diagnosis of bronchial asthma, all of whom underwent spa-based treatment. The representation of boys and girls in the sample was balanced, and the selection of patients was purposive. A requirement for inclusion in the study group was ongoing pharmacological treatment for bronchial asthma for a minimum duration of one year. The legal guardians of the patients consented to participation in the rehabilitation process under the condition of anonymity. They were informed about the processing of data collected through examinations and the observation of their child and provided written consent for inclusion in the observational study for the purposes of this research. Patients who did not meet the inclusion criteria or did not agree to the use and sharing of data for the observational study were excluded. Basic demographic characteristics of the study participants are summarized in Table 1.

Table 1
Demographic data of paediatric patients involved in the study

Demographic data	Value
n	10
Age (years)	6 - 9
Mean age (± SD)	7.2 ± 1.15
Gender	5 boys (50%), 5 girls (50%)
Pharmacological asthma treatment	ongoing ≥ 1 year (100%)
Place of residence	Slovakia (100%)

Table Note: n = Number of patients

All patients underwent examinations and spa rehabilitation during the same period, in December 2022, and the subsequently collected data were processed statistically. All measurements, with the exception of the Asthma Control Test, were conducted as part of the initial and final examinations, with a two-week interval during which all patients followed the same rehabilitation protocol.

Methods of Objective Assessment

To objectively assess the impact of the applied methods and procedures on the parameters derived from the research hypotheses and to evaluate their effectiveness, the following examinations and tests were used. The parameters of functional lung capacity and forced expiratory volume in the first second were assessed using spirometry with the Bionet SpiroCare device, following the methodology outlined by Ayuk et al. (2017). The spirometry assessments were conducted in the early morning hours, after waking and before any demanding physical activity. Patients were instructed in advance, completed breathing exercises, and underwent a simulation of the examination to ensure the measured values were objective and reliable.

Respiratory amplitude, which indicates the extent of chest expansion during breathing, was determined by calculating the difference between chest circumference measured at maximal expiration and maximal inspiration at the xiphosternal level. We also measured the distances from the processus xiphoideus to a horizontally aligned spinous process on each side. By calculating the difference between these values, we obtained the measurement of lateral thoracic deviation during breathing. The measurements were performed in the morning, after waking and before undergoing rehabilitation, using a measuring tape (Janíková, 1998).

The frequency of spontaneous breathing was determined through visual assessment by counting the number of breaths over the course of one minute, without prior notification to the patient about the examination (Vahlkvist et al., 2023). During the measurement, the patient was not speaking or engaging in any physical activity. The impact on the periodicity and intensity of symptoms and asthma control was assessed using the standardized Asthma Control Test (Appendix A), which patients completed on the day of the initial examination.

For the follow-up assessment, patients were contacted four weeks after completing the spa rehabilitation program to complete the test again. In the Asthma Control Test, patients, together with their legal guardians, answered a total of seven multiple-choice questions. The first four questions were answered by the child, scoring 0 to 3 points per response depending on the selected option. The remaining three questions were answered by the parent, with responses scored from 0 to 5 points. The total score was then compared to a standardized scale to determine the level of asthma control. This score was also used to compare the results before and after the rehabilitation program in order to draw conclusions about the therapy's effectiveness on the patient (Crimi et al., 2020; Nathan et al., 2022).

The overall physical fitness of the patient was assessed using the 6-Minute Walk Test (6MWT). The suitability of this test for our purposes was described by Giannitsi et al. (2019). The test was conducted outdoors, following a warm-up session, under strict supervision to ensure adherence to test protocols, such as maintaining the designated walking path and complete avoidance of running. The measurements focused on the distance walked, along with the recording of average heart rate and oxygen saturation values using a finger pulse SMART oximeter.

The data recorded for each patient were entered into an examination protocol, and a summary of the initial and final measurements was compiled into working tables, which served as the basis for the calculation of descriptive statistics for each investigated parameter. These included the calculation of the arithmetic mean, range, variance, maximum, minimum, median, and standard deviation. A right-skewness normality test and the Gauss test were performed. Based on the data characteristics, a T-test was used to determine the level of statistical significance, with the alpha level (α) set at 0.05 (Tables 2–7). All statistical calculations and test results were obtained using functions in Microsoft Excel.

Interventional Methods and Procedures

All patients underwent inpatient rehabilitation according to a pre-established rehabilitation plan with uniform scope, intensity, and conditions. The rehabilitation plan included kinesitherapy once daily for 30 minutes. This alternated between aerobic endurance exercises, with a total of five sessions, and exercises aimed at strengthening postural muscles, the deep stabilization system, and corrective exercises for proper posture, also totalling five sessions. Respiratory physiotherapy was conducted once daily for 30 minutes and involved active exercises combined with controlled breathing, resistive breathing using a resistance trainer, and practice of prolonged exhalation and other breathing modulation techniques, with patients completing a total of ten sessions. Electrotherapy was applied once daily for 15 minutes on alternating days, alternating between diathermy using the Fysiopuls Automatic 11165 device and Bioptron PRO 1 biolamp therapy, with five sessions of each modality. Patients used an infrared sauna at 55°C twice weekly for 20 minutes, totalling four sessions. Climatic therapy in the form of salt chamber exposure was administered once daily for two sessions of 10 minutes each, totalling ten sessions. Patients also spent time in the mountain environment, located at an altitude of 955 m above sea level, once daily for a minimum of two hours, totalling fourteen sessions. Hydrokinesiotherapy, consisting of active water exercises and supervised swimming, was conducted once weekly for 45 minutes, totalling two sessions. The inhalation regimen included inhalation of isotonic saline solution once daily for 15 minutes, totalling ten sessions, followed by nasal rinsing and oxygen therapy with highly concentrated oxygen once daily for 20 minutes, also totalling ten sessions.

Results

The objective method used to evaluate the impact of rehabilitation on functional lung capacity and forced expiratory volume in the first second was spirometric examination.

Table 2
Measurement of Forced Vital Capacity (FVC) with % expression using spirometry

FVC (L)	x̄	R	s2	max	min	mdn	SD	p
initial data	2.01	1.35	0.14447	2.58	1.23	2	0.3801	
final data	2.06	1.44	0.17012	2.73	1.29	2.03	0.41246	
difference in values	0.05	0.09	- 0.02565	0.15	0.06	0.03	0.03237	0.012
FVC %								
initial data	78.9	15	27.49	87	72	78.5	5.24309	
final data	81.2	16	31.36	90	74	79.5	5.6	
difference in values	2.3	1	- 3.87	3	2	1	0.35691	0.0004

Table Note: x̄ = Mean, R = Range, s² = Variance, max = Maximum, min = Minimum, mdn = Median, SD = Standard Deviation, p = P-value, α = Significance Level

FVC: $p = 0.012 < \alpha = 0.05$
FVC %: $p = 0.0004 < \alpha = 0.05$

Table 2 presents the results of forced vital capacity (FVC) measurements in 10 patients. The FVC values at the final measurement ranged from 1.29 to 2.73 L, with a mean value of 2.06 L. Compared to the baseline values, which ranged from 1.23 to 2.58 L with a mean of 2.01 L, there was not only an increase in range by 0.09 L but also an increase in the mean value by 0.05 L. Expressed as a percentage, the mean value rose from 78.9% to 81.2%, representing a difference of 2.3%. The minimum value increased by 2%, and the maximum by 3%, reaching a level of 90%. The statistical significance was assessed using a T-test based on the data characteristics, yielding p-values of 0.012 for the absolute values and 0.0004 for the percentage values. With an α set at 0.05, these results are considered statistically significant. The upward trend in the measured values confirms that the implemented rehabilitation plan positively influenced the functional vital capacity of the lungs.

Table 3
Measurement of Forced Expiratory Volume in 1 second (FEV1) with % expression using spirometry

Fev1 (L)	x̄	R	s2	max	min	mdn	SD	p
initial data	1.97	1.41	0.1466	2.58	1.17	1.975	0,38289	
final data	2.01	1.47	0.16806	2.62	1.15	2	0,40995	
difference in values	0.04	0.06	- 0.02146	0.04	0.02	0.025	0,02706	0.01
Fev1 %								
initial data	87.9	20	40.29	98	78	89.5	6.34744	
final data	90.4	24	57.84	101	77	91	7.60526	
difference in values	2.5	4	-17.55	3	-1	1.5	1.25782	0.0043

Table Note: x̄ = Mean, R = Range, s² = Variance, max = Maximum, min = Minimum, mdn = Median, SD = Standard Deviation, p = P-value, α = Significance Level

Fev1: $p = 0.01 < \alpha = 0.05$
Fev1%: $p = 0.0043 < \alpha = 0.05$

Table 3 shows the results of forced expiratory volume in one second (FEV1) measurements from a sample of 10 patients. Following rehabilitation, the maximum value increased from 2.48 L to 2.62 L, with the highest measured value reaching 101%. Paradoxically, the minimum measured value decreased by 1%, from 1.17 L to 1.15 L. Despite this, the average measured value rose from an initial 1.97 L to 2.01 L, an increase of 0.04 L, corresponding to a 2.5% increase in percentage terms. The range of variation widened from 20% to 24%. Statistical significance was assessed using a T-test based on data characteristics, yielding p-values of 0.01 for absolute values and 0.0043 for percentage values. With an α level of 0.05, these results are considered statistically significant. Based on the significant increase in the average forced expiratory volume in one second and its comparison, the positive effect of spa rehabilitation on this parameter can be confirmed.

The impact of rehabilitation on respiratory amplitude and lateral chest deviation during breathing was assessed based on calculations from chest circumference measurements and selective measurements of individual sides. Simultaneously, changes in respiratory rate were also evaluated.

Table 4
Measurement of Chest circumference difference and Lateral deviation during chest expansion in breathing

Chest circumference difference (cm)	x̄	R	s2	max	min	mdn	SD	p
initial data	4.05	5	2.0725	7	2	4	1.43962	
final data	4.45	5.5	2.06612	7.5	2	4	1.58824	
difference in values	0.4	0.5	0.00639	0.5	0	0	0.14862	0.0054
Lateral deviation (cm)								
initial data	0.85	1.5	0.2525	1.5	0	1	0.5025	
final data	0.55	1	1.90083	1	0	0.75	0.4717	
difference in values	-0.3	-0.5	-1.64833	-0.5	0	-0.25	-0.0308	0.0119

Table Note: x̄ = Mean, R = Range, s^2 = Variance, max = Maximum, min = Minimum, mdn = Median, SD = Standard Deviation, p = P-value, α = Significance Level

Chest circumference difference: $p = 0.0054 < \alpha = 0.05$
Lateral deviation: $p = 0.0119 < \alpha = 0.05$

Table 4 presents the statistical analysis of the measured data for respiratory amplitude and lateral chest deviation in the patients. The respiratory amplitude values at baseline ranged from 2 to 7 cm, with a mean value of 4.05 cm. Post-rehabilitation values ranged from 2 to 7.5 cm, with a mean of 4.45 cm. The increase in the maximum measured value by 0.5 cm resulted in a corresponding expansion of the range by 0.5 cm. The increase in the mean value by 0.4 cm, along with the T-test result compared to the significance level α = 0.05, confirms the statistical significance of the observed data.

Lateral chest deviation at baseline was measured between 0 and 1.5 cm. Post-rehabilitation values ranged from 0 to 1 cm, thus reducing the variability of the measured data by 0.5 cm. The positive effect of the rehabilitation process on this parameter is primarily indicated by the decrease in the mean measured value from 0.85 cm to 0.55 cm, representing a difference of -0.3 cm. The measurement is considered statistically significant based on the T-test result of 0.0119 with an α set at 0.05.

Table 5
Measurement of Respiratory rate per minute

Respiratory rate (No./min)	x̄	R	s2	max	min	mdn	SD	p
initial data	19.6	9	9.04	25	16	19	3.00666	
final data	18.8	9	8.96	25	16	18	2.99332	
difference in values	-0.8	0	0.08	0	0	-1	-0.01333	0.0054

Table Note: x̄ = Mean, R = Range, s^2 = Variance, max = Maximum, min = Minimum, mdn = Median, SD = Standard Deviation, p = P-value, α = Significance Level

Respiratory rate: $p = 0.0054 < \alpha = 0.05$

Table 5 displays the statistically evaluated data on respiratory rate measured in the sample of 10 patients. Although the minimum (min = 16) and maximum (max = 25) values, along with the corresponding range, were identical in both baseline and post-rehabilitation assessments, differences in standard deviation led to variation in mean values. At baseline, the average number of breaths per minute was 19.6, while post-rehabilitation it decreased to 18.8 breaths per minute, representing an average reduction of 0.8 breaths per minute. Considering statistical significance with α = 0.05, these results are significant, confirming a decrease in respiratory rate as an effect of the rehabilitation program.

To assess the impact of rehabilitation on symptom intensity in paediatric patients and overall control of bronchial asthma symptoms, a standardized Asthma Control Test was employed.

Table 6
Evaluation of the total score in the Asthma Control Test (ACT)

Asthma Control Test (points)	x̄	R	s2	max	min	mdn	SD	p
initial data	15.4	7	6.44	19	12	15	2.53772	
final data	17.5	7	6.25	22	15	17	2.5	
difference in values	2.1	0	0.19	3	2	2	-0.03772	0.01

Table Note: x̄ = Mean, R = Range, s^2 = Variance, max = Maximum, min = Minimum, mdn = Median, SD = Standard Deviation, p = P-value, α = Significance Level

Asthma Control Test: $p = 0.01 < \alpha = 0.05$

Table 6 presents the evaluation of the Asthma Control Test from a sample of 10 patients. The scores obtained at baseline ranged from 12 to 19 points, with a mean value of 15.4 points, which, according to the standardized scale, corresponds to a category of poorly controlled asthma symptoms. In the post-rehabilitation assessment, the range of scores remained the same (R = 7) as at baseline; however, both the minimum and maximum values increased by exactly 3 points compared to the initial measurement. The average score post-rehabilitation was 17.5 points, representing an increase of 2.1 points from baseline. According to the scale, the achieved result of 17.5 points falls within the category of moderate disease control. Based on the established significance level of α = 0.05 and the T-test calculation, which is appropriate given the data type, the results can be considered statistically significant. The comparison of results confirms that patients subjectively assess their overall condition as improved following rehabilitation; the severity and intensity of symptoms are reduced, and the disease is perceived as less limiting in daily life. The increase in mean score reflects an improvement in asthma symptom control from the lowest to the moderate level, directly indicating enhanced management of bronchial asthma symptoms.

For the purpose of analysing the impact of rehabilitation on the overall physical fitness of patients, we utilized the 6-minute walk test. The test involved measuring the distance walked within a 6-minute time frame, while simultaneously recording the average heart rate and oxygen saturation during the walk.

Table 7
Measurement of distance, average heart rate, and oxygen saturation during the 6-Minute Walk Test (6MWT)

6MWT - distance (m)	x̄	R	s2	max	min	mdn	SD	p
initial data	522.5	166	3556.25	593	427	526.5	59.6343	
final data	556.3	180	3284.81	632	452	553.5	57.31326	
difference in values	33.8	14	271.44	39	25	27	-2.32104	0.0005
6MWT - heart rate (No.)								
initial data	124.3	14	17.81	131	117	125.5	4.22012	
final data	124	17	26.6	131	114	123	5.15752	
difference in values	-0.3	3	-8.79	0	-3	-2.5	0.93733	0.3137
6MWT - O2 saturation (%)								
initial data	96.1	4	1.89	98	94	96	1.37477	
final data	96.9	4	1.89	99	95	97	1.37477	
difference in values	0.8	0	0	1	1	1	0	0.0016

Table Note: x̄ = Mean, R = Range, s^2 = Variance, max = Maximum, min = Minimum, mdn = Median, SD = Standard Deviation, p = P-value, α = Significance Level

Distance: $p = 0.0005 < \alpha = 0.05$
Heart rate: $p = 0.3137 > \alpha = 0.05$
O2 saturation: $p = 0.0016 < \alpha = 0.05$

Table 7 presents the statistically processed results of the three examined parameters from the sample of 10 patients. During the initial test, patients walked a distance ranging from

427 to 593 meters, with an average of 522.5 m. The minimum distance in the post-rehabilitation test increased by 25 m to 452 m, and the maximum distance increased by 39 m to 632 m. The average distance improved by 33.8 m to 556.3 m. The significance level was set at $\alpha = 0.05$, and the T-test result of 0.0005 indicates that $p = 0.0005 < \alpha = 0.05$, allowing us to conclude that the measurement is statistically significant and that rehabilitation had a positive impact on walking distance.

Analysis of average heart rate showed that initial measurements ranged from 117 to 131 beats per minute, with an average of 124.3 bpm. Post-rehabilitation data ranged from 114 to 131 bpm, maintaining the same maximum and average values (rounded to whole numbers), while the minimum value decreased by 3 bpm. Given the T-test result of $p = 0.3137 > \alpha = 0.05$ and the unchanged average heart rate, we conclude that the observed values are not statistically significant, and rehabilitation did not have a positive effect on reducing heart rate.

Prior to rehabilitation, patients had an average oxygen saturation of 96.1% during the 6MWT. Both the minimum and maximum saturation values increased by 1% after therapy, while the range remained unchanged. The average saturation increased by 0.8% to 96.9%. Based on the $\alpha = 0.05$ and the T-test result of 0.0016, the measurement is statistically significant. Since the average saturation increased compared to the initial measurement, we conclude that rehabilitation had a positive effect on this parameter.

Discussion

The aim of our pilot study was to determine the impact of a comprehensive 2-week spa rehabilitation program on quality of life, pulmonary functional parameters, overall physical fitness, and improved asthma control in paediatric patients aged 6–9 years.

Bronchial asthma currently affects over 300 million people worldwide, ranking among the most common chronic non-communicable diseases. Wu et al. (2017) report that treatment in Western countries is often financially burdensome, ranging from £509 to £2281 annually per asthmatic patient, which becomes a significant economic strain in cases of long-term therapy. Given the anticipated increase in disease incidence in the coming years, it is crucial to thoroughly address this issue and employ not only pharmacological treatment, but also adjunctive therapies aimed at asthma prevention and control.

The vision of this study was to evaluate the impact of a comprehensive approach to paediatric patients that combines several previously validated and commonly used rehabilitation methods, with the aim of enhancing their positive effects on the patient's health parameters. Furthermore, the study sought to highlight the potential of spa treatment in mountainous environments as the most effective rehabilitation option, owing to its multifaceted nature.

Spa-based rehabilitation is well-known and relatively widespread in Central Europe, thanks to the favourable natural conditions found in these countries. In Slovakia alone, there are more than ten spa healthcare facilities for children, many of which focus—among other indications—on bronchial asthma and other respiratory diseases. These facilities provide a comprehensive approach and employ the same rehabilitation methods as those used in our study. This form of rehabilitation, delivered in spa settings, is fully covered by public health insurance once a year based on defined indication criteria, making it widely accessible to the general population. This accessibility underscores its great potential for the broader prevention and management of asthma, which is why greater attention should be devoted to this topic (Relaxos 2024).

A review of available online resources revealed no study that evaluates the impact of the same combination of rehabilitation methods and interventions on the identical set of functional health parameters most relevant to bronchial asthma—parameters that we selected as objective indicators in our study.

Numerous studies have investigated individual rehabilitation methods or, at most, a combination of two approaches, as described below. Independent of each other, these studies have confirmed the positive effects of such interventions in patients with bronchial asthma, which has led to their incorporation into clinical practice. While there is little doubt that their combination—as is the case in spa rehabilitation—yields additional benefits, we believe it is essential to validate this assumption through systematic research.

The presence of scientifically grounded evidence supporting the benefits of this comprehensive approach, which has been used in clinical practice for decades, is crucial for the following reasons:

1. To enable the objective classification of this form of rehabilitation as a verified and beneficial approach for asthmatic patients, rather than a treatment option based solely on long-standing tradition and experience.
2. To define clear health-related goals that can realistically be achieved through such rehabilitation programs.
3. To allow for evidence-based modifications of the rehabilitation plan (e.g., adjustments in the frequency or intensity of procedures, or the addition/removal of specific interventions) in order to achieve even better long-term outcomes on a global scale.
4. To raise greater awareness among the general population regarding the availability and benefits of this type of rehabilitation.

In our exploratory phase, we implemented a rehabilitation plan comprising multiple therapy types and procedures, including kinesitherapy, hydrokinesiotherapy, respiratory physiotherapy, inhalation therapy, and electrotherapy, with a key component being the high-altitude environment in which rehabilitation took place. Our study focused on the effects of rehabilitation on respiratory rate, chest expansion during breathing, pulmonary functional capacity, and forced expiratory volume.

As Szafraniec et al. (2016) emphasize, physiotherapy plays a pivotal role in treating asthmatic patients. A rehabilitation plan for asthmatic patients should always include aerobic and strength exercises within kinesitherapy, complemented by respiratory physiotherapy, which can be augmented with additional therapeutic methods. While positive effects can be expected from individual techniques, their combination is presumed to yield a greater beneficial outcome. Spa treatment offers a wide range of procedures, and an appropriate indication of these can lead to significant improvements in breathing and respiratory muscle function.

Szafraniec et al. (2016) observed asthmatic patients undergoing a three-week sanatorium rehabilitation program that included respiratory exercises, inhalation, magnetotherapy, Solux lamp irradiation, and massage. Based on reductions in heart rate, increased distance covered during the 6-minute walk test (6MWT), and patients' subjective reports of health improvement, they confirmed that the three-week rehabilitation increased exercise capacity and health-related self-assessment in asthma patients. For objective evaluation of therapy effects, many authors, including Szafraniec, use spirometry alongside the 6MWT due to its relevance, which we also adopted. Despite differences in treatment duration, our results closely mirrored this study, except for the heart rate reduction, where, although a decreasing trend in average values was observed, it did not reach statistical significance.
Tong et al. (2022) highlight the crucial role of environmental factors and suggest that the rising trend of asthma and other allergic diseases over recent decades is largely driven by environmental changes. They emphasize environmental modifications for asthma treatment and management, including allergen reduction in homes and elimination of irritants. They recommend therapy in modified environments, such as spa rehabilitation or high-altitude climatic therapy with lower air temperature, humidity, and reduced partial oxygen pressure. Our findings on the effectiveness of comprehensive inpatient therapy in a mid-altitude mountainous environment are supported by Müller et al. (2018), who reported significant improvements in FEV1 and 6MWT distance following twice-daily breathing exercises on outdoor terraces at moderate altitude (700–1000 m) combined with daily kinesitherapy. These results suggest that climatic effects present at moderate altitudes are beneficial in treating asthma patients. Our study, conducted at a spa located at approximately 1000 meters above sea level, yielded similarly positive spirometric outcomes.

Massimo et al. (2013) discussed climatic therapy as a suitable alternative to improve the quality of life and reduce medication doses. They reported that 94.1% of patients did not use steroid-containing inhalers one-month post-treatment. Our findings align with this, as asthma control tests indicated improved quality of life and symptom reduction, with most patients achieving moderate asthma control after rehabilitation.

Manshina (2019) advocates that in our climate, balneotherapy, hydrotherapy, inhalation of medicinal and mineral waters combined with respiratory techniques and manual therapy represent the most suitable rehabilitation alternatives for asthma patients. For optimal adaptation, Manshina recommends a treatment duration of 21–30 days. Although our rehabilitation lasted only 14 days, we achieved the expected positive outcomes, confirming therapeutic efficacy. Manshina emphasizes that non-pharmacological aerosol therapy with various mineral waters exerts both local and systemic anti-inflammatory effects, improving bronchial patency and patient adaptation. Significant reductions in cough, asthma attacks,

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and lung wheezing were observed early in treatment, which our asthma control tests also confirmed.

Respiratory physiotherapy was a key component of our rehabilitation plan. Jin et al. (2023), in a systematic review analysing 14 randomized controlled trials including 1401 paediatric asthma patients, reported that respiratory physiotherapy—encompassing breathing techniques, resistance breathing via trainers, and drainage positioning—improved overall asthma quality of life scores, 6MWT distance, and asthma control compared to controls. However, they found no direct impact on FEV1 or vital capacity. While we agree with the positive effects on quality of life and 6MWT, our results differ as we observed improvements in pulmonary functional parameters. This discrepancy is echoed by Jiang et al. (2022), who showed that interval training combined with respiratory exercises enhances pulmonary function and forced expiratory volume. The difference may arise because Jiang et al. included endurance training alongside respiratory therapy, suggesting that pulmonary parameter improvements require a multimodal approach. Our observational study supports this, as combining respiratory physiotherapy with additional techniques that yielded pulmonary function gains.

We concur with Jiang et al. (2022) that the most effective kinesiotherapeutic method for asthmatic patients combines endurance, breathing, resistance, strength, and interval training. Accordingly, we incorporated these modalities into our rehabilitation plan.

Oxygen therapy has gained prominence and is widely used across various diagnoses. High Flow Nasal Oxygen (HFO) delivers warmed and humidified air at high flow rates via nasal cannula. Mok et al. (2023) explain that HFO ensures consistent oxygen delivery, improves gas exchange efficiency by continuous CO2 clearance from airways, and normalizes abnormal breathing patterns observed in asthma patients. During exertion, this results in higher endurance, reduced dyspnoea, and better oxygen saturation compared to conventional oxygen supplementation. Our patients received oxygen therapy comparable to Mok and his colleagues' experimental group (2023). Although Mok et al. (2023) recommend a minimum 6-week oxygen therapy, we applied it for 2 weeks within a comprehensive rehabilitation program. Our observations corroborate improved oxygen saturation during walking; however, we cannot attribute saturation improvements solely to oxygen therapy, as we assessed the entire rehabilitation protocol's combined effect.

Sandell and Davies (2023) reported that sauna therapy transiently improves pulmonary function and breathing ease in patients who subjectively report easier breathing. They suggest including sauna sessions at least twice weekly, consistent with our patient regimen. Hloušková and Spišák (2021) propose Solux as a suitable alternative infrared therapy for asthmatics, providing controlled superficial or deep heating. They also highlight diathermy's deep thermal effects, raising tissue temperature without hyperaemia risk. Our clinical experience confirms positive patient tolerance and contribution to overall favourable outcomes.

The results of our pilot study are consistent with findings from previous studies and surveys that evaluated specific rehabilitation methods individually or in smaller combinations. Based on this observation, we advocate the view that by combining individually validated methods, spa treatment can achieve even more positive outcomes within a relatively short time frame.

Besides a properly structured rehabilitation plan, motivating patients to engage in regular physical activity is crucial. Del Giacco et al. (2015) classify sports by asthma exacerbation risk: low risk includes short-duration efforts (under 5–8 minutes) such as sprints, tennis, gymnastics, and martial arts; moderate risk encompasses team sports like football, basketball, volleyball, and handball; high risk involves prolonged effort over 8 minutes or exercise in cold/dry environments such as high-altitude sports, long-distance running, marathons, skiing, and ice hockey. Swimming is a special category, with debates over its benefits due to exercise type versus chlorine exposure as an irritant. Based on this classification, we advised patients on physical activity for long-term asthma control and quality of life improvement. Notably, studies show asthmatic athletes have won more Olympic medals than non-asthmatic counterparts, confirming they can compete at the same level (Fitch, 2012).

Conclusion

In this pilot study, we assessed the impact of a comprehensive rehabilitation program—comprising kinesitherapy, respiratory physiotherapy, climatotherapy, electrotherapy, and inhalation therapy—on paediatric patients with bronchial asthma. The observational study included patients who underwent institutional spa rehabilitation over a period of two weeks. The objective was to evaluate the effects on pulmonary functional parameters, the 6-minute walk test, asthma control test results, thoracic respiratory amplitude, lateral thoracic deviation during breathing, and respiratory rate. Based on the comparison of baseline and post-treatment values, we can confirm that the applied rehabilitation protocol positively influenced all measured parameters, except for heart rate, where changes were not statistically significant, as well as the patients' subjective perception of their health status.

A limitation of this observational study, which may affect the specificity and relevance of the results, is the relatively small sample size. With an increased number of participants, a narrower age range in inclusion criteria, and patient selection based on the regularity of physical activity, the outcomes of this study might differ. A comparative analysis of the effectiveness of outpatient versus inpatient spa rehabilitation could be a subject for future research.

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Natália Plunárová – Physiotherapy student
natalia.plunarova@gmail.com
ORCID ID: 0009-0001-0808-5761

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Details Matter

A Case Report of Unrecognized Multiple Sclerosis and Retinitis Pigmentosa

Sara Bonet[1]
Andrija Labaj[1]
Anamarija Soldo Koruga[1,2]

1: Faculty of Medicine Osijek, J. J. Strossmayer University of Osijek
2: Department of Neurology, University Hospital Center Osijek

ABSTRACT

Multiple sclerosis (MS) is an autoimmune neurodegenerative condition. While it may have a dramatic onset with affected vision, symptoms are not always that clear, leaving room for error and mistreatment.

In 2015, a 37-year-old woman, treated for hip arthrosis, cervicobrachial and lumbosacral syndrome for over 20 years, had noticed additional weakness in her right hand and leg. Analgetic therapy was adjusted, and she started physical therapy. A year later, she complained of left eye pain, poor night vision, and color vision deficiency, which was then recognized and treated as conjunctivitis. Her right-sided weakness suddenly progressed in the summer, along with dysphasia, raising suspicion of a cerebrovascular incident. One year after initial symptoms, the patient was admitted to the Neurology Department under suspicion of demyelinating disease. Relapsing-remitting MS (RRMS) was confirmed with magnetic resonance and complete analysis of serum and cerebrospinal fluid, but her visual symptoms were attributed to a separate condition – retinitis pigmentosa (RP). In 2018, the patient was started on pharmacotherapy for RRMS, and the RP diagnosis was genetically confirmed. Due to the worsening of symptoms, the patient eventually switched to ofatumumab.

Minor symptoms can sometimes indicate far more complex diseases, including multifactorial etiology. A thorough examination and well-constructed differential diagnosis aid early recognition and treatment.

Keywords: Multiple sclerosis, Ofatumumab, Retinitis pigmentosa, Case report

Introduction

Multiple sclerosis (MS) is a chronic autoimmune demyelinating disorder of the central nervous system that often presents with complex and fluctuating neurological symptoms, including visual disturbances. Optic neuritis, a hallmark feature of MS, can lead to transient vision loss, blurring, and pain, frequently resulting in the misattribution of other ocular pathologies to MS itself. This diagnostic bias may obscure coexisting conditions, particularly those with overlapping symptoms affecting the musculoskeletal and nervous system. Retinitis pigmentosa (RP), a hereditary retinal dystrophy characterized by progressive peripheral vision loss and night blindness, can be particularly challenging to identify in patients with MS due to shared visual impairments. When RP remains undiagnosed, its symptoms may be mistakenly attributed to MS-related optic neuropathy, delaying appropriate ophthalmologic evaluation and management. Recognizing the potential for such coexisting pathologies is critical in patients presenting with atypical or persistent visual symptoms. A multidisciplinary approach is essential to distinguish between demyelinating and degenerative retinal conditions.

Musculoskeletal Pain Syndromes

Musculoskeletal pain syndromes encompass disorders of muscles, bones, joints, tendons, and associated soft tissues, often manifesting with both nociceptive and neuropathic features (Morawik et al., 2025; Urits et al., 2019). Common examples include low back pain, fibromyalgia, osteoarthritis, tendinopathies, and radiculopathy (Kreiner et al., 2020; Treede et al., 2019). Low back pain alone affects an estimated 60–70 % of adults at some point in their lives, representing the leading cause of years lived with disability worldwide (Apeldoorn et al., 2024; Kreiner et al., 2020). Fibromyalgia prevalence is approximately 2 %, with a higher female predominance (Treede et al., 2019). Etiologies usually vary by syndrome and these include: mechanical overload and degeneration in cases of Intervertebral disc herniation, facet-joint arthropathy, and tendon microtears (Apeldoorn et al., 2024; Coker et al., 2024); central sensitization leading to widespread hyperalgesia, which is most significant in terms of fibromyalgia (Morawik et al., 2025; Treede et al., 2019); or radiculopathy, often from herniated discs, which induces inflammatory mediator release and ectopic neuronal firing (Peene et al., 2024). Risk factors include age > 50, obesity, physically demanding or sedentary occupations, prior injury, smoking, and psychosocial stressors (Kabeer et al., 2023; Kreiner et al., 2020). Preexisting conditions such as diabetes may predispose to tendinopathies and neuropathic pain components (Matthews et al., 2025). However, chronic pain syndromes can occur in younger patients without preexisting conditions or apparent causes and, therefore, should be meticulously assessed.

Pain is a result of activation of nociceptive fibers in the central nervous system. In terms of pathophysiology, structural changes often cause degenerative disc disease and osteoarthritis, which subsequently produce mechanical instability and local inflammation (Apeldoorn et al., 2024). Local and neuroinflammation is promoted by the release of cytokines (e.g., TNF-α, IL-1β). Uncontrolled cytokine release sensitizes peripheral nociceptors, and chronic input drives central sensitization (Morawik et al., 2025). In chronic pain, maladaptive synaptic changes in the dorsal horn and thalamocortical circuits sustain pain perception beyond tissue healing (Treede et al., 2019). Peripheral structures (intervertebral discs, facet joints, muscle fascia, tendons) are primary sources of pain syndromes, whereas central mechanisms involve the spinal cord dorsal horn and supraspinal pain networks (Coker et al., 2024; Morawik et al., 2025).

Symptoms range from localized aching to shooting, radiating pain with sensory disturbances. Low Back Pain is perceived as a dull or sharp lumbar ache, often worsened by movement. Radicular symptoms (sciatica) suggest nerve-root involvement and can be confirmed by a positive straight-leg-raise test and MRI (magnetic resonance imaging) if necessary (Apeldoorn et al., 2024; Kreiner et al., 2020). Diagnosis of fibromyalgia relies on the 2016 ACR (American College of Rheumatology) criteria. It is a widespread musculoskeletal pain with tender points, nonrestorative sleep, and cognitive “fog” (Treede et al., 2019). Osteoarthritis, a specific entity, refers to joint pain exacerbated by use, crepitus, and limited range of motion. In cases of osteoarthritis, radiographs reveal joint-space narrowing and osteophytes (Nalikashvili et al., 2024).

Electrodiagnostic studies, such as electromyoneurography, testing nerve conduction velocities, help distinguish radiculopathy from peripheral neuropathy. On the other hand, laboratory tests (e.g., inflammatory markers) and imaging (X-ray, MRI) exclude inflammatory arthritides and neoplasms (Coker et al., 2024; Matthews et al., 2025).

Musculoskeletal pain and chronic pain syndromes can be signs of complex underlying pathology and should be evaluated and treated accordingly. Symptoms can overlap and indicate multiple conditions, highlighting the importance of detailed differential diagnosis. Lumbar spinal stenosis is characterized by neurogenic claudication relieved by flexion (Apeldoorn et al., 2024). Peripheral neuropathies are associated with diabetes or toxic etiologies and should be assessed via nerve conduction studies (Matthews et al., 2025). Inflammatory arthritides, e.g., rheumatoid arthritis, are distinguished by serology (RF, anti-CCP) and synovial fluid analysis (Nalikashvili et al., 2024). In patients with deep joint pain (hip) aggravated by weight-bearing, avascular necrosis should be suspected and assessed by MRI (Matthews et al., 2025). Symptoms may vary from mild to more severe. Visual Analog Scale (VAS) is the tool used to assess pain intensity experienced by patients (Kreiner et al., 2020; Peene et al., 2024). One should keep in mind that severe, in particular, chronic pain may mask newly onset symptomatology and should therefore thoroughly and regularly reevaluate patients with chronic pain. However, repeated imaging is rarely justified and usually reserved for red-flag symptoms (e.g., neurologic deficit, infection) or poor clinical response (Kabeer et al., 2023).

When possible, pain and pain syndromes should be managed in a conservative manner. Education, exercise therapy, weight optimization, and non-steroidal anti-inflammatory drugs (NSAIDs) constitute first-line interventions (Apeldoorn et al., 2024; Coker et al., 2024). Upon consulting a physiatrist, physical modalities can be deemed adequate. Manual therapy, acupuncture, and transcutaneous electrical nerve stimulation (TENS) may provide symptomatic relief (Morawik et al., 2025). Pharmacotherapy of pain and pain syndromes consists of NSAIDs and/or acetaminophen for nociceptive pain, and duloxetine or pregabalin (Treede et al., 2019) aimed at the neuropathic component. More severe cases might benefit from interventional procedures such as epidural steroid injections for radicular pain or intra-articular viscosupplementation for osteoarthritis (Apeldoorn et al., 2024; Coker et al., 2024). Multimodal chronic pain management should be the treatment standard of future practice, including cognitive-behavioral therapy and interdisciplinary rehabilitation, which would address central sensitization (Morawik et al., 2025; Treede et al., 2019).

Multiple Sclerosis

Multiple sclerosis (MS) is a chronic, immune-mediated disease characterized by focal demyelination and axonal loss in the central nervous system (CNS; Travers, 2022; Ward, 2022). Global prevalence estimates range from 30–300 per 100 000 population, and recent meta-analyses report a pooled prevalence of 143 per 100 000 (Minutti-Zanella et al., 2022; Ward, 2022). Women are affected approximately three times more than men (Pérez et al., 2023). Disease onset most commonly occurs between ages 20–40 years (Hauser et al., 2023; Kister & Bacon, 2020). MS etiology reflects a polygenic predisposition, considering HLA (Human leukocyte antigen) genes. However, multiple environmental modulators such as vitamin D deficiency, smoking, Epstein–Barr virus, and gut-microbiome dysbiosis were recognized as contributing to MS pathogenesis (Bar-Or, 2021; Hauser et al., 2023). A 2024 cohort study identified reduced *Faecalibacterium prausnitzii* and increased *Akkermansia* in early MS patients, linking microbiota shifts to peripheral immune activation (Aliyu et al., 2024).

In terms of pathophysiology, autoreactive $CD4^{+}$ and $CD8^{+}$ T lymphocytes, along with B-cell aggregates, breach the blood–brain barrier, initiating myelin damage. Activated microglia propagate chronic neurodegeneration, with cortical and deep-gray-matter atrophy, correlating with disability (Pérez et al., 2023; Samjoo et al., 2021, 2023). Areas of myelin damage are seen as T2 hyperintense signal lesions in magnetic resonance imaging (MRI). Lesions concentrate in the periventricular white matter, optic nerves, brainstem, cerebellar peduncles, and the spinal cord's dorsal columns (Inojosa et al., 2020; Yamout et al., 2024).

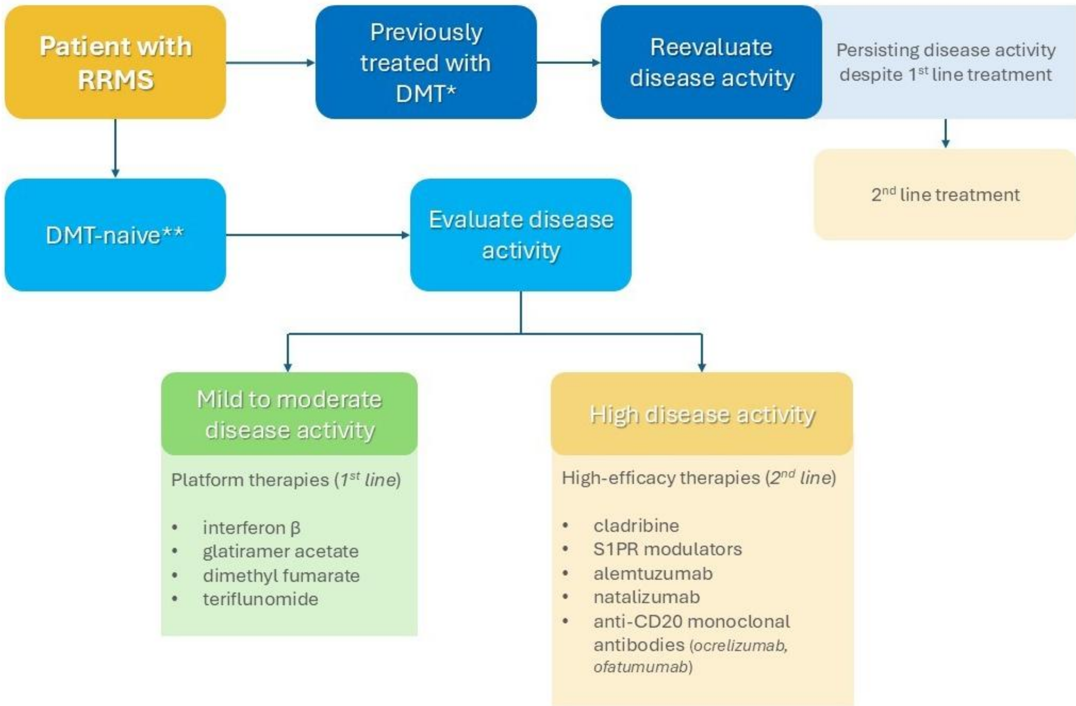
The 2017 McDonald criteria require dissemination in space (DIS) and time (DIT) via clinical attacks, MRI (T2 hyperintense and gadolinium-enhancing lesions), and cerebrospinal fluid oligoclonal bands to confirm MS diagnosis (Lublin et al., 2022; Pérez et al., 2023). Optic neuritis, characterized by subacute vision loss and retro-orbital pain, is often the inaugural manifestation. Sensory symptoms, such as numbness or Lhermitte's sign (a transient sensation of an electric shock that extends down the spine and extremities upon flexion and/or movement of the neck), may show a delayed onset (Kister & Bacon, 2020; Travers, 2022). Common symptoms include fatigue, motor weakness, spasticity, ataxia, sensory disturbances, and bladder or bowel dysfunction. Relapsing symptoms may remit partially or completely, whereas progressive forms display steady decline without clear attacks (Samjoo et al., 2023; Travers, 2022).

Considering symptoms and disease progression, there are four main MS phenotypes. Clinically isolated syndrome (CIS) refers to a single demyelinating event not yet fulfilling full MS criteria (Yamout et al., 2024). Relapsing–remitting MS (RRMS) is characterized by discrete clinical relapses followed by full or partial recovery. Approx. 85% cases are of this phenotype at the time of disease onset (Lublin et al., 2022; Travers, 2022). Secondary progressive MS (SPMS) shows an initial RRMS course with subsequent continuous neurologic decline, with or without superimposed relapses (Inojosa et al., 2020; Minutti-Zanella et al., 2022). On the other hand, primary progressive MS (PPMS) has a gradual progression from onset without distinct relapses and constitutes only 10–15 % of MS cases (Hauser et al., 2023; Ward, 2022).

Due to musculoskeletal and sensory symptoms, patients with MS are often faced with functional loss. To adequately quantify and monitor disability in these patients, the Expanded Disability Status Scale (EDSS) and Multiple Sclerosis Functional Composite (MSFC) are used (Inojosa et al., 2020). Annual or as-needed MRI tracks new or enlarging lesions and brain atrophy (Yamout et al., 2024). Most recently, serum neurofilament light chain, a marker of neuroaxonal damage, shows promise for monitoring subclinical activity (Bar-Or, 2021).

Depending on phenotype and symptom progression, and current disease status, patients' therapy may vary. Acute Relapse is treated with intravenous pulse corticosteroid therapy. High-dose intravenous methylprednisolone accelerates recovery (Travers, 2022). Long-term therapeutic options are disease-modifying therapies (DMTs). First-line options, such as interferon-β, glatiramer acetate, and teriflunomide, are of moderate efficacy (Hauser et al., 2023). When first-line therapeutics no longer present an adequate choice, patients are indicated for second-line therapy of high efficacy. This includes natalizumab, ocrelizumab, and alemtuzumab. Second-line therapy is reserved for highly active disease or poor prognostic indicators (Lublin et al., 2022; Samjoo et al., 2023). A combination of therapeutics may be required in most MS phenotypes, including RRMS, as shown in Figure 1. Early initiation of high-efficacy DMT is recommended for young patients with high lesion burden or rapid progression of disability scores. Optimal therapy choice should balance efficacy, safety, comorbidity profile, and patient preference (Hauser et al., 2023; Pérez et al., 2023). Other than disease-targeting therapies, supportive therapies are of great importance, often helping in alleviating patients' symptoms and disability. This includes physical therapy, spasticity management (e.g., baclofen), fatigue mitigation programs, cognitive rehabilitation, and vitamin D supplementation (Samjoo et al., 2020).

Figure 1. Treatment options for patients with relapsing-remitting multiple sclerosis (RRMS). *disease-modifying therapy; **patients who haven't been treated with disease-modifying therapy



Retinitis Pigmentosa

Retinitis pigmentosa (RP) comprises a group of inherited retinal dystrophies characterized by progressive loss of photoreceptors and retinal pigment epithelium (RPE) dysfunction, leading to visual field constriction and eventual central vision impairment (Liu et al., 2022; Vingolo et al., 2024). The overall prevalence is approximately 1 in 4 000 individuals worldwide, with no marked sex or ethnic predilection (Tsang & Smith, 2018; Wang et al., 2023). RP is predominantly genetic, with mutations in over 80 genes identified to date. Inheritance patterns include autosomal-recessive (50–60 %), autosomal-dominant (30–40 %), and X-linked (10 %) forms (Liu et al., 2022; Tsang & Smith, 2018). Key genes implicated are *RHO*, *USH2A*, and *RPGR*. Modifier factors such as oxidative stress and inflammation may accelerate photoreceptor apoptosis, though non-genetic risk factors are not well defined (Song et al., 2023).

Rod photoreceptors are affected first, resulting in nyctalopia. Subsequent cone degeneration leads to peripheral visual field loss ("tunnel vision") and eventual macular involvement with central acuity decline (O'Neal et al., 2025; Song et al., 2023). Mutant proteins disrupt phototransduction and RPE phagocytosis, prompting chronic microglial activation and apoptotic signaling cascades within the outer nuclear layer (Liu et al., 2022; Song et al., 2023).

Although the retina is an extension of the CNS, RP pathology localizes to the photoreceptor layer and RPE, particularly in the mid-peripheral retina (Wang et al., 2023).
RP subtypes are classified by inheritance pattern (autosomal-dominant, autosomal-recessive, X-linked) and by syndromic versus non-syndromic presentation. Syndromic forms include Usher syndrome (RP with sensorineural hearing loss) and Bardet–Biedl syndrome (RP with obesity, polydactyly, and renal anomalies; Abel et al., 2019; Tsang & Smith, 2018). Age at onset and progression rate also inform subclassification.

Diagnosis integrates ophthalmic examination and adjunctive testing. Fundoscopy shows characteristic bone-spicule pigmentation, attenuated arterioles, and waxy optic disc pallor (Vingolo et al., 2024). Electroretinography (ERG) can aid in diagnosis by markedly reduced scotopic (rod) responses, though photopic (cone) changes appear later (Liu et al., 2022). Optical coherence tomography (OCT) shows thinning of the outer nuclear layer and ellipsoid zone disruption (O'Neal et al., 2025). However definitive diagnosis is reached by genetic testing, which confirms causative mutations in known RP genes (Tsang & Smith, 2018).

Nyctalopia (night blindness) in adolescence or early adulthood is often the first symptom (Wang et al., 2023). Early disease manifests as difficulty seeing in low light and delayed dark adaptation. Over years to decades, peripheral field constriction progresses centripetally, producing "tunnel vision"; central acuity is typically preserved until late stages (O'Neal et al., 2025; Song et al., 2023). X-linked RP shows more rapid deterioration, often reaching legal blindness by the fourth decade (Tsang & Smith, 2018).

Retinitis pigmentosa currently has no cure. Management centers on slowing progression and maximizing remaining vision. Vitamin A Palmitate modestly slows rod degeneration in selected genotypes, though long-term safety requires monitoring (Liu et al., 2022). Antioxidant and neuroprotective therapies are currently under investigation to mitigate oxidative damage (Vingolo et al., 2024). Low-vision rehabilitation includes visual aids, orientation, and mobility training (Abel et al., 2019). Most recently, there are two emerging interventions. Gene therapy holds great potential. RPE65 gene replacement is approved, with trials ongoing for other targets (Vingolo et al., 2024). On the other hand, optogenetics and retinal prostheses aim to restore light sensitivity in advanced disease (O'Neal et al., 2025).

Conditions with overlapping presentations include cone–rod dystrophy (earlier central vision loss), vitamin A deficiency retinopathy, paraneoplastic retinopathy, and glaucoma (Abel et al., 2019; Liu et al., 2022). Syndromic associations (e.g., Usher syndrome) warrant audiologic and systemic evaluation (Tsang & Smith, 2018). Although rare, RP should be excluded in patients with unclear visual impairments.

Case presentation

We present a patient who, at the age of 37, developed weakness in her right arm and felt that her right leg had severely weakened, despite walking with crutches. For the past 20 years, the patient has been treated and monitored by a physiatrist and an orthopedist for aseptic necrosis of the hip and chronic cervicobrachial and lumbosacral syndrome. The patient had no other serious illnesses in her personal history, and her family history was not significant. Due to previously verified chronic pain syndromes, the patient was using non-steroidal anti-inflammatory drugs for analgesia pro re nata. Due to subjectively described symptoms of right-sided weakness, the patient was examined by a physiatrist in 2015, who verified weakness in her right arm in the anti-gravity position and noted that the patient could barely lift her right leg off the ground. The dose of analgesics was adjusted, and the

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general practitioner recommended parenteral dexamethasone along with analgesics for several days. Physical therapy for cervicobrachial and lumbosacral syndrome was initiated. A year later, in April, the patient noticed color vision deficiency in her left eye and complained of pain in the same eye. She was examined by an ophthalmologist and was diagnosed with conjunctivitis and treated accordingly. During the examination, the patient reported that she had poor night vision, which posed a significant difficulty for her and limited her movement. However, these symptoms were not further assessed, but were instead attributed to acute conjunctivitis, so the patient was not referred for additional treatment.

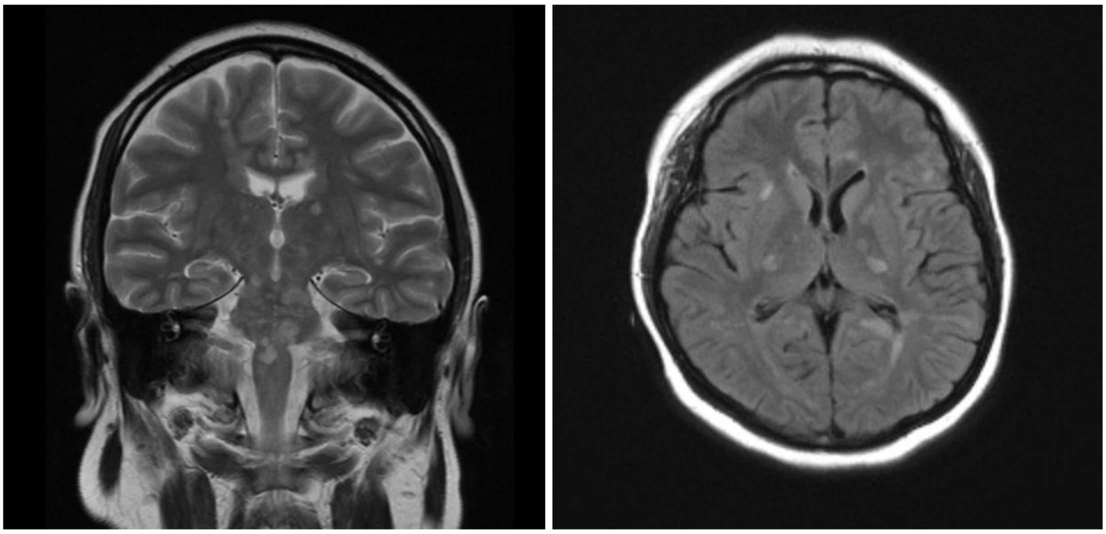
In August of the same year, during her vacation, the patient developed dysphasia and experienced sudden progression of weakness in her right extremities. The patient was then hospitalized under suspicion of an acute cerebrovascular accident and evaluated by a neurologist. A brain CT scan (computed tomography scan) performed at the time did not show signs of cerebrovascular accident and provided no explanation of the patient's symptoms. However, the patient was advised to continue further assessment and treatment by a neurologist after returning to her residence.

A month later, in September 2016, as advised, the patient reported for the examination to the neurologist at the Clinical Hospital Center Osijek. The patient was then admitted to the day hospital (partial hospitalization program) of the Clinic for Neurology for additional diagnostic processing, in order to confirm or rule out the suspicion of demyelinating disease of the central nervous system. Magnetic resonance imaging (MRI) of the brain, orbits, and cervical medulla was performed. The initial brain MRI findings (October 2016), seen in Figure 1., showed multiple zones of T2 increased signal intensity in the cerebellum, primarily in the peduncles with the largest diameter up to 9 mm on both sides, and in the brainstem, primarily in the pons and medulla oblongata. In the supratentorial paraventricular area, in the white matter of the hemispheres, and in the temporal subcortical area on the left side, several T2 signal hyperintensities were visible. Changes of the same characteristics were found both infratentorially and in the brainstem. On sections through the orbital region, there were smaller zones of discrete T2 signal hyperintensity in the area of the left optic nerve. These changes most likely correspond to earlier optic neuritis. The spinal cord was of appropriate dimensions. In the cervical medulla at the C IV level, on the left side, a dorsolateral T2 hyperintensity signal with a diameter of up to about 9 mm was visible. Most of the aforementioned lesions supratentorially and infratentorially, as well as lesions in the brainstem (medulla oblongata and pons), were imbibed with postcontrast agent, i.e., they showed signs of activity.

Complete laboratory processing of serum and cerebrospinal fluid confirmed positive oligoclonal zones. Other causes of the previously described demyelinating lesions were excluded. Additionally, testing of evoked potentials was performed, the pathological findings of which also confirmed the suspicion of demyelinating disease. Considering the results of the complete processing and the patient's previous symptoms, in 2017, the diagnosis of multiple sclerosis, relapsing-remitting type (RRMS), was made.

Due to the radiological signs of optic neuritis and earlier ophthalmological symptoms of unclear etiology, the patient was referred to a neuro-ophthalmologist for evaluation. After the examination, the neuro-ophthalmologist verified the sequelae of previously healed optic neuritis. Furthermore, given the reduction of the peripheral field of vision and impaired night vision, as well as the pathology verified during the examination, retinitis pigmentosa was suspected. The patient was sent for genetic testing to confirm the diagnosis. A year later, a mutation of the RDS gene (retinal degeneration slow gene, also known as PRPH2) was found, and the diagnosis of retinitis pigmentosa, autosomal dominant type RP7, was confirmed.

Figure 2. Magnetic resonance imaging (MRI) of the brain, T2 and FLAIR, showing multiple zones of T2 increased signal intensity, primarily in the pons and medulla oblongata, as well as in supratentorial paraventricular and subcortical areas.



In the meantime, the patient underwent hip surgery in 2017, and a total endoprosthesis of the right hip was implanted. In January 2018, 3 years after her initial symptoms, pharmacological treatment of relapsing-remitting multiple sclerosis with glatiramer acetate was started. At that moment, considering the symptoms and preservation of functions, the patient's initial EDSS was 3.0. Until October 2022, the patient had an inpatient EDSS score of 3.0 (pyramidal functional score 3 due to mild to moderate hemiparesis, fully ambulatory; able to walk >500 meters without aid/rest). There was no aggravation of symptoms, and the control MRI evaluation did not indicate disease activity. Relapse of the disease has not been clinically observed with the continuous glatiramer acetate therapy.

In the period from July 2022 to March 2023, a control MRI of the brain was performed, and the progression of the disease was observed. Three new infratentorial lesions and two new lesions in the area of the cervical medulla oblongata were verified. In November 2022, April 2023, and August 2023, the patient was treated with pulse corticosteroid therapy. An increase in EDSS of 1.5 to 2 points was recorded during the relapse, in the pyramidal functional system and the brainstem system. Glatiramer acetate therapy was continued. As part of regular monitoring, a complete ophthalmological control work-up was also performed. Given the clinically and radiologically verified disease activity, the patient was indicated to start treatment with the second-line therapy for the treatment of relapsing-remitting multiple sclerosis. The patient was presented with the therapeutic options, methods of administration, and expected effects as well as possible side effects of individual options, after which the decision was made to start treatment with ofatumumab. Treatment with ofatumumab was started in November 2023, after which the patient was stable and is regularly monitored for continuous evaluation of symptoms and treatment success.

Discussion

This case presents a rare example of RRMS in a patient with previously undiagnosed retinitis pigmentosa (RP). MS symptoms were subtle, masked by chronic pain syndromes, and inadequately evaluated. The delayed recognition of RP highlights the complexity of overlapping neurodegenerative and retinal disorders and underscores the importance of thorough ophthalmological and neurological assessments. Although optic neuritis is a well-established manifestation of RRMS, it may obscure underlying retinal pathology such as RP, especially when visual symptoms persist or progress atypically. A lack of reported cases of co-existing RP and RRMS suggests this association is rare and possibly coincidental, though a shared underlying mechanism cannot be excluded. In this patient, prolonged visual disturbances were initially attributed to conjunctivitis and later observed as optic neuritis. Only when visual field narrowing became pronounced and night blindness was reported, the patient underwent an ophthalmological re-evaluation, leading to the RP diagnosis. This delay reflects a diagnostic bias where known neurological conditions may overshadow additional retinal diseases.

While MS is a demyelinating autoimmune disease and RP is a hereditary retinal dystrophy, some studies suggest that mitochondrial dysfunction and inflammatory pathways may play roles in both. However, no definitive pathogenic link has been established yet. A study published in *Neurology* assessed retinal structures as potential indicators of axonal loss in benign multiple sclerosis (BMS) and RRMS. Using spectral-domain optical coherence tomography (OCT), the study found that both BMS and RRMS patients exhibited significant thinning of the retinal nerve fiber layer (RNFL) and reductions in total macular volume (TMV) compared to healthy controls. These findings suggest that retinal alterations are present in RRMS and may serve as biomarkers for disease progression (Razmjou et al., 2017).

Another prospective study investigated the rate of retinal atrophy over time in RRMS patients undergoing various disease-modifying therapies. The study utilized OCT to measure peripapillary RNFL and ganglion cell/inner plexiform layer (GC-IPL) thickness at baseline and every six months. Results indicated that the history of optic neuritis was associated with lower baseline GC-IPL thickness, and higher baseline GC-IPL thickness was linked to increased rates of GC-IPL thinning. These findings underscore the importance of monitoring retinal changes in RRMS patients, particularly those with a history of optic neuritis (Kabanovski et al., 2023).

In some cases, RRMS and RP can be observed in relation to a single syndrome. The Flammer syndrome (FS) refers to the phenotype with a predisposition for an altered vascular and microvascular reaction to stimuli like coldness or emotional stress. (Vahedian et al., 2017). FS seemed to increase the risk for certain eye diseases, and hereditary diseases, such as Leber's optic neuropathy or retinitis pigmentosa, were also associated with FS. Moreover, FS symptoms and signs occurred more frequently in patients with multiple sclerosis (Flammer & Konieczka, 2017).

Although the shared etiology of RP and RRMS remains unclear, RRMS might be related to mitochondrial dysfunction. A study from 2023 found that mtDNA copy number could serve as a marker of severe disability in MS patients (López-Armas et al., 2023). The retina's susceptibility to oxidative stress can impair mitochondrial function, leading to photoreceptor cell death. Autophagy might be crucial in maintaining retinal homeostasis and suggests that its dysregulation contributes to RP progression (Moreno et al., 2018).

While these studies do not establish a direct connection between RRMS and RP, they highlight the significance of retinal assessments in RRMS patients. Given the overlapping retinal changes observed in RRMS and the characteristic retinal degeneration in RP, comprehensive ophthalmologic evaluations may be beneficial for RRMS patients presenting with atypical visual symptoms.

Conclusion

This case emphasizes the importance of thorough evaluation of symptoms even in chronic patients, as well as not attributing all visual disturbances in MS patients to optic neuritis without thorough ophthalmologic evaluation, especially in the presence of progressive symptoms or night vision impairment. Early involvement of a neuro-ophthalmologist and use of electroretinography (ERG) or OCT may facilitate earlier RP detection. Further research into possible associations between demyelinating and retinal degenerative conditions may clarify whether co-occurrence is more than coincidental. In conclusion, this case of co-existing RRMS and undiagnosed RP underscores the necessity for comprehensive visual assessment in patients with neurological disease, especially when symptoms deviate from typical patterns. While a causal link between the two conditions remains unproven, their overlap may lead to misdiagnosis or delayed intervention. Clinicians should maintain a high index of suspicion for additional pathology when managing complex visual symptoms in MS patients, as well as in chronic pain syndromes and newly onset progression of symptoms.

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Sara Bonet – Medical student
sara.bonet06@gmail.com
ORCID ID: 0009-0006-1686-5318

Andrija Labaj – Medical student

Anamarija Soldo Koruga – Specialist in Neurology
anamarijasoldo@gmail.com
ORCID ID: 0000-0003-3375-547X

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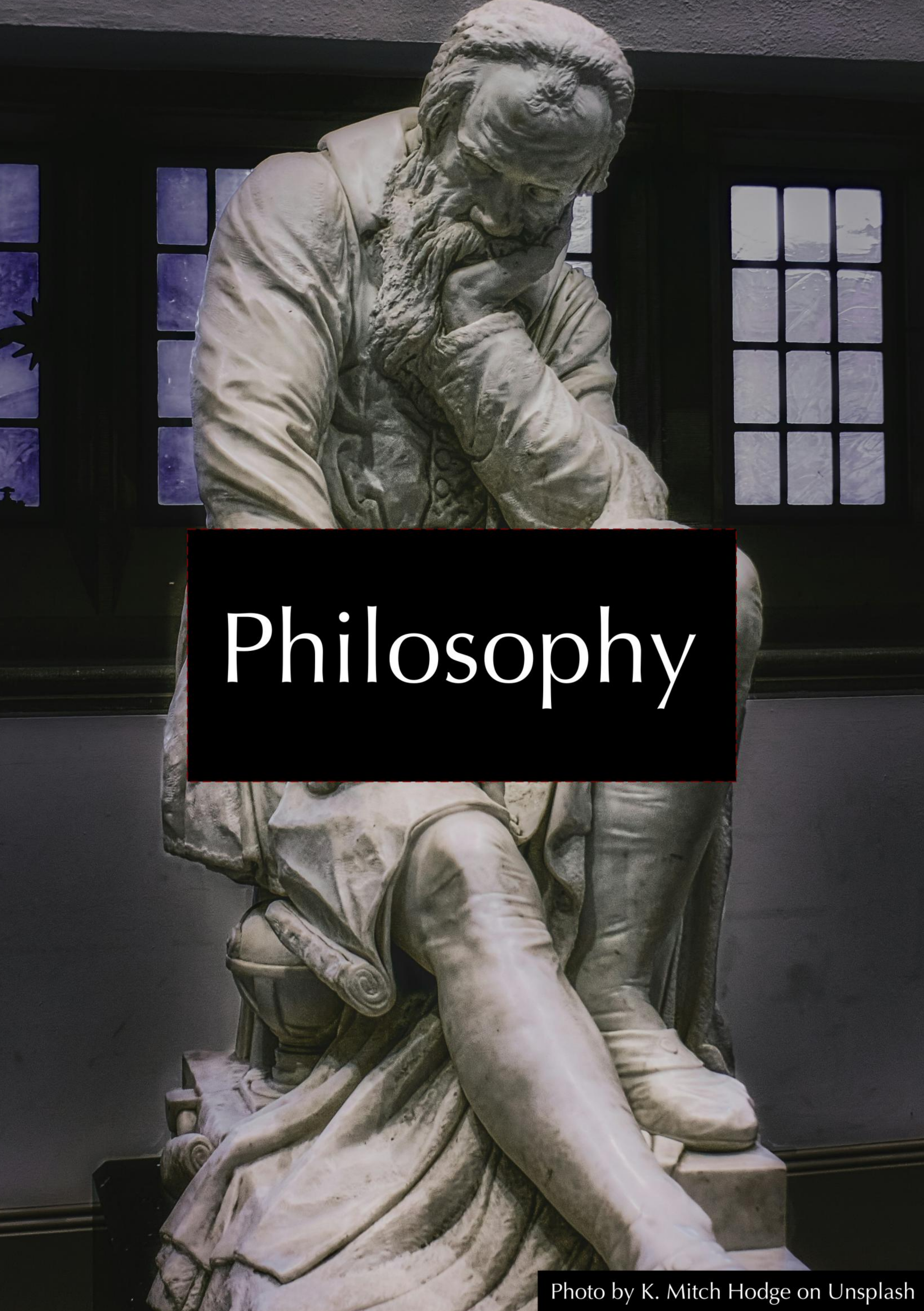

Philosophy

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An outline of the development of Heidegger’s view of science

Marián Ambrozy
Institute of Technology and Business in Prešov

ABSTRACT

The paper is a reflection on the question of whether there is continuity within Heidegger’s work in his conception of science. I take the view that science is the topic in which Heidegger’s philosophizing shows the least divergence during his active philosophical activity. I gradually analyze Heidegger’s seminal texts in which there are a number of references, reflections, and allusions to the theme of science. I have gone through selected texts both after the turn and before the turn. The study is, among other things, an attempt to refute the oft-pertracted claim that Heidegger can be considered an anti-scientific philosopher. I believe that the main differences in Heidegger lie in the different grasp of the meaning of philosophy or thinking after the turn. The common features lie above all in the retention of a critical view of science, in Heidegger’s unflagging interest in the subject of science, in his understanding of science as a mathematical science, and in his critique of mediation in science. I think that the field of science is a topic in Heidegger in which his thought shows signs of continuity.

Keywords: science, philosophy, thinking, Heidegger, Turn

Martin Heidegger can rightly be regarded as an inspiring philosopher. He is very often praised as an existentialist. This, too, is one aspect of his extensive work. Existentialism can only be attributed to Heidegger in a roundabout way. Heidegger did not take the positions mentioned after him. He oriented himself differently, above all by ceasing to be interested in topics that tend towards existentialism. Heidegger does mention existence after the turn, but it is the naming of the process in which the essence arises before man. What changes is the view of philosophy, which is replaced by thinking. A number of changes in Heidegger’s thought take place. One can speak of a rather different approach in many aspects of philosophical topics. Is there anything left in common in which continuity can be seen?

I believe it is Heidegger’s philosophy of science. This one, in our view, shows signs of continuity. We will try to defend the thesis that the Czech philosopher Kružíková was the first one to protract. This philosopher speaks of a certain degree of continuity between Heidegger before the turn and after the turn. This is preserved in part in Heidegger’s interest in the subject of science. Heidegger writes on this topic virtually throughout his life. In her pioneering work Heidegger’s Conception of Science, Kružíková argues that Heidegger did not transform his view of science during his lifetime. One cannot speak of any significant transformation of the view in this sense (Kružíková, 2010). In this study, I seek to defend the thesis postulated by Kružíková. I consider it to be her scientific discovery and original contribution.

First of all, it should be noted that Heidegger never rejected science. Heidegger is not an anti-scientific philosopher. Our philosopher sought to describe science. He can be regarded as a major ontologist of science. I consider possible assumptions about his anti-scientism to be unfounded. Heidegger was interested in science. His position is quite different from that of, for example, Kierkegaard, who is interested in man, his anthropological, ethical, and existentialist problems. Kierkegaard is completely uninterested in the subject of science. On the contrary, science is a problem to which Heidegger returns periodically throughout his life.

Kružíková points out that there is a more detailed division of Heidegger's work than into two periods (Kružíková, 2016). I do not consider it important to apply such a detailed division. Kružíková distinguishes as many as four periods; distinguishing Heidegger before the turn and after the turn is fully sufficient for the purpose of this study. We can briefly summarize the main features of Heidegger's philosophy before and after the turn.
„In the period after Being and Time that is sometimes called "the turn", Heidegger reconsiders the "apriorism" that he had previously regarded as the defining feature of scientific philosophy as such" (Gabriel, 2014, p. 57). Significant differences can be noted in the two periods. While before the turn the centre of Heidegger's interest is mainly the human being, after it he focuses more on being. Clearing (die Lichtung) means that being reveals itself and emerges before man. Being itself does not depend on man; nothing can be learned about being from anthropological positions. „This is not to say, that Heidegger abandons Dasein, since the thinking of being never escapes the question of human being who speaks being" (Risser, 1999, p. 2). Before the turn, metaphysics asks for the meaning of being. After the turn, Heidegger wants to replace philosophy with thinking. The problem of the meaning of being replaces the problem of the truth of being. Throughout the whole period of his work, Heidegger maintains a great deal of criticism against Western civilization. „Heidegger's critique of the decline of Western civilization since antiquity due to the departure from being in the form of metaphysical rationality is widely accepted among scholars of Eastern systems of thought and contemporary Eastern thinkers" (Yao, 2025, p. 4).

The purpose of the study is to show that, despite significant differences, there is a certain continuity between Heidegger before and after the turn. This lies precisely in his philosophy of science. Heidegger became interested in science as a young philosopher. It is significant that his last text also concerns science. He wrote it in 1976, the year of his death. The continuity of Heidegger's philosophy of science has already been convincingly demonstrated by Kružíková. Of course, there are some differences in the grasp of science before and after the turn. Before the turn, he considers the position of the branches of science to be based on pre-scientific experience. „In his later works, Heidegger no longer believed that science could be „reformed" through philosophy, but he tried to show that the view of science is limited because it is in a sense one-sided, and that in order to see the many other ways in which what is can be given to us, we need to return to the origins" (Kružíková, 2003, p. 146). Nevertheless, they also show signs of identity.

Heidegger began to deal with the subject of science already in his early texts. With rare exceptions, when dealing with theology, for example, he rarely engaged in reflection on any particular discipline. Such texts are indeed found in Heidegger, but they are rather fragments. Mostly, they were reflections on science in its complexity. In the early 1920s, Heidegger's Galilean conception of the expression of motion in time. Modern physics thus becomes a mathematical invariant of motion. The Cartesian proof of the thinking self in turn, according to Heidegger, implies proofs of mathematical rules (Sevalnikov, 2022). Heidegger further discusses the logical structure of time in historical science (Kružíková,

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2010). A Czech expert on Heidegger comments that the object of historical science is man. What is interesting for historical science is what is valuable for man. Historical scholarship seeks to bridge the time gap between the historian and the area under study.

Being and Time is one of Heidegger's most famous works. According to Leško, it was Heidegger's philosophical failure (Leško, 2010a). „Heidegger was only too well aware that his philosophical masterpiece could not fulfill the goal he pursued and that he had to look for other ways of fulfilling it" (Leško, 2010b). In Being and Time, Heidegger addresses, as a matter of priority, a different problem than the reflection on science. In particular, it concerns the theme of the forgetfulness of the meaning of being, of the dissociation between ontology and metaphysics. Kinkaid (2022) takes issue with the claim that this book is theology in disguise. Nevertheless, there are references in the text that refer to science. Heidegger declares that „its true progress comes about not so much in collecting results and storing them in 'handbooks' as in being forced to ask questions about the basic constitution of each area, these questions being chiefly a reaction to increasing knowledge in each area" (Heidegger, 2010, p. 8). Our philosopher considers a science to be developed if it is capable of its own self-reflection. He argues that despite the difference between the role of the sciences and the role of ontology, they are not incompatible. He also sees them as having the potential to understand being. He speaks of the substantive disciplines of the sciences, the sciences and move in some kind of „understanding of being" (Being and Time), Dasein, he says. Regional ontology proposes a subject of a particular science, in interaction with the regional structure of existence.

Research works with basic concepts. These concepts are associated with the establishment of a specific, specialized scientific discipline. Heidegger considers science to be fully developed if it is able to reflect on its own crisis. He speaks of the factual fields of the relevant scientific disciplines; sciences operate within a certain „understanding of being," and Dasein strives to reveal the already present essence in science. Regional ontology delineates the subject matter of a specific science in conjunction with the regional structure of being. Examples include physics and mathematics. Physics itself was able to reflect on its supposed completeness at the end of the 19th century, moved to a new paradigm in elementary physics, and accepted the generalization of motion and velocity in the general theory of relativity. Similarly, mathematics, based on Gödel's theorems, abandoned Hilbert's program. Our philosopher considers the crisis of the foundations of the positive sciences to be a general crisis of the foundations of science. Heidegger considers the problems of the foundations of science to be more important than the specific problems of the special sciences. They should be given more attention. Here, Heidegger argues that questions of ontology are more fundamental and, from the perspective of the history of thought, older. According to Heidegger, the basic concepts of the fields of knowledge are more important than the specialized research of the positive sciences itself.

Heidegger deals with the general reflection of theology in his lecture Phenomenology and Theology (1927). In the lecture, Heidegger argues that the positive sciences mediate what they thematize. He counts theology itself among the positive sciences, as is the case with biology, history, or philology. Theology is quite different than any positive science from philosophy. Heidegger here (admitting an alternative) means Christian theology. He seeks to characterize positive science as a science that reckons with the essence already present in the pre-scientific mode of conception. Heidegger seeks to characterize theology as a positive science by answering three questions expressing the specificities of the science's scientism and positivity: the investigation of scientism, the investigation of positivity, and the investigation of its relation to philosophy.

The positivity of theology is created by the totality of being, which is revealed by faith. Theology is determined by what faith provides in terms of content. Without faith, theology could not exist; without it, it would lack both meaning and content. As a science, theology must be describable by a specific conceptual apparatus. Without the possibility of conceptualization, there would be no theology as a science. Faith is the alpha and omega of theology as a science; faith is closely linked to the Christian meta-narrative, to the Christian perception of the philosophy of history. The very scientific nature of theology is predetermined by faith. Heidegger characterizes theology as a science of faith.

In the conclusion of the lecture, Heidegger seeks to answer the question of the relationship between philosophy and theology. He does not see it as somehow specific, but emphasizes the sameness of the distinction between philosophy and science, as is the case with any science. He outlines the question of whether philosophy is capable of reflecting on theological concepts in view of their authentic character concerning faith. However, concepts, even theological ones, are constituted through the prism of use and context. The autonomy of theology is characterized by the unnecessity of crutches borrowed from other sciences. In faith as a foundation, staying transcends pre-Christian existence. Pre-Christianly existing concepts used by theology are overcome in the sense of being „redefined" by being implemented in theology, i.e. their meaning loses its original pre-Christian connections. Philosophy thus seeks, by way of formal indication on the part of conceptual ontology, to help reveal the faith-appropriate meaning of theological concepts. Although theology, too, is a positive science according to Heidegger, its relation to philosophy is specific in a way that other sciences do not have in Heidegger's turn. Our philosopher says that theology must show the adequacy of its concepts to the totality (Heidegger, 2002a).

Likewise, the text *What is the metaphysics?* (Heidegger, 1998). It shows moments in which our philosopher comments on the topic of science. For the sake of simplicity, we will only draw on the published version of the lecture, although there is also an unpublished version (which makes a more radical statement about science). Heidegger does not favor a particular science in this lecture. He declares their equivalence despite the different subject matter they seek to grasp. Each of the sciences deals with a specific field of being. „ In all the sciences, when we follow their own most proper aim, we relate ourselves to be-ing itself" (Heidegger, 1998, p. 83). Heidegger is not yet critical in this lecture of the sciences, or of science in general.

There is no subordination or superiority among the sciences. No science has a higher status or is more scientific than another scientific discipline. Each science has its own specific way of grasping being. Scientific disciplines have their own field of research. Heidegger analyzes the way being reveals itself. According to Heidegger, being itself decides how it will appear. People use science to try to grasp being by force. Heidegger considers this an intrusion into being. In an unpublished version of the lecture, Heidegger intensified his critical view of science. This version is the original one. In it, he argues that understanding between the sciences is absurd, while working without understanding is difficult.

Let's analyze the situation that occurs after the turnaround. „On the longest day he ever lived, Heidegger could never be called a philosopher of science" (Richardson, 1968, p. 511). Heidegger emerges, despite this claim, as a philosopher of science, even after the turn. „Even though science has been rendered thoughtless by the positivistic image of science, there appears to be no dearth of thinkers, scientists included, seeking to provide us with more imaginative images of a science more responsive to the most profound exigencies of the human situation" (Kisiel, 1977, p. 181). Compare the extent to which the situation changes in Heidegger's reflection on science after the turn.

The situation has changed with regard to Heidegger's overall perception of the role of philosophy after the Turn. The Age of the World Picture is one of the foundational texts. This lecture is a visionary text. Heidegger speaks in this text of the objectification of the creature. The research seems to be quite violent in a certain context, our philosopher states. The objectification of being objectifies it. Heidegger argues that by objectifying in the scientific sense, the essence loses something. It is a removal from context. Heidegger regards such a grasp of the essence as incomplete, partial and one-sided. This is primarily true of particle physics. This is not Heidegger's only criticism of science.

Our philosopher also comments on specialization and planning in science. Management in science determines the actual scientific and publishing activity. Science thus receives lateral impulses. The question is, what actually determines the direction of scientific research? „From an inner compulsion, the researcher presses forward into the sphere occupied by the figure of, in the essential sense, the technologist" (Heidegger, 2002b, p. 64). Heidegger criticizes gradual specialization in the sense that the class of scholars could gradually be lost. „On the basis of their character as constant activity, the sciences create from themselves the appropriate coherence and unity" (Heidegger, 2002b, p. 64). Economic interests are what can influence science in a sideways way. Another impact of the economic management of science is that science itself may miss out on surprising discoveries. Specialization has quite serious consequences. It describes the nature of science as an institution. It notes that scholarship as a quality is being lost. Scholars are being replaced by researchers. Because of specialization, researchers come in who no longer need libraries. Publishers are the indicator that determines the portfolio of books published within scholarship. This acknowledges that there is a settings agenda at work in science. Although Heidegger does not directly make evaluations, he is essentially criticizing with his statements the dimension of specialization to which the figure of the scholar increasingly falls victim. Heidegger sees the university as a kind of bastion, in which it remains to some extent a place where a holistic approach to leadership as a whole does not escape. The unity of the sciences there, however, cannot be inferred historically in the sense of tracing the history of science, but on the basis of the similarity of its operational character. Heidegger expects that the operation of science will gradually shift more and more to separate research institutes and professional research schools. He sees in this an approach of the sciences to their new-age essence. „So the main character of the age of the world picture is the hegemony of natural sciences and their prominent role in drawing mainstreams of human beings' mundane happiness" (Qorbani, 2023, p. 515).

Heidegger also talks about de-divinization in science in the lecture. What does this mean? This term expresses a state of indecision about the existence of gods. In this text, Heidegger also talks about how being becomes an object in science. He says that it is torn out of context. It becomes an object and thus loses something. Heidegger even speaks of a certain violence in the pursuit of research. In such a case, science „sketches out in advance the manner in which the knowing procedure must bind itself and adhere to the sphere opened up" (Heidegger, 2002b, p. 69).

Another important text that talks about science is Science and Reflection. Heidegger reminds us that science seeks to put the being before itself and make an image of it. In this text, Heidegger's more radical view of science is evident. He argues that science is a theory of the real. He etymologizes here in a peculiar way. Heidegger derives the German word das Wirkliche from the Greek term εςγον. His etymology is specific. I will not comment on it in terms of linguistic correctness. Science reduces the concrete being it investigates to an object, it objectifies it.

The Question Concerning Technology is also an important text in science. Heidegger warns that technology can get out of hand. „Enframing means the gathering together of that setting-upon which sets upon man, i.e., challenges him forth, to reveal the real, in the mode of ordering, as standing reserve" (Heidegger, 1977, p. 20). Modern physics needs a very sophisticated technique for its work. Heidegger amplifies the critical view of science by a new element. The grasping of the totality by science is not an end in itself. The purpose is the extraction of energy from nature. Science thereby reduces Nature to a pre-enforceable state of stock. Therein lies the fundamental point of Heidegger's critical view of science. The objectification of Nature „disappears into objectlessness of standing-reserve" (Heidegger, 1977, p. 9). The exhaustive demanding that is typical of technology reduces the being to a state of reserve. Into this can be included the human being himself. Man also becomes an enforceable state of stock. The sum appears as a pre-calculable set of forces, which is a given in the nature of physics. Physics has exhibited these features since the time of Galileo. Here, Heidegger uses the term Gestell. It is the gathering together of everything for the purpose of use. Modern physics is a system of pre-calculable information. Physics cannot resign itself to this. As man too becomes a state of energy reserves, he is at risk. The original uncovering is denied. Heidegger sees salvation in art; it is the field in which it is possible to cope with technology. „The great breakthrough of 'The Question Concerning Technology' is that it shifts the focus away from specific technologies and toward the modes of thinking that lie behind these technologies" (Waddington, 2005, p. 577).

Theoretical science attempts to provide a quantifiable picture of the world. Gestell means the objectification of nature. This prevents the discovery of other forms of being. Heidegger sees a predatory relationship between humans and nature here. In this way, humans can reduce being and perceive it one-sidedly, partially. This passage is implicitly critical of the Enlightenment and positivist optimism in relation to science.

The text The End of Philosophy and the Task of Thinking can be considered one of the key texts within Heidegger's philosophical thought. According to Heidegger, philosophy loses its original inclination towards metaphysics. Philosophy ceases to have its original form, tending rather towards cybernetics. „Philosophy turns into the empirical science of man, of all that can become the experiential object of his technology for man, the technology by which he establishes himself in the world by working on it in the manifold modes of making and shaping" (Heidegger, 1972, p. 57). Our philosopher sees science as connected to technics. The sciences' impact on philosophy. Philosophy approaches the sciences, changing its ontological essence. Philosophy therefore ends. Thinking will replace philosophy in the future. „The task of thinking is here articulated specifically against the backdrop of both historical and transcendental subjectivity, indicating that a different style of thinking" (Ziarek, 2008, p. 249).

The creation of science is a departure from philosophy. Science deals with various areas of being. Philosophy dissolves into the sciences.

Heidegger made an interesting remark in his text *What is Called Thinking?* (Heidegger; 1968). Heidegger here declares that science does not think. What does he mean by this? Is he here denying rationality to science? Heidegger is talking about the gap between science and thinking. He is not saying that science is irrational, that it sins against correct logical reasoning. Science is different from thinking, which is supposed to replace philosophy. Thinking and science have no agreement with each other, nor do they in any way record each other. They both have developments and paths that have nothing in common. The goal of science is the work of technology. It is quite different from what thinking will aim at. „He argues, as well, that we shall continue to miss what is thoughtworthy if we continue to use "thinking" as a technological device rather than thinking of thinking as thoughtful dwelling" (Robbins, 2014, p. 15). Philosophy will be replaced by thinking. According to Heidegger, metaphysical thinking has come to an end. He considers it pointless to develop any exchanges between science and philosophy. Philosophy has dispersed into scientific forms of access to knowledge. Scientific progress will not help philosophy to

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reach thinking, because its goal is the world of technology. It is a connection between sociology, psychoanalysis, and psychology.

What, then, can be said about the possible development of views on science in Heidegger? We know that before the turn, Heidegger spoke of the forgetfulness of being. Here he was putting metaphysics in opposition to science. The approach of science is different from that of philosophy. Science has its disciplines, each investigating the being from its own point of view. Metaphysics mainly investigates the meaning of being, which has been forgotten. Heidegger's assessment of science also varied in relation to his general attitude towards philosophy. Stasiulis believes that Heidegger's science is neither rationalistic nor irrationalistic (Stasiulis, 2024). Philosophy may have looked to other sciences for fundamental concepts before the turn. Science establishes itself before the turn by virtue of its relation to the creature. In order for science to grasp the essence, the essence must have been available beforehand (Miechels, 2023). Science, in Heidegger's conception after the turn, is fundamentally different from the thinking that replaces philosophy. Philosophy itself becomes scientific, thus, according to Heidegger, approaching its end. Heidegger's famous theorem that science does not think does not deny rationality to science. He says that the object of real thinking is not a particular entity, but being (Giribet, 2022). Heidegger does not here lay an invective against science. Our philosopher does not condemn or disparage science. He has placed the concepts of science and thought in a circular scheme, Giribet reminds us. The scope of Heidegger's critique of science varies with time, and it increases. Yet this is not a rejection of science, a destructive critique of it. Heidegger saw science, with its dispositions, as distinct from philosophy and thought. Science has much less in common with thinking than it does with philosophy. Science, according to Heidegger, by no means encompasses the whole range of knowledge. Science before the turn is close to traditional ontology. The latter is based on Aristotle. Thinking after the turn asks more fundamental questions than philosophy. Science stands in opposition to thinking. Heidegger maintains a critical attitude towards science throughout his creative period. He amplifies this critique. Heidegger maintains the same conception of mathematical science. Heidegger's critique of the objectification of being by science also remains. The relation between science and philosophy changes in Heidegger, his critical view of science intensifies. Yet there is much in common in Heidegger's reflection on science throughout his career.

Heidegger criticizes science as such, but he cannot be considered an anti-scientific thinker. He perceives a lack of connection between original philosophical thinking, whose roots he often sees in the pre-Socratics, and scientific thinking. Scientific concepts are linked to philosophy. The latter has dissolved into the sciences. Heidegger's criticism of the scientific grasp of being connects him before and after his turn. If we divide Heidegger's work into the periods before and after the Kehre, we will certainly see a significant difference in his basic philosophical approach. The difference, of course, lies in the approach to metaphysics, to philosophy itself, to the fundamental questions that philosophy raises. However, Heidegger's reflection on science shows very similar features, so I can say that this aspect of Heidegger's work shows many signs of continuity, despite the existing differences. I do not mean to claim that there is no difference between Heidegger's thinking before and after the turn; that would be an absurd claim. I would only like to say that his philosophy of science does not differ in many respects and that much remained unchanged in this area throughout Heidegger's work.

I have pointed out the commonalities but also the differences in Heidegger's reflection on science. I have focused on the entire length of Heidegger's creative activity. Although some scholars divide Heidegger's work into as many as four stages, I base my analysis on a temporal division into two stages, namely the pre-turn and the post-turn stage. In this sense, I perceive both differences and agreement in Heidegger's view of science. I thus confirm the results achieved by Kružíková. I believe that Heidegger's philosophy of science is what shows considerable signs of continuity between Heidegger's philosophy before the turn and after the turn. The difference is, of course, in the overall grasp of the role of philosophy and the place of metaphysics. Here, the difference manifests itself very radically. The difference manifests itself in the field of reflection on science. The difference lies in the degree of critique, as well as in the degree of common interpenetration of science and philosophy, or thinking and philosophy. The common features lie in Heidegger's constant interest in the subject of science. Heidegger did not abandon its mathematical essence either. Heidegger equally criticizes the objectification of being by science. He maintains this position both before and after the turn.

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Marián Ambrozy – Associate profesor
ambrozy.marian@gmail.com
ORCID ID: 0000-0002-0421-436X

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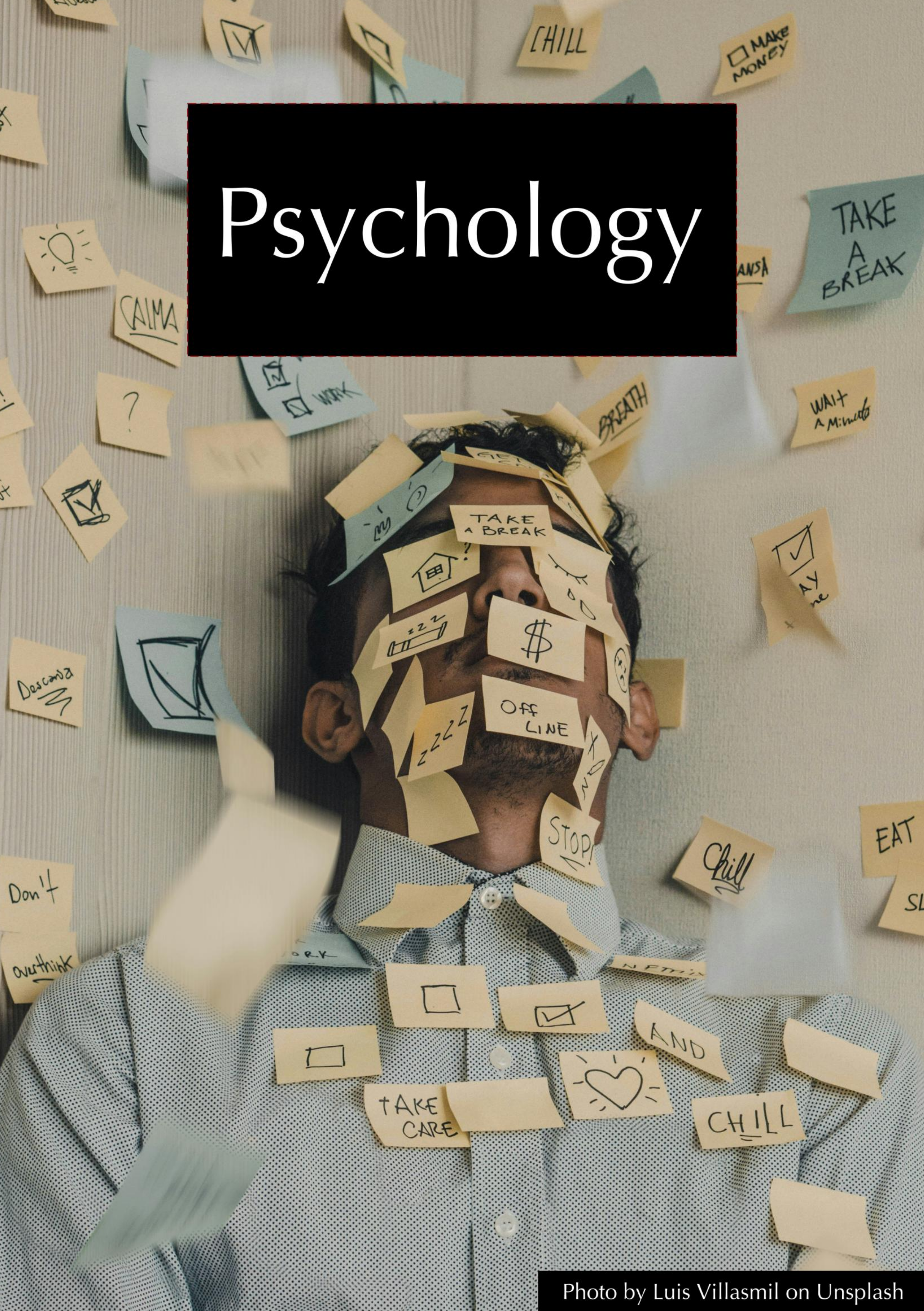
Psychology



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To leave the boat for the sea

Attitudes towards euthanasia, the good death,
and towards suicide, the invited death

Noémi Hajma
Institute of Psychology, University of Pécs

ABSTRACT

Objectives: The aim was to investigate a Hungarian general population sample's attitude towards euthanasia and suicide, taking into consideration the roles of relevant predictors. Correlation between the two attitudes was also explored in order to better understand their connection.
Methods: The final sample consisted of 264 respondents, with a majority of women (74.2%) and a mean age of 37.3 years (SD=16.1). Attitudes were measured by the Euthanasia Attitudes Scale and the Attitudes Towards Suicide Questionnaire. Relevant demographic data were collected as potential predictors. An open-ended question was provided in order to gain further insights. Data analysis was performed using the computer software program Jamovi (Version 2.3). Assessment of differences was based on Pearson's r tests, independent samples t-tests and ANOVA measures. Significance level was set at < 0.05.
Results: The mean score for euthanasia was 119 out of 150 (SD=26), while for suicide, the mean was 44 out of 70 (SD=12). A significant positive correlation was found between the scores on the EAS and the ATTS's three factors measuring acceptance of suicide ($p < .001$). Significant differences were found in relation to sex ($p = 0.009$ for euthanasia, $p = 0.046$ for suicide), age ($p = 0.006$ for euthanasia, $p < .001$ for suicide), religion ($p < .001$ for both), religion's effect $p < .001$ for both) and political affiliations ($p < .001$ for both) in predicting attitudes. Results of the qualitative part further supported those of the quantitative part, mainly focusing on support for euthanasia.
Conclusions: The sample was permissive towards euthanasia and was understanding and acceptive towards suicide as a solution and as a right, which conclusions were supported by both the quantitative and the qualitative analysis. Sex, age, religion, religion's effect on one's life and political affiliations are all associated with attitudes towards euthanasia and suicide. Precisely, being an atheist, having no religious affiliation at all, or having other equally or more important deciding factors in one's life other than one's religion, being a woman and a liberal and of a younger age are predictors of a permissive attitude towards euthanasia and suicide. Those who were permissive towards suicide were likely to accept euthanasia.

Keywords: Euthanasia • Suicide • Attitude • Predictor

Introduction

Measuring attitudes is highly relevant both in the case of euthanasia and suicide, although with differing focuses as to where and in what way they are the most useful. Considering euthanasia, attitudes might have to do more in regard to a potential legalization, further legislations and the creation of safeguards (Pereira, 2011), while in the case of suicide, attitudes are mostly important in the clinical field, serving as a basis for prevention programmes and interventions for suicidal persons (Wallace, 1994).

The scientific study of attitudes within the field of psychology has long been an important area since attitudes can be used for the creation of guidelines and decision making, even legal ones, thus they have a significant role in determining behaviors (Rokeach, 1973). Several definitions exist, but among the most widely accepted and cited ones, there is the definition given by Thurstone (1928), defining attitude as the "sum of personal tendencies and feelings, prejudice and bias, thought, belief, fear and anxiety on any subject" (cited in Kayagil, 2012, p. 3598). Additionally, an attitude is „an individual's disposition to respond favorably or unfavorably to an object, person, institution, or event" (Ajzen, 1989, p. 241).

In a practical sense, attitudes are expressed in one's affects, behaviors and cognitions (Myers, 1993), and they are regarded as important parts of personality as they have the power to predict one's behavior and they also tend to be stable over time (Larsen & Buss, 2005). In contrast, others argue that attitudes are not necessarily permanent and certainly not unchangeable, and this has critical importance especially in regard to suicide prevention programs (Diekstra & Kerkhof, 1989).

Euthanasia

The term "euthanasia" was derived from Greek, taking together the word "eu" meaning good and "thanatos" meaning death, thus euthanasia literally means good death. Regardless of this positive connotation, euthanasia has been and still continues to be an intensely debated topic and a public concern, especially in more affluent cultures and countries where there is a steady increase in age in the population alongside improved medical services like life-support technology (Wasserman et al., 2005). In this technology-dominated culture, advanced medicine has the chance to challenge human limitations; we can not only live in ways that were previously impossible, but we can also die in novel ways.

The emphasis on either the quality or quantity of life brings another meaningful aspect to this debate. Personal suffering, be it physical or mental, pain, and dignity are important factors when discussing end-of-life issues, as usually the experience of these constitutes the basis of a final decision whether to actively terminate life or allow it to end on its own by the refusal of life-sustaining treatments. In this sense, euthanasia could be understood as a means of enhancing the quality of life versus prolonging it at all costs (Holloway et al., 1995).

Classification of Euthanasia

In practice, euthanasia can be categorized in several ways, the most frequent distinction being that of active and passive euthanasia (Keown, 2002). The former one refers to cases where a doctor actively participates in the process of death by prescribing or administering a lethal drug that terminates the life of a patient, while in the latter case, there is no additional prescription of any medication, but most regularly, the refusal of life-prolonging technology and treatments, thus allowing the patient to die. The right to refuse any medical treatment, even life-saving or prolonging ones, is commonly recognized by law; thus, many countries allow passive euthanasia, which is occasionally also called "mercy killing" (Chowdhury, 2012). Finally, physician-assisted suicide, the most controversial form of euthanasia, is where the patient self-administers the lethal drug prescribed by the physician (Wasserman et al., 2005). Passive euthanasia typically has the strongest support out of all forms of euthanasia, but certainly in opposition to its active form (Gutierrez Castillo & Gutierrez Castillo, 2018; Wasserman et al., 2005), with physicians favouring it the most compared to family caregivers and the general population (Young et al., 2019).

For & Against Euthanasia

Despite the ongoing debates and controversies surrounding euthanasia, the practice has been legalized in several countries, mainly in a few Western European countries and some US states (Karumathil & Tripathi, 2021). Hungary is not included in this list, as based on The Health Care Act (1997. CLIV.), only the refusal of life-sustaining technology and treatments is allowed. However, this law can only be practiced by those who have such a disease which requires these technologies even in the earlier stages of their illness, thus it can be argued that the law discriminates against those who have another type of terminal illness, for instance amyotrophic lateral sclerosis (ALS), in which affected patients only need breathing-aid technology at the very last stage of their diseases, and preceding that they suffer greatly mainly mentally as a result of the undignified state of their condition which seriously compromises subjective quality of life (Frank, 2023). Such is the case of Karsai Dániel, a Hungarian lawyer who was recently diagnosed with ALS, and now he is working towards the change of the criminal law that targets people who aid others to commit suicide, regardless of the motivation and health condition of the person who wishes to die. His case makes the question of end-of-life decisions a particularly prominent public discussion in Hungary at the exact time of writing this paper, reflecting the topic's relevance.

To prevent abuses of the law, in every jurisdiction, laws and safeguards have been put in place in order to minimize or, as aimed, completely eliminate the possibility of misuse (Pereira, 2011). For instance, explicit consent by the person who wishes to end his or her life is a basis, along with administration of the lethal substance only by physicians after consulting with a second, independent physician who also approved of the practice, and lastly, mandatory reporting of all cases is also required. Nonetheless, critics of the practice warn the public that these safeguards can be bypassed and that there is a very real chance of broadening the law in regard to the people who are eligible for euthanasia (Pereira, 2011).

Commonly and firstly, euthanasia is considered both in practice and in theory in cases of terminally ill patients who are suffering greatly and their pain cannot effectively be controlled anymore (Levin et al., 2018). However, opposers highlight the hazard of going down the so-called "slippery slope", referring to a situation in which an innovation follows through an uncontrolled and unintended extension, finally reaching a much broader boundary compared to the initial aims and borders (Montagna, 2023). In the case of legalization of euthanasia this argument alarms of the chance of starting from only terminal patients who are eligible to die in this way to people who do not suffer from such severe conditions all the way to those who are agonized by a mental illness alone or to people who are vulnerable and not even capable of consciously consenting, including children who have a disability. Those who protest against the legalization of euthanasia are specifically concerned about the vulnerable members of society who could potentially be pressured into wishing to die by making them feel as if they are no longer "useful" for society and a burden to their loved ones either because of their advanced age or their physical and/or mental health (Sulmasy et al., 2018). Thus, euthanasia for some can be associated with the idea of killing the weak, and that consequently this practice could lead doctors to not treating patients to the best of their abilities, as death is an option easily accessed and available. Such opposers are also regularly referring to the Hippocratic oath, which binds every single physician as they must partake in it, clearly stating that one must not cause harm to others and that their primary aim as professionals is to protect life (Chowdhury, 2012). Euthanasia can also be portrayed as unnatural and an upsetting experience not just for physicians but for relatives as well (Kouwenhoven et al., 2013).

In support of euthanasia, which can be considered as a right to die, arguments are focusing on such concepts as dignity, autonomy and free will, allowing the individual freedom of choice and the opportunity to express his or her needs and desires even if it means that a merciful death is requested (Math & Chaturvedi, 2012). Following this logic, patients must have the right to autonomously choose when and how to die, as their body is their own; thus, they have the right to control what happens to it. Regarding dignity, many people do not wish to reach such a state where their consciousness, mental and physical abilities and thus their quality of life, is seriously compromised by a disease which also brings unbearable pain and suffering. In a sense, the notion of the right to life can be honored by respecting the right to die with dignity (Math & Chaturvedi, 2012). The right to die thus has the chance to contribute to an actual good death, fulfilling the meaning of the word 'euthanasia', by means of preventing suffering people from committing suicide, which would be highly distressing not just for them but for their loved ones as well (Kouwenhoven et al., 2013). Personal choice, autonomy and the subjective assessment of the situation are also highlighted in the argument that focuses on those people for whom the continuation of life in a minimally or totally unconscious state would be actually worse than death itself. Following this logic, once people deem their life to be not worth living anymore in a given condition, then it is a violation of human freedom to force them to carry on, the exact same way as it would be an unjustified interference to force people to die when they think that life is worth continuing (Benatar, 2011).

Suicide

Suicide is recognized as a global health issue by the World Health Organization, as more than 700.000 individuals take their lives every year globally, thus suicide is one of the leading causes of death worldwide. In fact, more people die by suicide than victims of malaria, HIV/AIDS, breast cancer, or war and homicide taken together. It is also the fourth leading cause of death in the young generation, among 15-29 year olds (WHO, 2019). Considering Hungary, suicide as a public health concern is highly relevant since among European countries, Hungary registered the second highest rate of deaths by suicide (Eurostat, 2020).

Attitudes towards suicide constitute to how we approach this topic both on a personal and on a societal level, as they play a significant role in our behaviour (Rokeach, 1973). Attitudes make themselves manifest in the classification system as well, since, based on a popularized view outlined by Shneidman (1985), suicide attempts were categorized as 'parasuicides' and actual suicide attempts. Parasuicides refer to those attempts that researchers viewed as lacking in the potential of ending life, in contrast to those actual ones that had this potential. This categorization implies that the fundamental motivation differs between these two, stating that a 'true' suicide attempt's ultimate aim is to escape from the unbearable psychological pain experienced by the suffering individual while those who commit a 'parasuicidal' act first and foremost aim at communicating their need for help, thus these actions are "cries for help", without the real intention to die (Shneidman, 1992).

However, this method of classification has been criticised and attacked from several fronts since such a view fails to take into account the accessibility of certain means, the public's general lack of knowledge of the lethality of a tool, the well-documented sex difference in the choice of means and lastly the true intent of the suicidal individual which could differ vastly case by case (e.g., Canetto, 1992). Additionally, even in the case of non-suicidal self-harm, while it is documented that most of those people who engage in self-destructive behaviours are not likely to commit suicide, previous history of self-harm is nonetheless the strongest predictor of future suicide and/or a suicide attempt, thus any kind of underlying motivation deserves careful and serious attention (Bennardi et al., 2016).

The Role of Stereotypes

Stereotypes play an important role in connection to suicide as they have the potential to shape attitudes, which could even result in an intentionally or unintentionally harmful manner when dealing with a suicidal person. Common stereotypes include categorising suicidal people as emotionally weak, attention-seekers, selfish, cowardly and malingerers, while also considering them as impious with notions such as they are not praying enough or that their belief is not strong enough. Furthermore, the idea that suicide is a betrayal of the family is also widespread (Sheehan et al., 2017). Stigmatisation can also be manifested within the suicidal individual through internalization; thus, negative attitudes from the external world can develop into self-stigmatisation (Corrigan et al., 2005). The given person can have the belief that the stereotypes and prejudices of society are actually true and applicable to him or her, thus the individual will start to think of themselves as devalued, unworthy and a misfit in relation to others. Consequently, the search for help can be significantly negatively affected, as the main reasons that condition the willingness to ask for help are prejudice (expressed by negative cognitions and emotions) and discrimination (expressed by behavior) towards the person who is stigmatized either by society or by him/herself or even by both avenues. This can eventually lead to social exclusion, avoidance, limited employment opportunities and more (Henderson et al., 2013).

Similarly to euthanasia, suicide is also a complex personal and societal issue, although in regard to suicide there might be more universally accepted statements, such as that generally cultures and countries around the world differ in terms of suicide rates, motives for suicide and methods used for it, social support and meanings given for suicide and maybe most importantly the availability and quality of health care provided for suicidal individuals (e.g. Lester, 2013; Siau et al., 2017). Despite the prevailing differences, however, condemnation of suicide can be found in virtually every culture. Even the term "committed suicide" reflects an attitude which evokes the not-so-long-ago past when suicide was legally considered a crime and a sin, deserving of abomination. Legislation has changed, but society changes more slowly, and as a result, stigmatization is still very prevalent and strong (Sudak et al., 2008).

Research Problem

Several predictors have previously been identified as playing an important role in relation to an individual's attitude towards both euthanasia and suicide. These predictors are investigated in this paper as well, with the aim of either strengthening the already existing literature, posing some challenges regarding the established knowledge, or simply to explore and deepen the understanding of different predictors' roles in relation to end-of-life issues.

The Role of Religion & Politics

First and foremost, religiosity has been proven to be of utmost importance, as it is consistently shown to have a strong negative influence on attitudes towards euthanasia and suicide, that is, those who are highly religious are very likely to have negative attitudes (Aghababaei & Wasserman, 2013; Chowdhury, 2012; Eskin et al., 2020; Saiz et al., 2021; Televantos et al., 2013). More specifically, the more religious a person is, the higher the importance of religion, the stronger the opposition towards both euthanasia and suicide (Foo et al., 2012; Inglehart et al., 2021; Singh, 1979; Stack, 2013; Terkamo-Moisio, 2016; Ziebertz & Reindl, 2013). Reversely, those who are either religious but not as strongly, or not as committed to their religion's teachings; those who are more secularised; those who do not believe in any religion are likely to be more accepting, thus having a more positive attitude towards both euthanasia and suicide (Cohen et al., 2006, 2012; Danyliv & O'Neill, 2015; Solomon & Peterson, 2020; Steck et al., 2014; Verbakel & Jaspers, 2010).

Liberals are shown to be more supportive of euthanasia, while those who have a conservative mindset are likely to oppose it (Aghababaei et al., 2013; Bulmer et al., 2017; Caddell & Newton, 1995; DeCesare, 2000; Dworkin, 2013; Lester et al., 1990; Moulton et al., 2006). Additionally, politically right wing individuals are also more likely to have stigmatizing attitudes towards suicide, along with stereotypes and social distance in relation to mental illness (DeLuca & Yanos, 2015; Diekstra & Kerkhof, 1988), and parallel to this conservatives are also more likely to have negative attitudes towards suicide, while liberals are more likely to approve of it (Agnew, 1998; Sawyer & Sobal, 1987; Stack & Kposowa, 2008).

The Role of Age & Sex

In regard to age, younger generations are shown to be more accepting both of euthanasia and suicide (e.g. Bartolomé & Coromina, 2020; Chowdhury, 2012; Cohen et al., 2006; Li & Philips, 2010; Na et al., 2018; Pereira & Cardoso, 2019; Singh, 1979), while also being less stigmatizing towards suicidal people as they were less likely to conceptualize it as an individual failure, but rather as a societal malfunction (Boldt, 1983). Contradicting this finding, however, more recently Batterham and colleagues (2013) found that young adults, despite having higher levels of suicide literacy, are actually more stigmatizing. Nonetheless, looking at an analysis of age-cohort from 1977 to 2016 in the USA, while the general pattern is that the majority of people support both euthanasia (68%) and also suicide for terminally ill persons (57%), the groups that tend to be more supportive are younger (Attell, 2017).

With respect to sex, while findings are more likely to be contradictory, women are in many instances shown to be less accepting of suicide while also being less supportive of euthanasia (Attel, 2017; Cohen et al., 2006; DeCesare, 2000; Deluty, 1989; Finlay, 1985; Singh, 1979; Televantos et al., 2013). According to Finlay's view, this gender difference could be associated with the gender correlation with religiosity, as women tend to be more religious than men (Finlay, 1985). However, there are several studies that could not find any significant differences between the two genders (Stronegger et al., 2013; Terkamo-Moisio, 2016; Zou et al., 2016). In fact, one of the most stable socioeconomic factors associated with assisted suicide in Switzerland over a 12-year period is being a female (Steck et al., 2014). Furthermore, across several different studies women are shown to be more empathetic and sympathetic towards suicidal people (Stillion et al., 1984; White & Stillion 1988), while simultaneously are also more likely to express the intention to help, although in regard to the general acceptability of suicide, there were no gender differences (Wallace, 1994). Be that as it may, harsher and more stigmatising attitudes towards suicide and suicidal individuals are shown to be more characteristic of men, even though most men do not have an intensely negative attitude (Batterham et al., 2013; Oliffe et al., 2016; Pereira & Cardoso, 2019).

The Connection Between Euthanasia & Suicide

Three factors within the questionnaire measuring attitudes towards suicide were found to be a solid basis for the general acceptance of suicide and its normative valuation, taken as a unity (Stecz, 2021). In regard to the acceptability of suicide in case of terminally ill persons, the trend is that across all survey years, approval of euthanasia is higher compared to suicide (Attel, 2017). Those who already have a more permissive attitude to the more stigmatized way of terminating life might also be more ready to accept euthanasia as a legalized practice, especially since many people may see it as a safe and controlled death as a result of the medical professional's presence (Attel, 2017).

Hypotheses

Considering all of the above, the current study operates based on the following hypotheses.

1. Religious people, compared to atheists, are expected to have more negative attitudes both towards euthanasia and suicide, the most negative ones possessed by those who are the most intrinsically religious.
2. Younger people, compared to older participants, are expected to have more positive attitudes both towards euthanasia and suicide.
3. In relation to gender, no specific hypothesis is set up connected to euthanasia; instead, sex differences will be investigated with an exploratory aim. Towards suicide, however, men are expected to have stronger negative attitudes.
4. Liberals are expected to have more positive attitudes towards both euthanasia and suicide, while conservatives are expected to show more negative attitudes.
5. Those who are more permissive of suicide are expected to be more acceptive of euthanasia.

Methods

Instruments

At the beginning of the questionnaire, participants were asked to provide some of their essential demographic data such as sex, age, educational background, permanent residency, political affiliation along with its intensity, and occupation, where if someone was a university student, he or she had to indicate if he or she belongs to a healthcare faculty (medical school or psychology) or studies on another faculty and similarly, within occupation respondents had the chance to indicate if they work in a field related to either physical or mental healthcare. Regarding religion, participants had to choose between the five main world religions, or they could declare themselves either an atheist or an agnostic, and lastly, the opportunity for a more personal religion was also given with the statement "I am religious/spiritual and/or I am a believer on my own personal terms and ways". Those who wished could also indicate their religious sect, such as Catholic or Protestant. Finally, religion's effect on the respondents life was also inquired with the pregiven answers ranging from strong intrinsic religiosity ("My whole approach to life is based on my religion, and I try hard to live all my life according to my religious beliefs") to moderate (Although I believe in my religion, many other things are equally or even more important in my life") and total a-religiousness ("I am not religious") with two additional ways of how religion's effect could manifest ("I practice my religion mainly because of the of opportunity of social bonding, to spend time with my loved ones"; "What religion offers me most is comfort in times of trouble and sorrow").

The Euthanasia Attitudes Scale (EAS) is a 30-item questionnaire (Holloway et al., 1995). Within the 30 questions, 16 are positively and 14 are negatively structured, balancing between passive and active euthanasia. Five factors were extracted, accounting for 54% of the common variance. Factors were labelled as follows: general orientation toward euthanasia, patients' rights issues, role of life-sustaining technology, professional's role, ethics and values. The scale possesses excellent psychometric properties, exhibiting stability over time, internal consistency, and discriminant validity. Euthanasia was defined within the questionnaire as "acting to terminate or failing to act in such a way as to extend the life of persons who are hopelessly sick or injured for reasons of mercy" (Holloway et al., 1995, p. 58).

Changes in the current study were made in regard to the structure of the possible answers. Contrary to the original, where there is no chance to take an undecided position with the 4-point Likert scale, this study allowed it using a 5-point Likert scale, ranging from strongly agree to strongly disagree at the two ends. This change also resulted in the need to alter the point system of evaluation, as based on the original scores, those below 75 are indicative of an overall negative attitude, while those above and to the maximum (75-120), attitudes are considered positive. In the current system, where the maximum score is 150, the threshold was altered to negative attitudes below 90, while a score between 90 and 150 means a positive attitude.

The Attitudes Towards Suicide (ATTS) is a 37-item questionnaire developed by Renberg and Jacobsson (2003). Answers are given on a 5-point Likert scale, ranging from strongly agree to strongly disagree. Higher scores are indicative of a more positive attitude and vice versa (Renberg et al. 2008). The scale has a ten-factor model, explaining 60% of the total variance. The factors are as follows: suicide as a right, incomprehensibility, non-communication, preventability, tabooing, normal-common, suicidal process, relation-caused, preparedness to prevent and resignation.

Lastly, at the very end of the questionnaire, an open-ended question was placed in order to give an opportunity for the participants for a more free and more detailed response. The wording of the instruction was the following: "Here you have the opportunity to express your thoughts on the topic in your own words instead of the pre-given options. Please take advantage of and share your opinion in this informal form, touching on any part of the questionnaire. This is a list of free ideas. This part is optional."

Participants

In total, 270 individuals responded to the questionnaire; however, the final sample included the answers of 264 people. Exclusion criteria were primarily based on the attention-check questions ("In order to verify that you pay attention, please select the number (...) option), as those who failed to give the correct answers on both of these were automatically excluded. Answer sheets of those who gave a wrong answer on only one of these checks were carefully examined to see if their responses were otherwise consistent or not. If they were, in fact, consistent, then these respondents were included in the final analysis. The questionnaire was distributed and advertised mainly through social media (Facebook & Instagram), while a few printed versions were also given out within the local community of the author. Answers from these printed versions were copied to the online form by the author. All respondents were informed that their anonymity would be protected and their answers would only be used as part of a research practice completion. Importantly, at the front page of the questionnaire, potential participants were informed about where they could seek help if the questions were too upsetting for them or if they themselves had suicidal thoughts or one of their loved ones; several phone numbers and websites were provided, ready to help those in need.

Procedure & Data Analysis

The Hungarian version of the ATTS was given to the author by a PhD student of the University of Pécs who conducts research concerning suicide, suicidal literacy and behavior. On the other hand, the EAS had to be translated into Hungarian during the course of this study. The back translation method was implemented by individuals who are related to the field of psychology, including both the author and the supervisor of this study. Descriptive statistics were used to describe the characteristics of the sample and for the reporting of the majority consensus on the ATTS' questions. Data analysis was performed using the computer software program Jamovi (Version 2.3). Assessment of differences was based on Pearson's r tests, independent samples t-tests and ANOVA measures.

Results

The sample's (n=264) mean age was 37.3 years (SD=16.1), the youngest being 18 years old while the oldest participant was 82. Further relevant data are presented in the table below.

Table 1.
Sociodemographic characteristics of the sample

Variables	Category	n	%
Sex	Women	196	74.2
	Men	68	25.8
Education	High school	121	45.8
	University degree & above	138	52.2
Occupation	Student	90	34.1
Permanent residency	Village & small city	130	49.3
	Bigger city & capital & agglomeration	134	50.7
Religion	Christian	132	50.0
	Muslim	6	2.3
	Buddhist	15	5.7

Variables	Category	n	%
	Atheist	38	14.4
	Agnostic	11	4.2
	Spiritual/religious in a personal way	54	20.5
Religion's Effect	Whole life approach based on religion	43	16.3
	Many other things are more/equally important	93	35.2
	Comfort & peace in times of trouble	50	18.9
	Social bonding	4	1.5
	Not religious	74	28.0
Political affiliation	Left-leaning	112	42.5
	Center	89	33.7
	Right-leaning	63	23.8

The Connection Between the Attitudes - Hypothesis 5.

Overall, the sample was generally permissive towards euthanasia, as the mean score was 119 out of 150 (SD=26), where scores over 90 indicate a positive attitude. The items in the EAS included questions both about passive and active euthanasia and about both general and personal situations, touching on issues related to the law and rights and ethical standpoints as well as a psychological viewpoint of understanding suffering at the end of life. Within the factor of "General orientation toward euthanasia", views could be expressed both in a general, more distanced way ("A terminally ill person who is in severe pain deserves the right to have his/her life ended in the easiest way possible") and a personal, closer sense ("If a friend of mine were in severe pain, close to death, and begged me to try to convince the doctors to end his/her life mercifully I would ignore his/her plea"). Within the factor of "Ethics and values" the questions were personal, focused on individual values and views in relation to euthanasia in a general sense ("I cannot envision any medical circumstance in which the termination of life would be merciful"). Similarly, questions related to the factor of "Role of life-sustaining technology", were also phrased in an individualized form, asking participants to think of these possible situations personally ("If I were faced with the prospect of having a loved one suffer a slow and painful death, I would support his/her decision to refuse further medical life sustaining treatment"). On the contrary, items under the factor of "Professional's role" were phrased in a more distanced, general way, thinking of professionals in terms of laws and right, what would be allowed and what not given that they have the power of deciding over life and death ("No one, including medical professionals, should be allowed to decide to end a suffering person's life") and they have the technology that could possibly sustain life more ("Some patients receive "comfort measures only" (for example, pain relieving drugs) and are allowed to die in peace without further life extending treatment. This practice should be prohibited"). Correspondingly, the items within the factor of "Patients' rights issues" were focused on questions and views about the law and related rights ("I believe there should be legal avenues by which an individual could pre-authorize his own death in case intolerable illnesses arise") while also raising the issue of intense suffering and the appropriate action facing it ("It is cruel to prolong intense suffering for someone who is mortally ill and desires to die").

The acceptance and understanding of suicide were also quite high, as out of the maximum 70 points measured by three factors within the ATTS (factors titled as “suicide as a right”, “incomprehensibilty” and “resignation/suicide as a solution”), where higher scores indicate higher permissiveness, the sample’s mean score was 44 (SD=12). In this case, scores over 42 would constitute as a positive attitude based on the same metric system as in the case of the euthanasia scale. The questions in the measurement related to both other people and the participants themselves in terms of a possible suicide and their attitude in the different scenarios and objects. Within the “suicide as a right” factor, questions were focused on acceptance in terms of law and rights, both generally (“People do have the right to take their own live”) and personally (“I would consider the possibility of taking my life if I were to suffer from a severe, incurable, disease”). Similarly, within the factor of “in-comprehensibilty”, the items were related both in a general (“Taking one’s own life is among one of the worst things to do to one´s relatives”) and a personal sense (“Loneliness for me could be a reason to take my life”), thinking of suicide and its acceptability and/or understandibility from a pyschological and ethical point of view. However, the factor of “resignation/suicide as a solution” focused on suicide solely in terms of the general (“Suicide can sometimes be a relief for those involved”), by which participants could think of both others or they could answer from their standpoint as well, especially if they had a personal connection to the topic in some sense or could of situations when suicide could serve as a “solution” (There may be situations where the only reasonable resolution is suicide”).

Conclusively, regarding the connection of euthanasia and suicide, there was also a significant positive correlation between the score on the EAS and the ATTS’s three factors measuring acceptance of suicide. Those who were permissive towards suicide were more likely to accept euthanasia ($r=0.758$, $p < .001$).

The Role of Religion - Hypothesis 1.

There was a significant main effect for religiosity in relation to euthanasia ($F(13, 250) = 3.08$, $p < .001$). Post-hoc tests revealed that this difference was driven by significant differences between atheists and Christians ($t(250) = 4.24$, $p = 0.003$) and Muslims ($t(250) = 3.91$, $p = 0.010$), in both cases atheists showing stronger positive attitudes towards euthanasia. Similarly, a significant main effect was found for religion’s effect on participants’ lives ($F(4, 259) = 18.9$, $p < .001$). Based on the post-hoc analysis this difference was due to the significant differences between those who base their whole approach to life on their religion and those for whom religion is mainly a source of comfort and peace ($t(259) = -4.19$, $p < .001$), and those for whom many other things are equally or more important in life ($t(259) = -6.96$, $p < .001$), while also differing from those who do not consider themselves as religious ($t(259) = -8.25$, $p < .001$). Additionally, there was also a significant difference between those for whom religion is a source of comfort and those who are not religious at all ($t(259) = -3{,}87$, $p = 0.001$). Those who are the most intrinsically religious are the same participants who are the most likely to be against euthanasia, while atheists were the most supportive of it (see Table 2).

Analogously, a main effect for religiosity regarding the permissibility and understanding of suicide were also found ($F(13, 250) = 2.85$, $p < .001$). Correspondingly to the attitudes towards euthanasia, post-hoc analysis showed that this was the result of significant differences between atheists and Christians, atheists again being more permissive ($t(250) = 4.11$, $p = 0.005$). However, in the case of suicide there was also a significant difference between Christians and those who consider themselves religious on their on personal terms, the latter more likely to have positive attitudes ($t(250) = -4.07$, $p = 0.006$). Religiosity's effect was again found to be significant ($F(4, 259) = 11.4$, $p < .001$), driven by the differences between those who base their whole approach to life on their religion and those for whom religion is mainly a source of comfort and peace ($t(259) = -4.27$, $p < .001$), and those for whom many other things are equally or more important in life ($t(259) = -5.75$, $p < .001$), while also differing from those who do not consider themselves as religious ($t(259) = -6.40$, $p < .001$), exactly like in the case of euthanasia (see Table 2). Thus, again, the more intrinsically religious a person is, the more likely that he or she will be dismissive of suicide and will show less understanding towards it.

Table 2

Mean differences with regards to religion on the EAS and the three factors of the ATTS

Variables	Category	Mean (EAS)	SD (EAS)	Mean (ATTS)	SD (ATTS)
Religion	Christians	113	28.1	40.9	12.1
	Muslims	90	40.3	35.2	16.9
	Buddhists	109	33.4	43.3	12.6
	Atheists	133	13.1	49.8	10.6
	Spiritual in p.w.	126	20.0	48.6	11.5
Religion's Effect	1. Whole life based	94.1	34.1	34.2	14.0
	2. Many things equal	124	19.2	46.3	9.98
	3. Comfort/peace	114	28.3	44.3	12.9
	4. Social bonding	131	14.8	48.2	10.1

Note. p.w. (personal way) 1. (Whole life approach based on religion) 2. (Many other things are more or equally important) 3. (Comfort & peace in times of trouble) 4. (Not religious)

Other Factors - Hypotheses 2., 3. & 4.

Regarding age there was a significant negative correlation between age and acceptance of euthanasia, which means that older participants had a greater likelihood of having negative attitudes towards both euthanasia ($r = -0-153$, $p = 0.006$) and suicide ($r = -0.194$, $p < .001$). In relation to gender there was a significant difference between men and women, as females were more likely to accept both euthanasia ($t(262) = -2.65$, $p = 0.009$) and suicide ($t(262) = -2.00$, $p = 0.046$) compared to males (see Table 3). Concerning political affiliations, liberals compared to conservatives were shown to be significantly more permissive towards both euthanasia ($r= -0.402$, $p < .001$) and suicide ($r= -.0371$, $p < .001$).

Table 3
Mean sex differences based on the EAS and the three factors of the ATTS

Category	Mean (EAS)	SD (EAS)	Mean (ATTS)	SD (ATTS)
Women	122	24.7	45.3	11.6
Men	112	29.1	41.8	13.6

Other Factors within the ATTS

While the EAS's aims to assess the general permissiveness towards euthanasia, the ATTS is more nuanced in its factor structure, assessing much more than solely the acceptability of suicide in different circumstances. Thus, it is worthwhile to investigate them one by one. If found, significant differences between the sample's groups are reported. Conversely, if no significant differences were found, then only the overall mean points are mentioned.

Preventability & Preparedness to Prevent

Most people in the sample are quite optimistic in regards to the preventability of suicide, while many of them are also ready to help others in a suicidal crisis. Out of the maximum 20 points, where higher scores indicate a more positive perspective, the sample's mean was 14.1. Men were more likely to think that suicide is preventable and they would be able to help ($t(262) = 2.80$, $p = 0.006$), as men had a mean of 14.9 ($SD=2.56$) while women's mean was 13.8 ($SD=2.86$). Younger respondents were also more likely to be optimistic in regard to suicide's preventability ($r= -0.243$, $p < .001$).

Noncommunication

This factor includes statements such as "people who talk about suicide do not die by suicide", or "suicide happens without warning", and "most people avoid talking about suicide". Higher scores indicate a general agreement with the notion that suicidal intent and thoughts are generally not communicated and that people avoid talking about suicide. Out of the maximum 25 points, the mean was 14.6, which means that, while not so strongly, but many participants were likely to think that suicide is generally non-communicated. In contrast, older respondents were significantly more likely to think that suicide is most often communicated ($r= -0.139$, $p = 0.012$).

Tabooing

On a positive note, the majority of the sample do not consider suicide to be a taboo topic, as out of the maximum 15 points, the mean was only 5.75.

Normal/Common

The majority thought that suicide is actually quite common and normal inasmuch as having the opinion that everyone can commit suicide and that almost everyone has suicidal thoughts at some point in their life. Out of the maximum 10 points the mean was 7.48. Young participants were more likely to have higher scores ($r = -0.207$, $p < .001$), just like liberals ($r = -0.181$, $p = 0.002$), thus the younger and more liberal someone was, the more likely he or she thought that suicide can be considered as normal/common. In connection to religiosity, those participants who base their whole life approach on religion (mean= 6.67, SD=2.15) were significantly less likely to think that suicide is normal/common compared to those for whom religion is mainly a comfort (mean=7.88, SD=1.61) as the statistical difference was significant ($t(259) = -3.06$, $p = 0.024$).

Relation-Caused

This factor investigates how much people think that suicide is a primarily a result of interpersonal conflicts and problems. Out of the maximum 15 points, the mean was 7.91, which demonstrates that the sample was the most undecided in relation to this factor.

Suicidal Process

This factor is a collection of differing views regarding suicide and suicidal people. These expressions of views are not so closely related to each other that a mean score could be a meaningful inference, thus they are examined separately. Most individuals in the sample *disagree* with the following statements; "most suicide attempts are impulsive actions (by nature)" (57.2%); "people who take their own lives are usually mentally ill" (52.6%);"a person once they have suicidal thoughts will never let them go" (61.4%), while they *agree* with the following ones; "when a person dies by suicide it is something that he/she has considered for a long time" (48.1%); "a suicide attempt is essentially a cry for help" (79.1%).

The Open-ended Question

Out of the 264 participants, 83 responded to the open-ended question. The majority expressed their more detailed view regarding euthanasia, while many of them commented in connection to both, and a minority shared their opinions exclusively in relation to suicide. Relevant comments are organised according to the measurements' factors, but starting with these phenomena's perceived relationship a few quotes alluded to the connection and similarity between euthanasia and suicide, mainly expressing their understanding views towards both.

"It is very thought-provoking that the outcome of the two topics is the same and yet can be interpreted so differently. For me, suicide could be prevented if much more emphasis was placed on mental health in the world, while euthanasia would facilitate and in many cases prevent us from becoming an aging society, and those who are no longer fit for a quality life could leave in peace."

"I agree with both. The decision should be my right as a citizen, in every case." "For me, there are similarities between suicide and euthanasia. Both are a response to some form of unbearable suffering. According to my experience, those people reject these „solutions" who cannot put themselves in the patient's perspective. Perhaps euthanasia finds more understanding than suicide. Maybe because fewer people experience pain caused by mental illness than physical pain."

EUTHANASIA

General Orientation Toward Euthanasia

Most participants used this opportunity to further reveal their stances with respect to their generalized view of euthanasia. However, several respondents expressed discontent with the fact that the questions were meant universally, as they stated that their answers depend on the particular scenario at hand, thus their answers could potentially change when faced with a similar situation in real life rather than in an anonymous questionnaire. Several participants also stated that while they do think that euthanasia should be legalized, it should be done only with strict rules and safeguards, so that abuse of the law is minimized. On the whole, explicitly religious comments predominated not only this section, but the entirety of the comments part, since many religious participants took the chance to elaborate their standpoints based on their beliefs.

"I don't think euthanasia is acceptable, even if the person is suffering greatly. When some kind of medicine is administered to a person in order to hasten death, we are playing God, which we have no right to do."

"The following opinion follows from my trust in God: If someone asks not to be artificially kept alive, then this is OK (natural death) - If someone asks to end their life artificially, it is not OK (murder)."

"As a Muslim, one can only judge one's own life. One cannot criticize the life and actions of another person. A Muslim rejects suicide or murder, but if another person commits it, one cannot judge him or her. Islam forbids all forms of suicide and murder."

Nonetheless, several religiously affiliated participants expressed their views in contrast to their religion's beliefs, while an atheist expressed his discontent with religion's influence.

"Everyone has one life. How you live and how you end it should be your own decision. There is no ideology that has the right to override this. Be it any supported religion. No one should be allowed to extend the rules of his own religion to the life and death of other people."

"It is precisely because of this topic that I am only partially religious. I understand if someone doesn't want to suffer anymore and would ask to end their life. It's their decision."

"As a practicing Buddhist, I believe that it can be a mistake to choose this way of death, or to „participate" in this in any form, but it is by no means a crime. I understand and accept it, since every situation is different. Whatever the „participants" choose, they cannot avoid the „consequences" of their decision, the law of karma. Either way, the decision is important."

Personal investments also has the power to influence people's attitude; "Half a year ago, when my grandmother contracted another hospital infection in addition to a stroke and I saw her suffering and collapsing both mentally and physically almost every single day, I would have liked to give her a death without suffering, but unfortunately it was not possible, so body and spirit exhaustion killed her."

Two participants explicitly alluded to the case of Karsai Dániel, the Hungarian lawyer who has ALS and went to the European Court of Human Rights in order to gain the right to make more extensive end-of-life decisions within the border of Hungary.

"For me, the issue of euthanasia is much more related to undignified situations and helplessness, than to pain, which can be alleviated quite well at the moment. In the euthanasia debate that has recently emerged in connection with ALS, it can be observed what situations a person can end up in at the end of his life depending on his illness."

Patients' Rights Issues

"Human rights should be two-way. Ideally, I should have the opportunity to end my life, but it should also be possible to keep me alive with the help of medical science."

"The key criterion in the matter of euthanasia is the patient's self-determination. Active euthanasia in any form is not acceptable without the patient's consent or advance directive, and it is equally unacceptable to deny the patient assisted suicide. (If it can be ensured that the patient's free decision is involved, even psychiatric patients must be given the opportunity.)"

Role of Life-Sustaining Technology

"Protecting life is very important, but it cannot be protected infinitely. If it only prolongs suffering, it is harmful."

Professional's Role

"It is a very bad medical practice when professionals do not provide sufficient information or they are intentionally silent about the patient's condition. In such a case, the patient cannot make a responsible decision regarding his own treatment, even though his life is at stake. The decisions should be made by him, not by the doctors. If we are responsible for our actions according to the law, then the law should provide the right and the opportunity to make the decisions about our life and death ourselves, and not let outsiders decide for us."

Ethics and Values

"I also thought about what happens if someone has been struggling with severe depression for years and wants to request euthanasia. After all, in this case he does not have a terminal illness, but he still suffers. I don't know what the ethically correct thing to do here would be."

SUICIDE

In regard to suicide, considerably less participants expressed their views, thus not all of the ATTS's factors could be demonstrated with a relevant quote and even those that can, contain less comments compared to euthanasia. Those who did express their opinions mentioned potential preventive ways; their general understanding even though they may not themselves think of suicide as a rightful solution to life's hardships; or they elaborated on their dismissivenss based on religious convictions. Thus, while based on the quantitative measurement of the ATTS regarding the acceptability of suicide the sample was found to be generally permissive, those who took the opportunity to comment with their own words were substantially more likely to express views of dismissiveness.

Incomprehensibility

"I can only understand one form of suicide: if it saves the lives of many people. In such a case, I consider it a sacrifice."

Preventability

"Suicides because of mental ill health can be prevented and avoided because there are people who love and help."

"I think that people struggling with mental problems and suicidal thoughts can all be brought back with the right kind of help."

Tabooing

"The suicide of non-patients should be talked about without taboos. If we made suicide accessible (with abuse-preventing conditions) and stopped „saving" suicidal people, we could eliminate „cry for help" self-harm and threatening suicide for emotional blackmail."

Normal-Common

"Suicide is not a good way for an individual to end suffering, but it is understandable why many choose it."

Relation-Caused

"Suffering is not the problem, but leaving someone alone is. The problem is not loving someone, not caring about someone."

"My father committed suicide knowing that my brother and I would become orphans. He had an alcohol problem that no one helped him with. He lost his job during the regime change and went completely downhill. I am aware that I could not have saved him at the age of 11, but the guilt haunts me to this day. And the what if...questions. This is why I will never commit suicide because I know what this kind of death does to a family. I hate him for leaving me here, but I also love him because he was a very lovable father."

Resignation/Suicide as a Solution

"I think that even in a very bad situation, if you have the right people by your side, they can help you, but if someone can't be helped, then it's better if they go. (...) Suicide is an interesting thing for me and I think that those who commit suicide do not deserve life because they cannot appreciate what they have because there is a solution for everything."

"Death should not be hastened in any way, because it is possible that they can help as a result of the treatments, and there is no problem in life for which the only solution is suicide. These people turn away from God and choose the easy way. Everyone has their own written path and what trials they have to go through until the time of their death, which no one can take away except God."

Discussion

The General Population's Attitude Towards Euthanasia and Suicide

This study aimed at investigating attitudes towards euthanasia and suicide based on a Hungarian sample. Relevant factors were also examined in order to strengthen or weaken the results from other international studies inquiring the role of these predictors. As the results have shown, the sample was permissive towards euthanasia, and were quite understanding and acceptive towards suicide as solution and as right as well. Specifically, those who approved of either were significantly more likely to approve of the other too. With respect to the predictors' roles, the results indicated that religion, religion's effect on one's life, age, gender and political affiliation are all important factors in both cases. Precisely, being an atheist, having no religious affiliation at all, or having other equally or more important deciding factors in one's life other than one's religion, being a woman and a liberal and of a younger age are all predictors of a more permissive attitude both towards euthanasia and suicide. Thus, the hypotheses on which the current study operated were all proven to be supported by the results which are also in line with previous studies.

As the first hypothesis predicted, a negative correlation was indeed found between being religious and attitudes towards both euthanasia and suicide, foreseeing negative, thus dismissive attitudes on the part of religious groups, while also predicting that the more intrinsically religious someone is the more likely he or she will have negative attitudes. These results strengthen the previously well-established findings in regard to religion (e.g.

Aghababaei & Wasserman, 2013; Danyliv & O'Neill, 2015; Eskin et al., 2020; Inglehart et al., 2021; Saiz et al., 2021; Solomon & Peterson, 2020; Terkamo-Moisio, 2016). In accordance with the second hypothesis, significant age differences were found both in the case of euthanasia and suicide, anticipating that younger participants will be more permissive, which was indeed the result, supporting previous studies (e.g. Attell, 2017; Bartolomé & Chowdhury, 2012; Cohen et al., 2006; Coromina, 2020; Li & Philips, 2010; Na et al., 2018; Pereira & Cardoso, 2019; Singh, 1979). With regards to sex differences no specific hypothesis was set in connection to euthanasia, only to suicide, predicting that men on average will have a more dismissive attitude compared to women, which proved to be right as they were less accepting towards suicide conceptualized as a solution and as a right, which is line with previous findings predicting stigmatising attitudes more likely to be characteristic of men (e.g. Batterham et al., 2013; Oliffe et al., 2016; Wellman & Wellman, 1986). While no speculation was made regarding euthanasia, the current study's result, showing that women are more likely to accept and endorse the right to die, is in contradiction with several preceding studies showing the opposite; that men are more acceptive, or that there is no significant sex differences (e.g. Attel, 2017; Cohen et al., 2006; DeCesare, 2000; Finlay, 1985; Singh, 1979; Stronegger et al., 2013; Televantos et al., 2013; Terkamo-Moisio, 2016; Zou et al., 2016). This contradiction highlights the need for further studies in regards to sex differences, especially since when it comes to real life choices instead of hypothetical attitude questions, women are more likely to die by euthanasia (Doherty et al., 2022; George, 2007; Steck et al., 2014). According to the fourth hypothesis liberals are more likely to accept the right to die in the form of euthanasia while they are also more permissive towards suicide, which was indeed the case as politically conservative respondents were significantly less permissive towards both, again strengthening previous results (e.g. Aghababaei et al., 2013; Agnew, 1998; Bulmer et al., 2017; Dworkin, 2013; Moulton et al., 2006; Sawyer & Sobal, 1987; Stack & Kposowa, 2008). Finally, as the last hypothesis forecasted, those who are understanding and acceptive towards suicide are also more likely to be permissive towards euthanasia. Direct comparison on this basis is not possible however, since no previous study examined the attitudes of the same population on these two end-of-life issues using the measures of the EAS and the ATTS, thus, in this sense, the current study serves as a pioneer.

The qualitative part, providing an open-ended question to the participants, further strengthens the above results as most comments were an elaboration on why the respondents support euthanasia, while many of those who were dismissive towards it referenced their religious beliefs as the basis of their negative attitudes. The comments most often were related to the participants' general orientation towards euthanasia based on their ethics and values, while the issue of patients' rights was also frequently mentioned, highlighting the importance of personal autonomy and choice, even to the point of mental suffering, such as in the case of psychiatric patients. In regard to suicide, substantially less participants expressed their detailed views while those who were dismissive were in the majority, expressing their views on what could be the reason why others choose suicide and what could we do to help them, in which most referred to the need for strong and supportive interpersonal and professional help. Interestingly, while the general acceptance and understanding of suicide was quite high considering the whole sample, those who took the opportunity to reveal their attitude and thoughts in their own words were more likely to express views of dismissiveness, mainly based on their religious morals and values.

With respect to suicide attitudes it has also been found that the sample was quite optimistic in relation the preventability of suicide while many of them feel ready to help other in a crisis if needed. Men and young participants were more likely to think that suicide is preventable and that they would be able to help. While the general consensus was that suicide and suicidal intents and thoughts are non-communicated and that close relationships partners are unable to truly understand what a suicidal person goes through, older respondents were more likely to disagree with these statements. Regarding tabooing, most participants did not consider suicide to be a taboo topic, however, the fact that they were willing to take part in a survey focused on voluntary death may speak of their unrepresentativeness compared to the whole population. Perhaps consequently, the overall consensus was that suicide is quite common and normal inasmuch as everyone can take their life or could have suicidal thoughts. The younger and more liberal someone was, the more likely he or she thought that suicide was common/normal, while those for whom religion is the most important factor leading their life approach disagreed with this notion the most. Lastly, the sample was the most undecided in regards to the question whether suicide is primarily relation-caused or not.

Since there is no previous study that investigated the attitudes towards both euthanasia and suicide on the same Hungarian sample, direct comparison is not possible. However, the general attitudes of Hungarians towards euthanasia using other measures have been examined before and very recently as well, as a result of Karsai Dániel's case who brought euthanasia, or more precisely the topic of end-of-life decisions, forward into the public sphere. The two most recent surveys were carried out by the online market research institutes of Opinio and IDEA, using nationally representative samples. Based on the latter's results 62% of the adult population supports active euthanasia for terminally ill patients (IDEA, 2023). In line with the current study's findings, women and voters of liberal political parties were more permissive. In contrast however, older people were more likely to be supportive compared to 18-29 year olds. Comparably, based on the results of Opinio, 79% of Hungarians consider euthanasia acceptable; 20% of those surveyed fully support the right to self-determination, while 59% support it under certain circumstances. Only 7% are completely opposed to people being able to decide on the manner and time of their own death, while 14% were undecided (Opinio, 2023). Based on a recent doctoral thesis however, in case on a painful incurable illness, only 27.1% would accept physician assisted suicide regarding their family member, while 36.3% would accept it for themselves. In case of euthanasia, 28.9% would be supportive of their relative's decision asking a physician to administer a lethal drug for them, while 38% would accept it as a possibility for themselves (Busa, 2023).

Comparing Hungary to other nations, taking an international perspective comparing 62 countries all around the world, Hungary ranks as the 25th, the first being the most permissive (Netherlands) and last being the most dismissive (Jordan), as measured by the World Values Survey (Inglehart et al., 2021). Before Hungary, thus the more accepting countries are mostly part of Western and Northern Europe, while after Hungary the countries are mostly from Eastern Europe, the Balkan, South America, Asian and Middle Eastern countries along with some African ones. Surveys were administered in 7 different waves, starting from 1981 finishing with 2018. Answers ranged from 1 = "never justifiable" to 10 = "always justifiable." Hungarians were the least permissive towards euthanasia in the 1981-1984 period (mean = 2.67) while the most permissive score was in the period of 1994-1998 (mean = 6.17). Most recently, according to the data from 2018, the mean is 4.93, thus slightly below the half point, which means that while not so strongly, Hungarians are more likely to be against euthanasia on a large, representative scale (Inglehart et al., 2021).

Literature on measuring attitudes towards suicide using a representative Hungarian sample is severely scarce, if studies on physician assisted suicide are excluded, and they are, since the current study handles PAS within the framework of euthanasia. Nonetheless, there have been some studies investigating attitudes towards suicide within selected populations.

Comparing regional politicians among 5 European countries, the results indicated that those politicians held more permissive attitudes towards suicide, where suicide rates are higher and there are no developed state-supported prevention strategies (Hungary, Lithuania, Austria), while politicians from Sweden and Norway held less permissive attitudes, their countries having lower suicide rates and developed prevention strategies (Skruibis et al., 2010). As the current study's results shows, this permissiveness is not only characteristic of Hungarian politicians but of the average Hungarian citizen as well. However, this permissiveness does not necessarily entail a less judgemental attitude, quite the contrary, as Hungarian politicians (along with Lithuanian ones) mentioned personality traits as a main cause of suicide, implying that the suffering individual is to blame for his or her mental constitution. Additionally, within psychological causes, Hungarians and Lithuanians were the only politicians to mention such causes as "weakness and lack of maturity", "laziness to live" and "egoism" (Knizek et al., 2008). In relation to the other factors related to suicide, regarding preparedness to help, Hungarians were in the middle of the five countries representatives, indicating that they did not feel neither incapable of help, nor were they too hopeful about their abilities, although they were more optimistic about general preventability than Austrians, a country with lower suicide rate (Skruibis et al., 2010). Hungarians were also more likely to see suicide as relation-caused compared to their Northern European counterparts. Lastly, the only significant difference between male and female politicians was found with respect to perceived preventability of suicide, man being slightly more optimistic than women (Skruibis et al., 2010), which is in line with the current study's findings. While it seems that there is no significant difference in regard to the acceptability of suicide between Hungarian politicians and a general citizen, helping professionals were found to be more likely to have a dismissive attitude, denying the right to commit suicide more often than the general population (Susánszky et al., 2008). However, in relation to a terminally ill person wishing to die their opinion was similar to that of the general population.

The Role of Religiosity Regarding End-of-Life Issues

Christians in the sample were significantly more likely to be against both euthanasia and suicide as solutions to life's hardships, especially those Christians who were the most intrinsically religious as measured by how important do they consider their religion and religious beliefs. As a demonstrative example, all of the four pastor included in the sample had lower scores on the ATTS's three factors combined measuring permissiveness and understanding of suicide, while 3 of them had negative attitudes towards euthanasia as well. One of them however, reached a score beyond the cutting point for a positive attitude towards euthanasia, which exemplifies that while the role of religiosity as a predictor is reliably strong, the association between these factors are not set in stone. In fact, differing religious groups have all been shown to liberalize their stances on euthanasia over the years to varying degrees, Protestants exhibiting the most substantial change of view (Moulton et al., 2006).

Muslims, compared to atheists, were significantly less likely to consider both euthanasia and suicide as acceptable, thus as a group they were adhering to their religions' teachings and morals, especially in contrast to non-believers. Individually however, there were important differences in the sample, as only half of the Muslims had a low score with regards to the acceptability of euthanasia, while the other half had actually scored beyond the cut-off point for permissiveness. Consequently, just like in the case of Christianity, while it is safe to predict that religious groups on the whole will be less permissive towards euthanasia compared to atheists as a group, this does not mean that individual differences within the same religious groups are nonexistent nor that these differences are without significance. Nonetheless, the results from the quantitative measurements comparing religious groups to non-believers and showing that religious people are substantially more likely to be dismissive towards both euthanasia and suicide were supported by the findings of the qualitative part as well. Comments explicitly referencing religious teachings and beliefs as justifications for not accepting these ways of death were dominating, clearly showing that religious participants took a great interest in expressing their views in regard to end-of-life issues.

Out of the three world religion investigated in this study, Buddhists were the only religious group which did not differ from atheists with regards to the acceptability of suicide and euthanasia, thus Buddhists were quite permissive towards both similarly to those respondents who did not consider themselves as religious. As a matter of fact, out of the 15 Buddhist participants, only three of them had a low score on the EAS, indicating a dismissive attitude, while three of them had a very high score (above 140 out the maximum 150) implying a strong acceptance of euthanasia. Even in the qualitative part, a few Buddhists expressed their views of acceptance and understanding in contrast to their religion's teachings, instead highlighting the role and importance of personal decisions and individual responsibility. Despite the theoretical background, this result is actually in line with other findings examining practicing Buddhists' views on death and dying. In relation to suicide, Buddhists had higher acceptance rate compared to Muslims (Foo et al., 2012), while it has also been shown that the more intrinsically religious a Buddhist is, the more likely that he or she will have a favourable attitude towards suicide (Saiz et al., 2021). With respect to euthanasia, some Buddhists supported it under certain conditions, in opposition to their vows, because they believed that not disrupting a patient's agency and viewing each patient as a unique being was more important than the moral correctness of the action (Larm, 2019).

Limitations

Despite its contributions in the field of attitudes towards euthanasia and suicide concerning a Hungarian population, the current study and its results are not without limitations. Several important limitations relate to the sample. Firstly, the number of participants were not enough for a nationally representative sample, thus, while this study investigated the attitudes of the general population, its results cannot be generalized to the whole Hungarian population. Additionally, women, liberals and highly educated individuals along with university students were overrepresented; groups that have a greater likelihood to accept both euthanasia and suicide, thus the overall positive attitude towards both could be the direct result of their impacts. The case of women and liberals were elaborated previously, but it has also been found that students, along with their generally younger ages, and highly educated persons are more permissive towards both euthanasia and suicide (e.g. Cohen et al., 2006; DeCesare, 2000; Horsfall et al., 2001; Nathan & Nathan, 2020; Singh, 1979; Televantos et al., 2013).

There are also additional limitations beyond the sample that must be taken into consideration when interpreting the results of this study. While attitudes are a tool to predict behavior, their strength may not be that reliably strong in certain circumstances (Glasman & Albarracín, 2006; Nelson & Bernat, 1989), while some people may also change their view as time passes due to several reasons (Albarracin & Shavitt, 2018; Itzchakov & DeMarree, 2022; Wolfe et al., 1999). Moreover, specifically related to euthanasia and suicide, in both cases the type and specific circumstances of life termination, or even simply the wording of the questions matter greatly in affecting attitudes towards them (Deluty, 1989; Huber et al., 1992; Hagelin, 2004). Thus, for all of the above-mentioned reasons, this study's results should be interpreted and generalized with caution.

Conclusion

To conclude, this study contributes to the literature on attitudes towards euthanasia and suicide in two key ways. First and foremost, no previous study has investigated these two attitudes on the same Hungarian sample before, exploring them separately and in connection to each other, thus this paper opened up and explored in depth an important area of study that has been neglected so far. Additionally, the study included both a quantitative and a qualitative part, supporting and further elaborating each other's results, giving participants the chance to provide information about their attitudes in an exhaustive manner.

Secondly, in investigating the roles of several predictors, the findings were consistent and thus strengthened previous studies using international samples, highlighting similarities across different countries and cultures. As the results suggested, sex, age, religion, religion's effect in one's life and political affiliations are all associated with attitudes towards both euthanasia and suicide. More specifically, being a woman, younger in age, an atheist or considering many other things equally or even more important than one's religion and being a liberal are predictors of a permissive attitude both towards euthanasia and suicide. Additionally, those who approved of suicide in certain circumstances and were understanding towards it were significantly more likely to approve of euthanasia as well and vice versa. Taken together, the majority of the sample was permissive towards euthanasia, and were quite understanding and acceptive towards suicide as a solution and as a right.

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Noémi Hajma – Psychology BA student, third year
hnnoemi01@gmail.com

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(Don't) Take It Lightly

Humour's Impact on Anxiety and Coping

Sára Kárpáti
Kata Kumli
Faculty of Humanities and Social Sciences, University of Pécs

ABSTRACT

Humour and laughter are innate, universal human experiences that are present across all cultures and have important cognitive, emotional, and social functions. The term 'humour' refers to things that people say or do that are considered funny and make other people laugh. Researchers proposed various theories to explain what we consider funny and grouping models were invented that enable the categorisation of different humour types, of which the most widely accepted is the Humour Styles Questionnaire. Humour has long been considered an effective way of coping with distress and anxiety, but research shows that compared to dark (negative) humour, light (positive) humour proved to be more effective for downregulating negative emotions. The purpose of this study was to explore the connection between different types of humour, cartoon humour preference and experienced anxiety. The data for the research were accumulated via a self-report online questionnaire filled out by 200 participants (Mage =25.5) from a multicultural background with an age range of 18 to 74 years. Apart from measuring their humour styles and trait anxiety, participants were also asked to watch short light- and dark-humoured cartoon scenes and report their experienced level of state anxiety before watching the videos and after each section.

Firstly, the research revealed that those participants who showed a preference for Self-defeating humour had higher reported trait anxiety, while those who engaged in Affiliative humour reported lower trait anxiety. There was no significant relationship between trait anxiety and either Self-enhancing or Aggressive humour styles. Secondly, it was found that the reported state anxiety of subjects was significantly lower after watching the light humour cartoon section than before the videos and after watching the dark humour cartoon block. Altogether, it can be stated that our experiment results on the different types of humour and anxiety mostly aligned with the findings of previous scientific research on the topic. At the end of the paper, the limitations of the study are presented, and we also provided some implications for further research.

Keywords: humour, humour styles, trait anxiety, state anxiety, dark humour, light humour

Theoretical background

What is humour?

We all understand what it is like to experience humour, as most of us find ourselves laughing at something funny several times a day. The term 'humour' describes things that individuals say or do that are deemed funny and make other people laugh (Martin et al., 2003). While humour is a form of play, it has very important cognitive, emotional, and social functions (Martin & Ford, 2018). Polimeni and Reiss (2006) describe humour and laughter as universal and essential human experiences, present across all cultures, individuals, and types of interpersonal relationships. Despite cultural differences regarding what is considered funny and when laughter is appropriate, the sound of laughter is universal and indistinguishable across cultures (Condren, 2023). According to Martin & Ford (2018), laughter is also one of the first social vocalisations made by infants, and the fact that even children who were born deaf and blind laugh without having perceived others laugh, highlights the innate nature of laughter.

Laughter can be described as a physiological and behavioural reaction to humour, observable in numerous social interactions and situations. But what exactly do scientists mean by humour? According to Libera (2020), humour is the state of being amused, a form of social play triggered by recognizing playful incongruity, which elicits the emotional response of mirth, typically expressed through smiling and laughter. While the fundamental cognitive, emotional, and behavioural aspects of humour are consistent across all instances, the variety of events and cues that can trigger a humorous response is diverse. Martin and Ford (2018) explain that the complexity of human language and imagination allows the creation of humour in seemingly limitless forms. As human culture and technology have progressed, we have invented new ways and styles to convey humour, ranging from spontaneous interpersonal joking and humorous literature to comedy films, radio and television shows, and even memes and cartoons shared over the Internet (Stieger & Formann, 2014).

It has been reported that having a good sense of humour is a very valuable social trait because it is believed to co-occur with other desirable personality traits (e.g., Cann & Calhoun, 2001; Cann & Matson, 2014). People who are skilled at using humour are viewed as more credible (Wrench & Punyanunt-Carter, 2005), competent (Graham et al., 1992), and they are more appealing as friends (Wanzer et al., 1996) or romantic partners (Buss, 1988). Humour has also been linked to a reduction in perceived stress (e.g., Cann & Etzel, 2008; Ruch, 1997) and depression (e.g., Martin et al., 2003), a rise in feelings of self-worth (e.g., Kuiper et al., 1993), as well as an increase in optimism and general well-being (e.g., Martin et al., 2003). Thus, it appears that using humour in everyday life can benefit both the one producing the humour and the person receiving it (Cann et al., 2009).

What do we consider funny?

The question of what makes something humorous has puzzled scientists for centuries. Philosophers and psychologists have developed various theories to address this question. The superiority theory of humour suggests that the main motivation for humour is the sense of triumph or pleasure derived from the pain, mistakes, or indignities of others (Morreall, 2023). This theory implies that laughter and humour are negative in nature, as they involve ridiculing or disparaging others. We laugh „at" something or someone because we perceive them as inferior to ourselves. Indeed, laughter based on insult and ridicule remains common today, from playgrounds to television shows and social media websites (Libera, 2020).

Another significant theory of humour is called the relief theory. This theory, based on Freud's concept of the unconscious, suggests that repressing sexual or aggressive thoughts and urges leads to a buildup of energy that is released through laughter (Freud, 1926). It is a hydraulic explanation in which "laughter does in the nervous system what a pressure-relief valve does in a steam boiler" (Morreall, 2023). Although the psychological foundations of this theory have largely been debunked, it is notable that modern comedy intentionally employs the technique of building tension and then releasing it.

The third and currently most widely accepted theory of humour is the incongruity theory (Morreall, 1987). This theory emphasizes the cognitive processes involved in perceiving and interpreting a stimulus, identifying the perception of incongruity as a fundamental element of all types of humour (Martin & Ford, 2018). According to this theory, humour arises when our brains recognize two things as existing together in a way that initially seems illogical, and humour occurs when the discomfort caused by this incongruity is resolved (Libera, 2020). Situations, incidents or things are considered incongruous when their existence causes a contradiction with the recipient's situation model (Zwaan et al., 1995). Some examples of incongruity are odd, unusual, unexpected events that are out of the ordinary. For instance, human beings acting rigidly like robots (a common theme of silent movies), peasants acting like kings on medieval carnivals, or even a sloth getting fined for speeding in the modern animation movie, Zootopia (Howard & Moore, 2016). In the case of jokes, the incongruity arises between the setting and the punchline, while in many other types of humour, it must be deduced from contextual clues like tone of voice, or facial expressions (e.g., Miczo et al., 2009).

The different types of humour

According to Ruch and colleagues (2018), people habitually differ in terms of humour behaviours not only quantitatively (some individuals show more humour production and appreciation than others) but also qualitatively (people enjoy different forms of humour). The qualitative aspect highlights that humour might have different forms, types, distinctive qualities or styles.

Light and Dark Humour

Humour can be grouped in several ways, one of which is differentiating between Dark and Light humour. Dark humour relies upon ridicule and includes the use of satire, mocking, insulting other people and/or groups, degrading widely accepted values, and making fun of the flaws in the world and the moral concepts that are deemed absurd (Mendiburo-Seguel

& Heintz, 2020). It is strongly related to sick humour which depends on moral and social norm violations as well as deviations from norms; and it highlights the absurd aspects of life by contrasting tragic and comedic components (Kim et al., 2023). Moreover, Dark humour seems to elicit mixed emotions, such as amusement and embarrassment or disgust, because it has a wide negative content and can actually serve negative interpersonal aims (Aillaud & Piolat, 2012).

On the other hand, Light humour is associated with benign and pleasant influences, behaviours, and cognitions. A few of these are using wit, appreciating paradoxes and absurdities, displaying funny aspects of things that toy with rationality and logic, and overall employing pleasant topics to elicit mirth (Mendiburo-Seguel & Heintz, 2020).

Humour styles

Based on the results of numerous humour and well-being studies, Martin et al. (2003) developed the well-known and widely used four-category humour styles model. They identified four humour styles (*Affiliative, Self-enhancing, Aggressive, and Self-defeating*) as everyday functions of humour related to psycho-social well-being. Their framework distinguishes between two primary functions: enhancing oneself and enhancing relationships with others. Both functions can be achieved in adaptive ways (*Affiliative* and *Self-enhancing humour*) or maladaptive ways (*Aggressive* and *Self-defeating humour*; Martin et al., 2003). The four humour styles are not mutually exclusive: people may employ any or all of the styles regularly, however, their frequency of use may vary. In the following section, each humour style will be discussed in more detail.

Affiliative humour improves interpersonal relationships. This humour style consists of telling jokes to make others laugh and put them at ease. People who score highly on this dimension frequently make jokes, say amusing things, and engage in clever banter to elicit laughter from others, build relationships, and ease tensions between people. In an effort to make people feel comfortable, they may also partake in self-deprecating humour, which involves making humorous remarks about oneself and not taking themselves too seriously all the while embracing who they are and keeping a positive view of themselves. Individuals who score high on this scale generally seem to be happy, emotionally stable, socially outgoing, and kind towards others (Martin et al., 2003).

Self-enhancing humour style is associated with a funny and positive view of life. It operates similarly to a coping strategy by disregarding unpleasant feelings and using humour to see the positive aspects of every situation. Even under pressure, someone with this humour style can maintain a cheerful attitude. This component includes a general appreciation of humour, a propensity to find humour in life's incongruities, and the ability to have a light-hearted attitude in the face of stressful situations or hardships. Moreover, this dimension is hypothesised to be negatively correlated with unpleasant emotions, like depression and anxiety, and positively correlated with self-esteem, and mental well-being. This is because it focuses on the regulation of negative emotions via humorous perspective-taking (Martin et al., 2003).

Aggressive humour style is characterised by derogatory humour, mocking, sarcasm, and ridicule, all of which bring down others. When making jokes, those who employ this kind of humour disregard the emotions of other people. Generally speaking, it refers to the propensity to express humour without considering how it can affect other people (such as using sexist or racist humour). Additionally, this humour style might be a manifestation of compulsive displays of humour, which occur when a person is unable to refrain from making comical remarks despite knowing that they may be offensive to others. It also involves using humour as a tool for control over other people by subtly threatening to make fun of them (Martin et al., 2003).

Self-defeating humour is defined as a type of comedy that pokes fun at oneself to make other people laugh. This kind of self-deprecating humour could be an attempt to fit in, gain approval, become more popular or win over other people. This humour style also seems to include the tendency to act comically to cover up one's underlying negative emotions or to postpone solving problems productively. Hence, it is also considered to encompass the use of humour as a type of protective denial. The person displaying this type of humour may appear cheerful, bright, or funny to others, yet beneath this comedic approach lurk emotions of avoidance, emotional neediness, and low self-worth. This humour style is said to have a negative correlation with self-esteem, psychological well-being, and relationship satisfaction and a positive correlation with negative emotions like anxiety and depression (Martin et al., 2003).

The relationship between humour, anxiety and coping

Anxiety is an adaptive emotional reaction that is characterised by an overwhelming feeling of fear, tension, and panic. It is understood to be a future-focused emotional state connected to being ready for upcoming stressful situations or possible unfavourable events (Pretorius & Padmanabhanunni, 2023; Tuma & Maser, 1990). Anxiety symptoms include exaggerated worrying, hypervigilance (Wittchen & Hoyer, 2001), withdrawal or avoidance, and physical manifestations (e.g., muscle tightness, heart palpitations) brought on by an elevated sympathetic nervous system activation (Alvares et al., 2016).

Numerous studies have explored the relationship between humour and anxiety. Martin et al. (2003) argue that positive and negative humour styles are differentially related to anxiety relief and psychological health. As mentioned above, they suggested that only positive humour styles (*Affiliative* and *Self-enhancing*) correlate positively with mental health and well-being, so only light (positive) humour can be considered an effective form of emotion regulation.

Humour has been considered an effective way of coping with negative emotions like anxiety for a long time (Samson & Gross, 2012). The ability to perceive humour in adverse situations may serve as a helpful and effective strategy within cognitive reappraisal (Perchtold et al., 2019). Cognitive reappraisal involves reinterpreting the subjective meaning of an emotionally arousing event to reduce its negative emotional impact on the individual (Wang & Yin, 2023). Perchtold and colleagues (2019) suggest that the use of humour may promote psychological well-being by fostering a more positive evaluation of stressful events. Generally, a greater tendency to use humour is linked to viewing events in a more positive and less threatening manner.

However, the findings of Samson and Gross (2012) suggest that positive and negative humour may have importantly different affective consequences. Compared to negative (Dark) humour, positive (Light) humour proved more effective for up-regulating positive and downregulating negative emotions. In the research procedure, subjects were shown arousing pictures of negative content (such as violence, accidents, dangerous animals etc.) and then they had to apply positive or negative humour to reappraise what they had seen. The results showed that only Light humour could decrease the negative affect experienced by the subjects, while Dark humour proved much less effective, or in some cases, totally ineffective in lowering anxiety levels (Samson and Gross, 2012).

Another study (Napp, 2023) explored the relationships between the four humour styles identified by Martin et al. (2003) and various indicators of well-being. The findings revealed that negative humour styles (*Aggressive* and *Self-defeating humour*) were significantly correlated to higher levels of psychological distress. Therefore, individuals who often belittle others for amusement or use self-deprecating humour to entertain other people, are likely to experience increased psychological distress. Moreover, humour may act as a masking tool for many distressed people to cover up their trauma. Individuals who tend to hide their true selves in the form of Self-defeating humour may be struggling with a deeper traumatic experience (Barrett, 2016). Additionally, the study found that individuals who frequently browse dark memes and seek out other Dark-humoured online content are more likely to experience anxiety and psychological distress. According to Napp (2023), frequent exposure to Dark humour memes could potentially worsen anxiety, as continuously confronting these depressing, negative subjects might increase distress, despite having the ability to laugh at them.

Research conducted by Perchtold et al. (2019) also indicated that the use of good-natured (Light) humour for cognitive reappraisal more effectively enhances (up-regulates) positive emotions and reduces (down-regulates) negative emotions compared to mean-spirited (Dark) humour. Individuals who habitually use benign (Light) humour and less frequently engage in malicious (Dark) humour reported higher life satisfaction and lower levels of general anxiety (Yue, 2017). Moreover, a greater use of positive humour as a reappraisal strategy was associated with fewer depressive experiences in everyday life (Perchtold et al., 2019).

The relationship between humour and anxiety is regulated by a number of processes, including emotion regulation, redirection, and rephrasing techniques for stressful situations (Dionigi et al., 2021; Kuiper et al., 2014). Benign humour is recognised as an effective coping mechanism (e.g., Dionigi et al., 2023; Papousek et al., 2017; Perchtold et al., 2019) because it can help people reframe the subjective meaning of an emotionally upsetting situation, hereby changing the emotional effect the event has on the individual (Perchtold et al., 2019). Studies have shown that those with a positive sense of humour are less likely than people with a negative sense of humour to experience anxiety, and tension, and to negatively perceive stressful situations in life (Kuiper, 2012).

Hypotheses

This particular research is aimed at exploring the relationship between different humour styles, cartoon humour preference and perceived anxiety. We expect that our results regarding Light and Dark humour preference and experienced anxiety will be congruent with the findings of other researchers. Based on the literature and our own expectations, we formulated the following hypotheses:

1. There will be a connection between participants' preferred humour styles and their level of reported trait anxiety.
   - 1.1 Those individuals who have higher reported trait anxiety will be more likely to apply negative humour styles (Self-defeating and Aggressive humour).
   - 1.2 Those individuals who have lower reported trait anxiety will be more likely to apply positive humour styles (Self-enhancing and Affiliative humour).
2. The reported state anxiety of the subjects will be different before and after watching the light humour cartoon block versus the dark humour cartoon block.
   - 2.1 Light humour is expected to decrease distress, so it is hypothesised that subjects will experience the lowest level of state anxiety after watching the light humour cartoon block.
   - 2.2 Dark humour is generally associated with a higher level of distress and worse coping, so it is hypothesised that subjects will experience the highest level of state anxiety after watching the dark humour cartoon block.

Methodology

Participants

To measure and get an in-depth understanding of the demographics of the sample, the participants had to answer questions regarding their age, gender, nationality, and their highest level of education. A total of 200 answers were recorded, 135 females and 63 males took part in the experiment while 2 individuals preferred not to share their gender. The participants' ages (M = 25.5 SD = 9.35) ranged from 18 to 74 years (women: M = 25.0, SD = 9.15; men: M = 26.6 years, SD = 9.83). The majority of the respondents' highest level of education was a high school diploma (N=129), 49 people had a Bachelor's Degree, 20 had a Master's Degree, and 2 individuals held a PhD. While Hungarian individuals made up the great majority of the sample (N=152), the final sample pool featured an extensive degree of diversity:

1 Albanian, 1 Austrian, 3 British, 2 Chinese, 1 Egyptian, 2 French, 5 Germans, 1 Iranian, 2 Irish, 4 Italians, 1 Jordan, 1 Kashmiri, 3 Kazakhs, 8 Mongolians, 1 Norwegian, 1 Polish, 1 Russian, 2 Slovaks, 2 Spanish, 2 Thai, 3 Turkish and 1 Yemeni.

Measurement tools

HSQ (Humour Styles Questionnaire)

The Humour Styles Questionnaire (HSQ; Martin et al., 2003) consists of 32 self-report items, divided into four 8-item subscales, measuring the four distinct humour styles: *Affiliative*, *Self-enhancing*, *Aggressive*, and *Self-defeating humour*. Participants use a 7-point Likert scale, ranging from 1 (Totally Disagree) to 7 (Totally Agree), to rate to what extent they agree with each of the statements of the questionnaire regarding their everyday humour usage.

The reliability of each factor in the current study sample was the following for McDonald's v: Affiliative=.873; Self-enhancing=.810; Aggressive=.751; Self-defeating=.837.

STAI-5 (Shortened version of the State-Trait Anxiety Inventory)

Differentiating between the two subscales of anxiety, *trait* and *state* anxiety, has been an important topic of discussion in the discipline of anxiety research (Elwood et al., 2012; Zsido et al., 2020).

It is believed that *trait anxiety* is a personality trait or inherent inclination describing an individual's tendency to experience feelings of state anxiety in a stressful environment. Individuals with high trait anxiety frequently see threats where others may not (Pretorius & Padmanabhanunni, 2023; Zsido et al., 2020).

On the other hand, *state anxiety* describes a temporary emotional response of anxiety brought on by perceived stressors in a situation characterised by unpleasant emotions of tension and worrisome thoughts. State anxiety arises only in the face of stressful events, and it goes away as soon as things get resolved (Pretorius & Padmanabhanunni, 2023; Zsido et al., 2020).

The original Spielberger State-Trait Anxiety Inventory (STAI; Spielberger et al., 1985) is used to assess the level of anxiety that a person experiences in that particular moment (STAI-S subscale; measuring state anxiety) and the extent to which an individual feels anxious in general (STAI-T subscale; measuring trait anxiety). However, the original battery of assessments might prove to be too long for researchers who wish to incorporate several other measurement tools in their survey apart from STAI.

Consequently, Zsido and colleagues (2020) created the Shortened version of the State-Trait Anxiety Inventory (STAI-5) to resolve this issue. The STAI-5 is a shortened, yet valid and reliable measurement tool in situations where the employment of the full-form scale is impractical (Zsido et al., 2020). It consists of 10 self-report items with two 5-item subscales. The items are presented in a 4-point Likert scale, ranging from 1 (Not at all) to 4 (Very much so).

The reliability of each factor in the current study sample was the following for McDonald's v: STAIT-5=.805; STAIS-5=.824.

Procedure

The participants in our study were asked to complete a self-report Google Forms questionnaire that contained many different parts intended to measure the subjects' trait anxiety, preferred humour styles and cartoon humour preference. All of the applied measurement tools were used in their original language (English). Completing the questionnaire took around 20 minutes, and the participation of individuals was voluntary and fully anonymous. The study was carried out in compliance with the ethical requirements. Participants were mostly recruited from within our university and via social media platforms by posting the Forms questionnaire online and also sharing it via private chats.

In the second half of the questionnaire, participants were shown six short funny video scenes from different animated cartoons and they had to rate how much they liked each scene on a 10-point Likert scale ranging from 1 = "not at all" to 10 = "very much". The cartoon scenes were shown in two different blocks, based on whether their content was considered Light or Dark humour. Before watching the videos and after having watched each cartoon block, participants had to fill out questions measuring their level of state anxiety (STAI-S) and experienced emotions. We used two different versions of the questionnaire: half of the participants (100) were shown the Light humour section first and the Dark humour section came second, while the other half (100) viewed the Dark humour cartoon block first, followed by the Light humour section. All 200 participants were selected randomly and watched the cartoons within the same one-month period. As some of the included cartoons had mature age ratings, only individuals above the age of 18 were allowed to participate in the research. The cartoon episodes used in the experiment were short (15-20 seconds long) scenes from different YouTube videos publicly available on the internet (see Appendix).

The participants' responses given to the Google Forms questionnaire were then transformed into an Excel sheet, in which the responses were collected. After having received all the 200 responses, the final results of individuals were calculated for each included questionnaire respectively, so that they were ready to be used for statistical analysis.

Stimulus material

The questionnaire involved 6 videos in total from various comedy cartoon shows and movies, which represented the different types of humour to measure what kind of humour participants enjoy, 3 of which contained Light, and 3 which contained Dark humour scenes.

The scenes were chosen from a larger pool of 23 cartoon clips according to the adherence to different comic styles by 15 independent raters. The Comic Styles can be arranged into Light and Dark humour categories, with Fun, Humour, Nonsense and Wit belonging to Light humour and Irony, Satire, Sarcasm and Cynicism representing Dark humour (Ruch et al., 2018). We had an online questionnaire where first, participants could read about the 8 comic styles proposed by Ruch et al. (2018) and then, after watching each clip, they had to indicate on a 10-point Likert-scale how strongly they thought that one of the comic styles was represented in the video. Afterwards, we checked the means and standard deviations of the ratings for each clip. Finally, the final six scenes were selected according to the mean values and according to which videos had the lowest standard deviation within the sample.

Light humour scenes were chosen from Zootopia (Howard & Moore, 2016), and SpongeBob SquarePants (Hillenburg et al., 1999-present), while Dark humour ones were from Family Guy (MacFarlane et al., 1999-present), The Simpsons (Brooks et al., 1989-present), and South Park (Parker et al., 1997-present).

The Simpsons (Brooks et al., 1989-present), South Park (Parker et al., 1997-present), and Family Guy (MacFarlane et al., 1999-present), have been selected for the Dark humour block because these are sitcoms which are marketed at an adult audience (Smith, 2005), and have become known for using Dark humour, exaggeration, and stereotyping in conjunction with the depiction of controversial political and social topics (Zsila et al., 2021). Therefore, they can be expected to evoke negative feelings, anxiety and frustration in participants (Dhaenens & Van Bauwel, 2011; Raymond, 2013).

Analysis plan

For the statistical analysis of the accumulated data, correlation analyses and a repeated measures ANOVA were used to test our hypotheses. First, we ran four correlation analyses, to see whether there is a connection between the reported trait anxiety level of the individuals and the use of Self-defeating, Aggressive, Self-enhancing or Affiliative humour styles, as stated in hypothesis 1. Within all four analyses, we applied the Spearman variation, as the data of the STAI-T sum scores were not normally distributed (Shapiro-Wilk $p = .002$). Then, we applied a repeated measures ANOVA, to see whether the level of state anxiety reported by the participants was significantly different before and after watching the Light and Dark-humoured cartoon blocks, as stated in hypothesis 2. In addition, we tested whether the order of watching the Light or the Dark humour block (seeing one or the other first) resulted in different reported state anxiety levels. We used the non-parametric alternative of the independent samples t-test in both cases as the assumption of normality was violated (Shapiro-Wilk $p<.001$).

Results

Humour styles and trait anxiety

Regarding the connection between reported trait anxiety and the use of negative humour styles, the following results were found: A Spearman correlation analysis revealed a significant weak positive correlation between state anxiety and the use of Self-defeating humour (rho (198) = .288, p < .001), meaning that participants who scored higher on trait anxiety (STAI-T), were more likely to apply Self-defeating humour regularly. The other correlation analysis regarding the connection between trait anxiety and the use of Aggressive humour showed no significant correlation (rho (198) = -.095, p = .181).

Looking at the connection between reported trait anxiety and the use of positive humour styles, the results were the following: A Spearman correlation analysis revealed a weak negative correlation between trait anxiety and the use of Affiliative humour (rho (198) = -.174, p = .014). This means that subjects who scored higher on trait anxiety (STAI-T), were less likely to apply Affiliative humour regularly. The other correlation analysis regarding the connection between trait anxiety and the use of Self-enhancing humour showed no significant correlation (rho (198) = -.081, p = .254). Within all four analyses, we applied the Spearman variation, as the data of the STAI-T sum scores were not normally distributed (Shapiro-Wilk p = .002).

Table I.
Relationship between humour styles and trait anxiety

		Self-defeating	Affiliative	Self-enhancing	Aggressive
STAIT-5	Spearman's rho	0.288 ***	-0.174 *	-0.081	-0.095
	df	198	198	198	198
	p-value	< .001	0.014	0.254	0.181

Note. * p < .05, ** p < .01, *** p < .001

Cartoons and state anxiety

Firstly, we counterbalanced the 2 versions of the questionnaires for the present study to see if it made any difference if the respondents had seen the Dark or the Light humour videos first.

No significant difference was found between the state anxiety of the two groups in either the "after-the-Light block" (U = 4812, p = .632) or "after-the-Dark block" (U = 4621, p = .350) conditions. The state anxiety levels of the group who saw the Light cartoon block first were the following: after the Light block: (M = 7.38, SD = 3.25), after the Dark block: (M = 9.44, SD = 3.77). The state anxiety levels of the group who saw the Dark cartoon block first were the following: after the Light block (M = 7.78, SD = 3.60), after the Dark block (M = 8.59, SD = 3.58). We used the non-parametric alternative of the independent samples t-test in both cases as the assumption of normality was violated (Shapiro-Wilk p<.001).

Regarding the difference between participants' state anxiety before the videos, after watching the Light-humoured cartoons and, after viewing the Dark-humoured scenes, the results were the following: A Repeated Measures ANOVA indicated that a significant difference can be found between the three conditions ($F(1.83, 363.65)=26.3$, $\eta^2_p= 0.117$, p<

.001). Within the analysis, we used the Greenhouse-Geisser sphericity correction, as the assumption of sphericity was violated (p< .001). A post hoc analysis with Tukey correction revealed that the reported level of state anxiety was significantly lower after people watched the Light humour videos (M=7.58; SE=0.242) than after watching Dark humour videos (M=9.02; SE=0.261) (t(199)=-7.35, p< .001) or Before (M=8.36; SE=0.236) watching any videos at all (t(199)=4.52, p< .001). Moreover, the difference between the reported level of state anxiety after watching the Dark cartoon block (M = 9.02, SE = 0.261) compared with before having seen any of the videos (M = 8.36, SE = 0.236) was also significant (t(199)=-2.95, p=0.010). The difference in state anxiety before watching any videos, after the Light cartoon block and after the Dark cartoon block is depicted in *Figure I.* and in *Table II.*

Figure I.
The differences in reported state anxiety before seeing the cartoons, after seeing the light humour cartoon block and after seeing the dark humour cartoon block

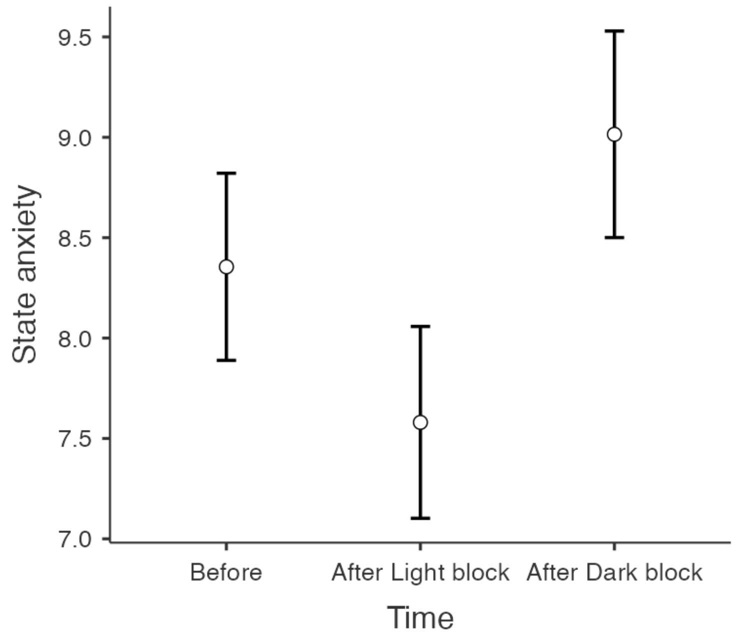

Table II.
Difference between state anxiety levels before watching any videos, after the Light block and after the Dark block

Comparison							
Time		**Time**	**Mean Difference**	**SE**	**df**	**t**	**p_{tukey}**
Before	-	After Light block	0.775	0.171	199	4.52	< .001
	-	After Dark block	-0.660	0.224	199	-2.95	0.010
After Light block	-	After Dark block	-1.435	0.195	199	-7.35	< .001

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Discussion

General discussion

The aim of this study was to look into humour's impact on somebody's life both in broad (e.g., trait anxiety) and in a narrower sense (e.g., state anxiety in relation to visual stimuli). We based our hypotheses on the scientific foundation presented in the *Theoretical background* and gathered data using an online questionnaire that had several self-report measurement tools along with cartoon clips showing Light and Dark humour scenes. The data for the research were accumulated via an online questionnaire filled out by 200 participants from a multicultural background. The sample included individuals from various age groups, with a mean age of 25.5 years. The questionnaire contained the HSQ (Martin et al., 2003), SP-CSM-24 (Torres-Marín et al., 2023) and STAI-5 (Zsido et al., 2020) self-report measurement tools along with Light and Dark-humoured cartoon scenes. The experiment replicated several previous findings.

Humour styles and trait anxiety

We hypothesized that there would be a connection between participants' preferred humour styles and their level of reported trait anxiety. Specifically, we theorized that people with a higher level of trait anxiety will be more likely to use negative humour styles, while individuals who have lower reported trait anxiety will be more likely to apply positive humour styles.

The first part of the hypothesis was partially supported by the statistical analysis since a significant positive correlation was found between participants' trait anxiety and the preference for Self-defeating humour, but no relationship was revealed with the Aggressive humour style. This result supports the findings of Napp (2023), who stated that people who often use Self-defeating humour to conceal their true selves and to entertain others are likely to experience increased psychological distress, moreover, according to Barrett (2016), they may be struggling with some deeper trauma. Our result is also congruent with Martin et al. (2003), who described Self-defeating humour as a form of defensive denial, used to mask negative feelings, to avoid confrontation and dealing constructively with problems. He found that Self-defeating humour is positively related to anxiety and depression and negatively connected to psychological well-being (Martin et al., 2003). Furthermore, Self-defeating humour is used to avoid dealing with issues related to emotional neediness and to conceal negative perceptions about oneself. Ultimately, Self-defeating humour has been linked to less resistance to life's challenges (Kuiper, 2012), which can manifest in higher anxiety levels. Regarding Aggressive humour, our result did not support Napp's (2023) finding, that individuals who often belittle others for amusement are more likely to experience anxiety. This could be explained by the relief theory of humour (Freud, 1926), which suggests that using Aggressive humour can help to get rid of the buildup of aggressive energy that causes inner tension if not released from time to time.

The other part of our first hypothesis regarding the use of positive humour styles was also partially supported by the statistical analysis, as only Affiliative humour showed a negative correlation with trait anxiety, Self-enhancing humour was not significantly related to it. This finding is congruent with Martin et al.'s (2003) result that Affiliative humour is primarily associated with positive emotional states, as it facilitates relationships with others and helps to reduce interpersonal tension. Affiliative humour can also act as a buffer between unpleasant life experiences and psychological instability, thus, it can serve as a protective element that aids in stress management (Martin & Ford, 2018) and decreases unpleasant emotions, including anger, depression, and anxiety (Mendiburo-Seguel et al., 2015). Unexpectedly, however, Self-enhancing humour was not negatively correlated with state anxiety in our sample, as previous research results show that Self-enhancing humour involves maintaining a humourous outlook even in stressful situations and finding amusement in life's incongruities, thus it is positively related to psychological well-being and inversely related to negative emotions like depression and anxiety (Martin et al., 2003; Yue, 2017).

Cartoons and state anxiety

Regarding state anxiety levels, people became significantly less anxious upon watching the Light humour video block, compared to their score recorded before watching any videos. At the same time, participants became significantly more anxious after watching the Dark humour video block in comparison with their score after watching the videos containing Light humour or before watching any videos at all. Thus, the experiment's results confirmed both parts of our second hypothesis.

Our second hypothesis stated that the reported state anxiety of the subjects would be different before and after watching the Light humour cartoon block versus the Dark humour cartoon block. More specifically, we assumed that participants would experience the lowest level of state anxiety after watching the Light humour cartoon block and the highest level of state anxiety after watching the Dark humour cartoon block. The facts that firstly, Aggressive humour causes more negative affect than Affiliative humour (e.g., Cann et al., 2015), and secondly, since the Dark humour videos could have aroused more negative affect in the subjects than the Light humour ones (Cann et al., 2015) can together serve as an explanation for the study results. In addition, they can answer the question why there was such a substantial difference between people's reported state anxiety levels in response to the videos depicting the two different types of humour. Our results were also congruent with the results of Samson and Gross (2012) who suggested that positive and negative humour have different affective consequences: compared to Dark humour, Light humour is more useful for up-regulating positive and downregulating negative emotions. In their experiment, only Light humour proved to be an effective tool for reducing distress induced by negative pictures, Dark humour was ineffective. In our experiment as well, Light humour videos caused a significant decrease in participants' reported state anxiety, both in the group which had not seen any videos before the Light-humoured cartoons and the group which had seen the Dark humour block first, supporting Samson and Gross' (2012) finding. Our results replicated the research findings of Perchtold et al. (2019) too, who also found that mean-spirited humour is much less effective for cognitive reappraisal, thus the reduction of negative emotions.

While according to earlier behavioural research (Epstein & Smith, 1956), aggression raises the degree of humour in materials, Anderson and Bushman (2002) argues, that hostility and aggression are a feature of Aggressive humour and as such provocative and violent scenes are the primary source of frustration. This can explain why people reported higher state anxiety levels after seeing the Dark humour video segment (Liu et al., 2019). Being around humour can influence someone's affective state. In general, humour is considered to be pleasant, and when executed skillfully, it can be amusing and produce the emotional state known as mirth (Martin & Ford, 2018). Consequently, humour exposure can increase reported positive affect while decreasing negative affect (Cann et al., 2000). However, due to the upsetting content, a primary characteristic of Dark humour (e.g. Kim et al., 2023), which can evoke negative feelings in people (Dhaenens & Van Bauwel, 2011; Raymond, 2013) it is understandable why there was a significant difference between participants' reported state anxiety levels before watching any videos and after watching the Dark humour block.

Humour is a fundamental human quality that can be elicited by social situations, verbal content (jokes), and visual content (cartoons or movies). Cartoons are a popular form of humour that use images with incongruous aspects that must be resolved by the viewer to get the punch line (Samson et al., 2008). Animated TV series produced since the 1980s such as The Simpsons (Brooks et al., 1989-present), South Park (Parker et al., 1997-present), and Family Guy (MacFarlane et al., 1999-present), have generally been marketed at an adult audience (Smith, 2005), and have become known for using Dark humour, exaggeration, and stereotyping combined with the depiction of controversial political and social topics (Dhaenens & Van Bauwel, 2011; Raymond, 2013; Zsila et al., 2021). These topics can understandably be upsetting for some which can even further explain the results of the experiment that subjects reported state anxiety levels were higher after watching the Dark humour videos, and also validates the sitcoms we chose for the Dark humour video block.

Limitations

All in all, it can be stated that our research results mostly supported the findings of other researchers in the field. Nevertheless, it should be noted that the present study is not without limitations, which should be taken into account in the interpretation of the previously presented results. A large portion of the data, for instance, was derived from self-reports; this might be problematic when evaluating characteristics like humour that are related to social desirability. Moreover, the survey was distributed among the psychology students at the University of Pécs, resulting in the majority of the participants being from that community, which also could have had an impact on the results.

Implications for further/future research

Studying sitcoms can be beneficial in several ways. First, understanding why people laugh at things can shed light on the sociological and psychological characteristics of both individuals and groups. For instance, comedy analysis can be helpful in elucidating certain elements of specific cultures or nations. Secondly, exchanging a typology of methods for characterising and comparing sitcoms would be advantageous for writers, producers, and broadcasting companies as well. For example, researching the types of humour that resonate with particular audiences could help with the targeting and creation of television shows (Juckel et al., 2016).

Regarding the future, it would be worthwhile to carry out further studies on the topic of humour on larger, more representative samples to get a deeper understanding of how the sense of humour is connected to personality and whether it can be improved or changed within the individual over time.

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Appendix

Light humour video section:

Zootopia (Howard & Moore, 2016): https://youtu.be/YWXN7x4EGK0
SpongeBob - first clip (Hillenburg et al., 1999-present): https://youtu.be/v8U_Xp9do8E
SpongeBob - second clip (Hillenburg et al., 1999-present): https://youtu.be/5f5ng6Aa7cM

Dark humour video section:

The Simpsons (Brooks et al., 1989-present): https://youtu.be/s2CIVGLDnvE
Family Guy (MacFarlane et al., 1999-present): https://youtu.be/dN_qojIB1Fw
South Park (Parker et al., 1997-present): https://youtu.be/C-a5y3hdOKc

Sára Kárpáti – Psychology MA student
karpatisara.7@gmail.com
ORCID ID: 0009-0002-7077-2244

Kata Kumli – Psychology MA student
kata.kumli@gmail.com
ORCID ID: 0009-0003-6265-5547

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Chronic diseases in relation to self-esteem and self-efficacy

Laura Luksik
Faculty of Humanities and Social Sciences, University of Pécs

ABSTRACT

The purpose of the present study was to explore the effects of chronic illness on self-esteem and self-efficacy among patients who were diagnosed with chronic diseases. First, I wanted to find out whether those participants who have changes in their appearance (e.g., hair loss, skin rashes, etc.) due to the illness and/or treatment have lower or higher self-esteem compared to those people who were diagnosed with a disease that does not affect appearance. Then, I examined the concept of self-efficacy: I looked for differences in self-efficacy between participants diagnosed with a chronic illness and the control group (people not diagnosed with a chronic illness). My hypothesis was that different diseases can make people's daily lives so difficult that a lower level of self-efficacy may develop in their case. Finally, as a third aspect, I included the concept of internal-external control attitudes. I hypothesized that chronic patients with internal control, in whom their diagnosis and/or treatment caused a change in their external appearance, would have a higher level of self-esteem compared to chronic patients with an external control attitude.
Convenience sampling was used. The sample (73 participants) consisted of young adults aged between 18 and 35 years, both men and women, diagnosed and non-diagnosed people. I used the following questionnaires for the study: the Rosenberg Self-Esteem Scale, the General Self-Efficacy Scale, and the Internal-External Scale. The statistical analyses did not show significant results. In this light, revisiting the question of the effect of chronic diseases, it can be said that the results may be related to the Health Action Process Approach model, which approaches health and well-being not only at the physical level.

Keywords: chronic illness, self-esteem, self-efficacy, internal-external control attitude

Theoretical background

The topic of my research is the impact of chronic diseases on self-esteem through symptoms and side effects of different treatments, and whether there is a difference in the dominance of internal and external control on patients' self-esteem. The expected result is that the above-mentioned factors influence self-esteem in a negative direction and that subjects with the internal control dimension have lower negative self-esteem compared to those with the external control dimension.

The problem statement derives from personal experience. I have met more and more people with chronic illnesses in recent years. I have seen the change in their outward appearance, and I have been shocked by some of the symptoms. For many individuals with chronic illnesses, managing their health involves more than just taking prescribed medication regularly. Various other factors can complicate their daily lives, impacting not only them but also their relatives. I am considering, for instance, an individual suffering from an illness that has so severely weakened his or her body that he or she can no longer maintain basic hygiene independently. Additionally, some illnesses necessitate a strict diet, demanding constant and meticulous attention to every meal and ingredient purchased each day. This can also be a source of stress, albeit in a different way. It made me wonder, if I, as an outsider, am touched by what I have seen, what effect it might have on that person.

In the following, I will begin by defining the term „chronic disease". Next, I will discuss the concepts of self-esteem and self-efficacy. Last but not least, I will present Rotter's theory of external and internal locus of control.

Chronic disease

The term „chronic disease" does not have a universally accepted definition. Different organizations, doctors, and patients interpret it in various ways, though there is considerable overlap among their definitions. There is no consensus on which specific conditions should be classified as chronic diseases, nor is there a clear agreement on the duration that qualifies a condition as chronic (Bernell & Howard, 2016). According to the National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP; 2022), „chronic diseases are defined broadly as conditions that last 1 year or more and require ongoing medical attention or limit activities of daily living or both". The three most common chronic diseases in the United States are heart disease, cancer, and diabetes (National Center for Chronic Disease Prevention and Health Promotion, 2022). In addition to the previous examples, the NCCDPHP lists the following also as chronic illnesses: chronic lung disease, Alzheimer's disease, chronic kidney disease, arthritis, prediabetes, epilepsy, and lupus (National Center for Chronic Disease Prevention and Health Promotion, 2022). Furthermore, the World Health Organization (WHO; 2023) defines „noncommunicable diseases (NCDs), also known as chronic diseases, tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behavioural factors. The main types of NCDs are cardiovascular diseases (such as heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructive pulmonary disease and asthma) and diabetes".

Recently, the prevalence of chronic diseases worldwide has increased significantly, affecting individuals of all socioeconomic backgrounds (Chan, 2021; World Health Organization, 2014). However, these diseases are especially common in low- and middle-income countries, where over three-quarters (31.4 million) of global deaths from diseases occur (World Health Organization, 2023).

Quality of life is a significant factor that has a considerable impact on chronic diseases. According to the World Health Organization (2012), a person's perception of his or her life situation is influenced by the culture and value system in which he or she lives. These elements are connected to the individual's norms, goals, and expectations. Thus, quality of life encompasses a person's health status, independence, and the social domain of his or her life (Akkus & Ayhan, 2020; World Health Organization, 2012; World Health Organization Quality of Life, 1996, as cited by Güngör & Özdemir, 2023). Besides, quality of life also includes psychological well-being categories that relate to social, behavioural, emotional, and mental aspects (Akkus & Ayhan, 2020; Güngör & Özdemir, 2023). Günger and Özdemir (2023) conducted a study that investigated the attitudes of children with chronic illness towards their illness and the circumstances of their quality of life. At the beginning of the study, the quality of life of ill children was relatively low, and their attitudes towards their illness were neutral. However, it was found that as the quality of life of the participants increased, they showed a positive change in attitudes towards their illness (Güngör & Özdemir, 2023). In my opinion, this is an important finding. If children are greatly impacted by the quality of their living conditions, we can assume that adults are similarly affected. Additionally, many individuals with chronic illnesses often reside in poor living conditions or have low socioeconomic status. All of these factors may contribute to negative attitudes among diagnosed individuals towards their illness, which also may, in turn, exacerbate their condition.

Self-esteem

Self-esteem plays an important role in our daily lives and has gained popularity as a topic among the general public, particularly over the past decade. There is a lot of research on this phenomenon within academia, and it is a focus across several fields of psychology. Before discussing in more detail the concept of self-esteem, I think it is important to clarify that there are some other related terms, such as „self-evaluation" and „self-worth". The term „self-esteem" refers to the positive value we place on ourselves by default. Conversely, the term „self-evaluation" is more neutral and refers to the process of determining value. Additionally, there is a third term, „self-worth", which more accurately conveys that the self has a quality of value (Komlósi et al., 2017). In some writings, they use these terms as synonyms, but as we can see, they have slightly different meanings. I will use the term „self-esteem" consistently for clarity.

We can distinguish between different types of self-esteem, such as global and specific self-esteem. Global self-esteem refers to the overall perception of one's self-worth, encompassing both affective and cognitive dimensions. In contrast, specific self-esteem is shaped by specific areas of the self, meaning that a person's self-esteem consists of multiple aspects. In the following sections, I will explain the concept of global self-esteem.

William James, an American psychologist and philosopher, was the first to address the issue of self-esteem. However, he mainly approached it from an affective perspective and referred to the phenomenon as the average level of self-esteem (James, 1890; Komlósi et al., 2017). Later, it was Morris Rosenberg (1989) who introduced the concept of global self-esteem and developed a measurement procedure to assess the self as a whole (Komlósi et al., 2017). This method is referred to as the Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965), which I will utilize in the study and will provide more detailed information about the questionnaire in the method section later in the paper.

There have been several studies on the stability of global self-esteem. Most studies conclude that this type of self-esteem is significantly stable. This result further supports the idea that Rosenberg believed, i.e., self-esteem is trait-specific, meaning it develops and stabilizes relatively early in individual human development (Komlósi et al., 2017). Further studies have examined the RSES questionnaire from a methodological perspective, and several conclusions have been drawn from the results that are important for our knowledge of personality organization, especially related to self-esteem. Such conclusions, among others, indicate that self-esteem can be traced back to two different formation processes: the sub-factor of self-competence and the sub-factor of self-esteem as perceived by others, as Tafarodi and Swann (2001) identified (Komlósi et al., 2017; Tafarodi & Milne, 2002; Tafarodi & Swann, 2001). According to Tafarodi and Milne (2002), „Self-competence is defined as the valuative experience of oneself as a causal agent, an intentional being with efficacy and power. Self-liking, on the other hand, is defined as the valuative experience of oneself as a social object, a good or bad person according to internalized criteria for worth" (Tafarodi & Milne, 2002, p. 444).

People are generally motivated to and strive to maintain and protect their positive self-esteem (Komlósi, 2007; Sallay et al., 2014). This is explained, for example, by the „Terror Management Theory" (TMT), first described in the 1980s by Jeff Greenberg, Tom Pyszczynski, and Sheldon Solomon. The model is founded on the idea that self-preservation is a fundamental goal of humanity, which is incompatible with the concept of mortality and leads to anxiety. The psychodynamics of coping with thoughts of death can be understood through a dual defense model, in which individuals manage these thoughts through both proximal and distal defenses. Upon first becoming aware of thoughts related to death, a person typically adopts a proximal coping style, which often involves various defense mechanisms such as repression or rationalization. Then thoughts about mortality in our subconscious are strengthened, leading to the dominance of a distal defense mechanism. For instance, this can be defending our worldview or positively reinforcing our self-esteem. Finally, the availability of death-related thoughts has decreased (Békés, 2004; Pyszczynski et al., 2003). Based on this, positive self-esteem can be interpreted as a protective factor against the thought of mortality and the associated anxiety symptoms (Békés, 2004; Pyszczynski et al., 2004; Sallay et al., 2014).

The diagnosis of certain chronic illnesses can bring a sense of mortality to the forefront, along with an increase in anxiety symptoms, which may induce the reinforcement of positive self-esteem based on TMT theory.

Furthermore, research by Taylor and Stanton (2007) has shown that higher levels of self-esteem positively influence coping with stress, as well as overall mental and physical health conditions (Sallay et al., 2014). These factors may play an important role in managing chronic illness and influencing its progression.

Self-efficacy

Self-efficacy plays an essential role in our everyday lives. It is part of our connection to the world around us and has an impact on our behaviour, effort, perseverance, thoughts, and feelings. Self-efficacy helps us determine what we can and cannot do, as well as how much energy we should invest in various tasks. Thus, self-efficacy refers to our beliefs about our abilities to perform, change our behaviour, and take the necessary action in order to achieve particular goals (Bandura, 1977, 1986; Urbán, 2022). If someone feels that his or her self-efficacy is low, it can be easy to perceive tasks as unrealistically difficult. This perception may lead to feelings of failure, tension, helplessness, and possibly to procrastination. Conversely, if someone thinks of himself or herself as high in self-efficacy, he or she is calmer and likes to challenge himself or herself, devoting more attention and effort to the task at hand (Bandura, 1977, 1986; Urbán, 2022; Van Dinther et al., 2011).

People diagnosed with a chronic disease must learn to live with their illness, which requires flexibility, adaptation, and sometimes a change in lifestyle. For patients to be able to facilitate this change and for professionals to assist patients in walking, or in many cases re-walking, this journey, various so-called health behaviour models have been developed over the decades. In most of these models, self-efficacy plays a key role. In the following, I will illustrate the importance of self-efficacy through Ralf Schwarzer's (2008) Health Action Process Approach (HAPA) model of health behaviour. According to this model, health behaviour is maintained through a cyclical process of initiating, maintaining, and restarting action. In addition, it divides the initiation of action into two phases: the motivational phase and the volitional phase. In the motivational phase, the person sets priorities and weighs the arguments for and against action. Three factors play a role in this phase: perception of threat, expectations of the outcome, and self-efficacy (Urbán, 2022).

The model separates perceived personal self-efficacy into three distinct forms, each differing in function. These are: task self-efficacy, maintenance self-efficacy, and recovery self-efficacy (Health Psychology Department, 2014; Teleki & Tiringer, 2017; Urbán, 2022). Task self-efficacy occurs when a person has not yet taken concrete steps to achieve a goal, but is motivated to do so and is confident in his or her ability to take the necessary actions. Individuals with high self-efficacy envision expected success, strategies, and their anticipated outcomes, while people with low self-efficacy envision failure and defeat. The other type is maintenance self-efficacy, which refers to a person's confidence in his or her ability to overcome difficulties. A person with high self-efficacy will show greater effort and persistence in achieving a goal compared to someone with low self-efficacy. The third type, recovery self-efficacy, is related to the difficulty of relapsing and starting anew. The person perceives relapse as a stumbling block and believes that he or she is capable of making a fresh start. Individuals with high self-efficacy do not blame themselves, instead, they label the stumble as difficulties caused by external circumstances. In contrast, those with low self-efficacy tend to self-blame, attributing their stumble to their own characteristics, often equating the stumble with a complete setback (Health Psychology Department, 2014; Schwarzer, 2008; Urbán, 2022).

The next phase of the model is the volitional phase, which is the post-decision but pre-action phase, and is about translating a person's intention to act into actual action. The success of this stage is facilitated by formulating concrete behavioural changes, making a plan to achieve the specific goal, in which self-efficacy also plays an important role. Self-regulatory processes play a crucial role in cognitive-driven actions, as they help to maintain persistence and overcome obstacles. Self-efficacy is also a key here, as it increases persistence and effort, besides protecting the individual from unexpected external influences (Health Psychology Department, 2014; Urbán, 2022).

So, overall, based on the HAPA model, it can be said that self-efficacy plays an important part in the process from pre-action deliberation and decision making, planning, through to the initiation of the action, its maintenance, and eventually starting it anew. This function of self-efficacy has been confirmed by several studies. One study has shown that outcome expectations, self-efficacy, and threat perception influence predicting the intention to exercise regularly and to control weight (Schwartz & Fuchs, 1995, as cited by Urbán, 2022). Another study that specializes in testicular self-examination, besides intention and outcome expectations, also found self-efficacy to be one of the best predictors of action (Barling & Lehmann, 1999; Urbán, 2022). In a study by Sniehotta et al. (2005), individuals who were undergoing cardiac rehabilitation were examined. They found that, after commitment to action, maintenance self-efficacy and action planning were independent of each other and significant predictors of subsequent physical activity (Sniehotta et al., 2005; Teleki & Tiringer, 2017). Richert et al. (2010) conducted research in which they followed people's vegetable and fruit consumption habits for four weeks. They have shown that planning helped to translate intention into action; however, it also required an appropriate level of self-efficacy. For individuals with low self-efficacy, planning by itself was not sufficient (Richert et al., 2010; Teleki & Tiringer, 2017). Furthermore, the results of a meta-analysis of 95 studies highlight the importance of self-efficacy in predicting health behaviours in the motivational as well as in the volitional phases (Zhang et al., 2019).

There are many chronic diseases known that, during their progression, can lead to a loss of autonomy, and that specific condition can bring low self-efficacy to the patient's life, as well. This process can further exacerbate the patient's condition, which can also induce a low quality of life (Chan, 2021; Cheng et al., 2019). Several studies examining older people come to the conclusion that chronic illnesses have an effect on patients' physical and emotional well-being, and also manifest a deterioration in their quality of life by limiting their daily activities (Carillo et al., 2009, as cited by Öztürk et al., 2011; Franzen et al., 2007; Johansson et al., 2004; Kempen et al., 1999; Wandell & Tovi, 2000). Therefore, the relationship between quality of life, autonomy, and chronic illness can be interpreted as a vicious circle, whereby low socioeconomic status restricts people from living a better quality of life. Besides this, if the condition of an individual already living with a chronic disease deteriorates, it can lead to a regression of his or her autonomy and independence, as well. Now, we can assume that an individual's worsening condition can impact on his or her quality of life, as his or her vulnerability and inability to care for himself or herself consequences that he or she cannot afford a higher quality of life. This, in turn, also leads to a worsening of his or her condition, and so on.

Several research topics have focused on the relationship between chronic patients' quality of life and their self-efficacy. Among others, a study that examined patients on parenteral nutrition found that physical changes correlated with increasing daily functioning, self-efficacy, and emotionally supportive social relationships are important factors for a positive change in quality of life (Theilla et al., 2019). Additionally, the importance of self-efficacy was also highlighted in a study of patients with multiple sclerosis, which found that self-efficacy improves patients' quality of life, however, it is important to note that it also depends on the type of multiple sclerosis (Dehghan et al., 2023). In summary, self-efficacy also influences both the quality of life of chronic patients and the course of their disease.

Research findings and the HAPA model also highlight the role and function of perceived personal self-efficacy. For this reason, it has been determined as an important factor to investigate in my research with chronic patients.

Internal-external control attitude

The theory of locus of control, namely whether a person is located along an internal or external dimension of control, is the brainchild of Julian Rotter (1954; 1966), who has focused on this subject within the social learning theory. Nevertheless, the relevance of believing in fate and luck had already been explored earlier by social scientists and social psychologists, whose work provided an important basis for Rotter's theory (Rotter, 1966). The difference between the two loci of control is that in the case of the internal locus of control, the individual looks to his or her own behaviour for reinforcement. In contrast, the individual who looks for reinforcement to luck, fate, chance, or powerful others falls within the external locus of control attitude (Rotter & Mulry, 1965).

Rotter summarized the results of his earlier research and also published a questionnaire, created by himself, in a paper published in 1966. This method is the so-called I-E Scale, which stands for the terms 'internal' and 'external' control. The questionnaire will be discussed in more detail in the method section later, as I utilized it in my research.

The question of which attitudes discussed above a person possesses is important, as it raises several queries from a health science perspective regarding how some individuals cope with varying levels of chronic illnesses, whether serious or less serious. Rotter's questionnaire was subsequently further developed and enhanced with a third dimension by Levenson (Berend & Kotosz, 2012; Levenson, 1973), namely, we can discuss internal locus of control, powerful others, and chance (Levenson, 1972). Wallston et al. (1978) then adapted Levenson's theory to create the Multidimensional Health Locus of Control (MHLC) model. This adaptation allowed the locus of control theory questionnaire to be utilized for testing health-related attitudes and enabled the examination and explanation of individual variance (Berend & Kotosz, 2012; Wallston et al., 1976, 1978). According to Wallston et al. (1978), the MHLC questionnaire can predict the health behaviors of individuals with diseases. They illustrated this with an example of a patient experiencing unpleasant side effects from a medication prescribed by his or her doctor (an authority figure). If the patient attributes control to a 'powerful other', he or she is likely to continue taking the medication. In contrast, if the patient has a strong sense of 'internal control', it is assumed that after noticing the symptoms, the patient will pause taking the medication for a few days, self-monitor, and then resume taking it to see if the side effects recur. However, those with a dominance of external control, namely the dimension of 'chance', are likely to stop taking the medication entirely (Wallston et al., 1978). Practical use of the questionnaire has shown that individuals with an internal control dominance are more informed about self-diagnosis compared to their external control counterparts (Berend & Komosz, 2012; Lowery & DuCette, 1976), and that prevention is more effective among individuals with internal control (Berend & Kotosz, 2012; Dabbs & Kirscht, 1971).

Consequently, individuals with an internal control attitude dominance are more likely to adopt proactive coping strategies and thus may have a positive impact on their health status. I am thinking here that a patient, who is inquiring about prevention and is also interested and educated about his or her illness, can bring awareness into his or her daily life, which means, for example, adopting supportive habits that have an impact on his or her physiological as well as psychological well-being. Additionally, if a person is in treatment, he or she is more likely to have a successful outcome, but of course, this depends on many other factors and circumstances, as well. In any case, I wanted to highlight that the dominance of the internal locus of control can be a huge advantage in terms of patients' disease progression and is therefore worth exploring.

Hypothesis

Hypothesis 1: A negative change in appearance associated with chronic illness induces lower self-esteem.

Hypothesis 2: Chronic illness is associated with a lower sense of self-efficacy among those who are affected.

Hypothesis 3: For individuals who have a dominant internal locus of control, the impact of their illness and/or treatment on their external appearance does not have as much influence on their self-esteem as it does for people who have a dominance of the external control dimension.

Method

Participants and procedure

The research sample consists of 73 individuals, of whom 55 are women (75.3%) and 18 are men (24.7%). The participants were volunteer young adults; the mean age of the sample is 22.6 years (SD = 5.71), with an age range of 18-35. Among the participants, 30 (41.1%) were diagnosed with a chronic disease, while the control group consisted of 43 (58.9%) healthy individuals. The sample of diagnosed chronic patients was also grouped according to additional criteria (internal-external control attitude, change in external appearance due to disease and/or treatment), which are presented in Table 1. Besides, the chronic diseases indicated by the participants are included in Table 2; the specific designation of the diagnosis was optional, which is why not all categories are shown with a specific designation. Furthermore, it is important to note that the total number of individual diseases is higher than the full sample, as in some cases the cumulative presence of different diseases could be observed.

Table 1
Grouping of diagnosed chronic patients

Aspects	N	%
Change in external appearance		
Yes	22	73.3
No	2	26.7
Internal-external control attitude		
Internal locus of control	11	36.7
External locus of control	19	63.3
Internal-external control attitude and Change in external appearance		
Internal locus of control + No change in external appearance	3	10
Internal locus of control + Change in external appearance	8	26.7
External locus of control + No change in external appearance	5	16.7
External locus of control + Change in external appearance	14	46.7

Note. Distribution (number and percentage) of individuals diagnosed with chronic disease (N=30) according to three grouping criteria. Source: Own compilation.

Table 2
Distribution of chronic disease categories

Chronic disease categories	N	Specific name of the chronic disease
Cardiovascular disease	1	Vitium cordis
Malignant tumour	0	
Benign tumour	1	
Diabetes	1	Type I diabetes mellitus
Respiratory disease	3	Asthma

Chronic disease categories	N	Specific name of the chronic disease
Autoimmune disease	8	Psoriasis, Hashimoto's, Dermatopolymyositis, Crohn's disease, Celiac disease, Rheumatoid arthritis
Acquired immune deficiency	2	
Disease of the musculoskeletal system	2	
Organ failure	1	
Allergy	11	Atopic dermatitis, Pollen, Pet dander, Lactose intolerance
Metabolic disorder	1	Complex malabsorption (suspected IBS)
Insulin resistance	4	
Others	2	Endometriosis
	4	Polycystic ovary syndrome
	2	Migraine

Note. Chronic disease categories were marked by the examined individuals, the number of patients marking the category (number), specific name of the diagnosis (optional). Source: Own compilation.

During the research, I collected data by utilizing a questionnaire package, for which Google Forms provided the interface. Convenience sampling and the snowball method were used. Accordingly, I shared the questionnaire package on different social media platforms in specific closed groups, which were themed around a concrete chronic disease. Participation was anonymous, with the criterion of being at least 18 years old. The questionnaire package was structured as follows: a short information sheet about the research, a consent form, demographic questions, and subsequently three questionnaires. The participants were informed that the results would be treated in aggregate, so that their identities could not be revealed. In the instructions, I asked the respondents to choose the option that best characterized them, and I have drawn their attention not to think too much about any one answer, but to listen to their first impressions. I did not use experimental manipulation in the measurement.

Questionnaires

The data were collected via a self-designed questionnaire package, consisting of a section assessing demographic data, the Rosenberg Self-Esteem Scale, the General Self-Efficacy Scale, and the Internal-External Scale.

Demographic data included the following information: age, biological sex, age at diagnosis, type of chronic disease diagnosed, specific name of the disease (optional), symptoms of the disease, whether and which treatment was received, and if so, the designation and possible side effects of the treatment.

The Rosenberg Self-Esteem Scale was created by Morris Rosenberg in 1965 and is used in contemporary research in positive psychology, personality psychology, as well as health psychology. In 2014, several researchers worked on its Hungarian adaptation: Sallay et al., Rózsa and Komlósi, and Urbán et al. (Sallay et al., 2014). In the current study, I utilize the translation of Rózsa and Komlósi (2014). The scale consists of 10 items, of which items 3, 5, 8, 9, and 10 are reversed. The respondents are asked to rate their level of agreement with the statements on a Likert-type scale from 1 to 4 (Komlósi et al., 2017). The reliability of the questionnaire on the sample is correct (Cronbach's alpha: 0.883).

The original creators of the General Self-Efficacy Scale were Schwarzer and Jerusalem in 1995. The Hungarian adaptation was also made in 1995 by Kopp et al. The scale consists of 10 items. Respondents are asked to rate statements on a Likert-type scale from 1 to 4, considering that the given statement how much is characteristic of them (Hungarian Adaptation of the General Self-Efficacy Scale, 1995). The questionnaire's reliability on the sample is correct (Cronbach's alpha: 0.899).

The Internal-External Scale was published by Julian Rotter in 1966 in a paper summarising the results of his earlier research. Its Hungarian adaptation is attributed to Attila Oláh (1982). The questionnaire consists of 29 items, of which items 1, 8, 14, 19, 24, and 27 are filler items. Also, it measures the individuals' locus of control along two dimensions, i.e., the internal and external control sites (Oláh, 1982). The reliability of the questionnaire on the sample is rather correct (Cronbach's alpha: 0.723).

Statistics

All self-reports were fully completed by all respondents, so all questionnaire data were included in the statistical analysis. Excel and Jamovi were used to organise the database and run the statistical analysis. Also, I used JASP to create figures of the research's results. The assumption of normality was tested with the Shapiro-Wilk Test, and Levene's Test was used in order to check homogeneity. The sample is normally distributed and homogeneous for all three hypotheses.

For the first hypothesis, I used an independent samples t-test. The independent variables were two groups of diagnosed chronic patients, and the grouping variable was the symptom of change in external appearance as a result of illness and/or treatment (Table 1). The dependent variable was the Rosenberg Self-Esteem Scale scores.

Then, an independent samples t-test was used to test the second hypothesis. In this case, the independent variable was the group of diagnosed individuals and the control group (people not diagnosed with a chronic disease). The General Self-Efficacy Scale scores were the dependent variable.

Finally, in order to test the third hypothesis, an ANOVA was used. I separated four groups based on internal-external control attitudes and changes in external appearance within individuals diagnosed with chronic disease: (1) internal control - change in external appearance; (2) internal control - no change in external appearance; (3) external control - change in external appearance and (4) external control - no change in external appearance

(Table 1). These four groups were the independent variable. The dependent variable was the Rosenberg Self-Esteem Scale scores.

Results

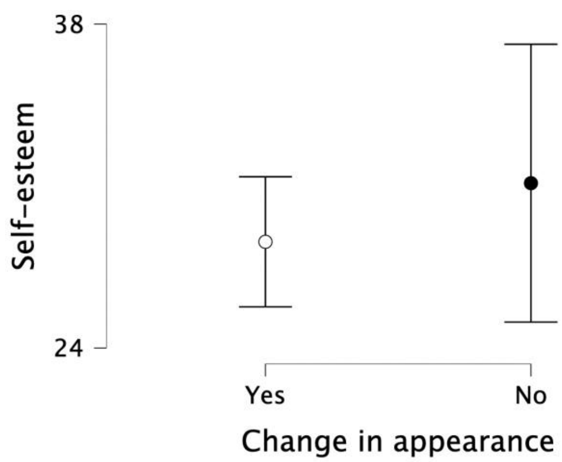
First, to examine the first hypothesis, I used Student's t-test. The results showed no significant difference between the two groups ($t(28) = -0.936$; $p = 0.357$; Cohen's $d = -0.386$). Thus, among individuals diagnosed with a chronic illness, changes in appearance induced by illness and/or treatment do not influence their self-esteem. Table 3 and Figure 1 show the descriptive statistics.

Table 3
Descriptive Statistics of the First Hypothesis

Variable	N	M	SD
Group 1	22	28.6	6.34
Group 2	8	31.1	7.18

Note. Group 1 = chronically ill individuals who experienced changes in their external appearance, Group 2 = chronically ill individuals who have not experienced changes in their external appearance. Source: Own compliation based on Jamovi.

Figure 1
Descriptive Plots of the First Hypothesis



Note. Source: JASP.

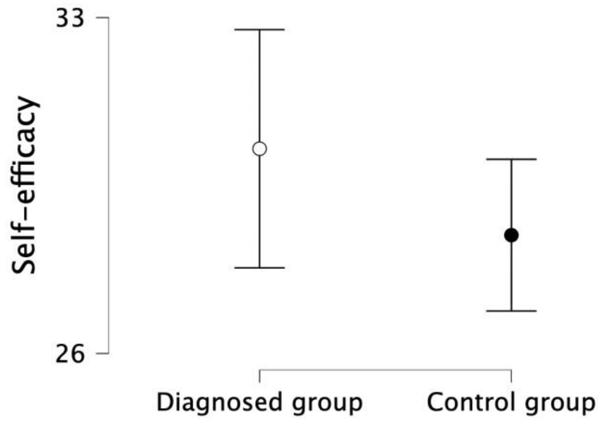
Secondly, I used Student's t-test to verify the second hypothesis. According to the results, there is no significant difference between the two groups ($t(71) = -1.31$; $p = 0.196$; Cohen's $d = -0.310$). In other words, I found no difference in self-efficacy levels between those with a chronic illness diagnosis compared to the control group's (individuals not diagnosed with a chronic illness) self-efficacy levels. See Table 4 and Figure 2 for the descriptive statistics.

Table 4
Descriptive Statistics of the Second Hypothesis

Variable	N	M	SD
Group 1	43	28.5	5.14
Group 2	30	30.3	6.65

Note. Group 1 = participants non-diagnosed with chronic diseases, Group 2 = participants diagnosed with chronic diseases. Source: Own complication based on Jamovi.

Figure 2
Descriptive Plots of the Second Hypothesis



Note. Source: JASP.

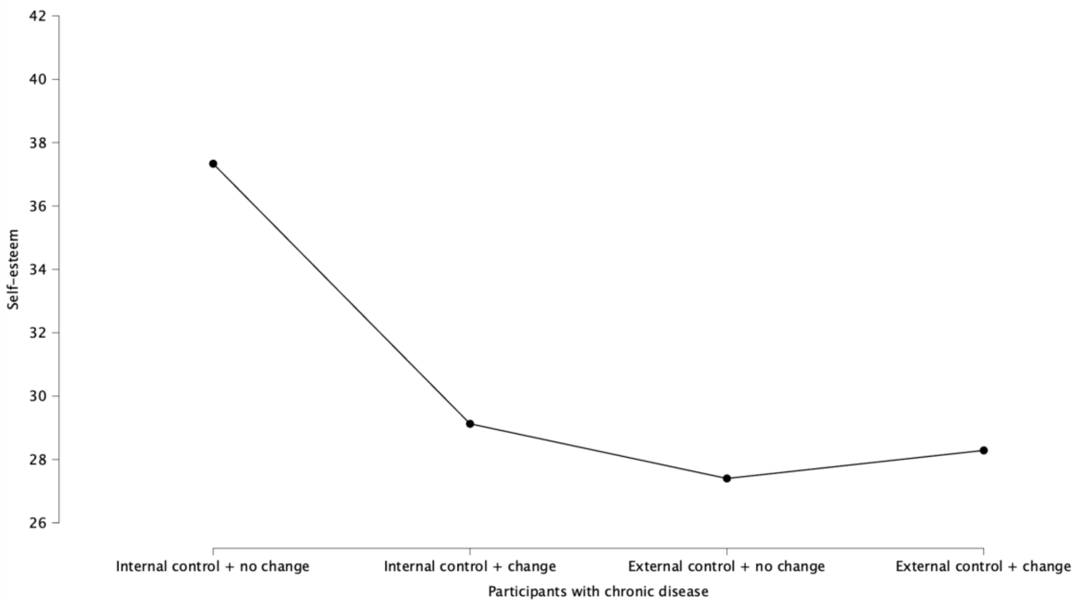
At last, for the third hypothesis, the results of the ANOVA showed no significant difference between the four groups ($F(3,26) = 1.93$; $p = 0.149$; $\eta p^2 = 0.182$). Consequently, whether the dimension of internal or external control is dominant for a person does not influence the self-esteem of chronically ill individuals experiencing changes in external appearance. The descriptive statistics can be seen in Table 5 and Figure 3.

Table 5
Descriptive Statistics of the Third Hypothesis

Variable	N	M	SD	95% Confidence Interval	
				Lower	Upper
Group 1	8	37.3	4.3	29.9	44.8
Group 2	3	29.1	1.2	24.6	33.7
Group 3	14	27.4	7.4	21.7	33.1
Group 4	5	28.3	6.6	24.9	31.7

Note. Group 1 = internal control - change in external appearance, Group 2 = internal control - no change in external appearance, Group 3 = external control - change in external appearance, Group 4 = external control - no change in external appearance. Source: Own complication based on Jamovi and JASP.

Figure 3
Descriptive Plots of the Third Hypothesis



Note. Source: JASP.

Discussion

The first hypothesis, that is, a negative change in appearance associated with chronic illness would induce lower self-esteem, was not supported by the findings. However, the descriptive statistics show (Table 3 and Figure 1) that the group that experienced a change in appearance as a result of disease symptoms and/or treatment received, had a lower mean score (M = 28.6) in self-esteem compared to the group that did not experience such symptoms (M = 31.1). This non-significant result can be explained first of all by the small number of elements and the deficiency of the sample. It is important to underline that one-third of the 30 individuals were diagnosed with allergies (Table 2). This kind of condition rarely goes with symptoms that can have a serious impact on the appearance and thus the self-esteem of the person. In light of the findings, another way of looking at the results may be suggested, which states that positive self-esteem may have a protective role for chronic patients. I would like to refer back to the TMT theory by Greenberg et al. (1986). Accordingly, a diagnosis of a chronic illness, I am thinking here of autoimmune diseases or cancer, may induce feelings of mortality and anxiety, which the person copes with by distal defenses, and that can reinforce the individual's self-esteem in a positive direction.

The second hypothesis, that is, chronic illness would be associated with a lower sense of self-efficacy in affected individuals, was not demonstrated. One explanation can be that the sample is weak: it has a low number of elements, and there are only a few cases, which may mean a diagnosis and/or treatment that consistently renders daily life more difficult and inhibits self-care. On the other hand, this result can also be interpreted as the need for chronic patients to adapt to the changes caused by their illness and the different treatments. In order to overcome difficulties and accept changes, patients need to develop and implement different self-specific strategies. This process requires a higher level of self-efficacy. Referring back to Schwarzer's (2008) HAPA model, it assumes three types of self-efficacy, which influence the person's health behaviour from planning and initiating an action, through maintaining it, to starting over again. Considering the current findings and the theory of the HAPA model, it is possible that during the coping process, the self-efficacy of the individual concerned does not deteriorate, but is maintained or even increased. The descriptive statistics (Table 4 and Figure 2) also show that the mean score ($M = 30.3$) in self-efficacy of the participants diagnosed with chronic illness is higher compared to the mean score ($M = 28.5$) of the control group (respondents without chronic illness).

Supplementary, as an outlook, it may be worth considering reclassifying people diagnosed with an allergy to the group of individuals not diagnosed with a chronic disease. Besides, another option could be to examine the development of self-efficacy separately in three different groups. These groups would be: (1) people without chronic illness diagnosis (control group); (2) individuals with a diagnosis of chronic disease who have a prognosis, that is compatible with daily life, performance of basic tasks and self-care (such as polycystic ovary syndrome, atopic dermatitis, etc.); and (3) patients with chronic disease diagnosis whose illness, sooner or later, prove to be incompatible with everyday responsibilities and may be unable to perform self-care with assistance or completely (for instance Parkinson's disease). Furthermore, it may also be useful in the future to consider examining the treatment received's effectiveness and how it has an impact on patients' self-efficacy and thus their self-esteem.

The findings did not support the third hypothesis, which investigated the internal and external control attitudes of people diagnosed with a chronic disease in relation to the symptom(s) and side effect(s) of their illness and/or treatment. The analysis results conducted to test the hypothesis did not show any significant differences between the four groups (Table 5 and Figure 3). However, it is important to point out that since the effect size is higher than 0.1 ($\eta p^2 = 0.182$), it can be assumed that if a larger sample could be drawn, it may be possible to detect a significant difference between the four groups. Therefore, it is strongly recommended to extend the database for the future. Additionally, it is also recommended to reconsider the grouping criteria, as the already small sample (30 participants) was grouped according to two criteria (internal-external control attitude and change in external appearance) proved to be too much; the distribution of certain groups is unfavourable (Table 1). Finally, I would contemplate utilizing the questionnaire developed by Wallston et al. (1978) instead of the I-E Scale (Rotter, 1966), as the MHLC questionnaire has already been supplemented with a third dimension, and moreover, it was developed to examine health-related attitudes and individual variance.

I consider a limitation of this work to be that it focuses on a rather specific population: chronically ill young adults. The respondents are mainly university students, most of them are healthy or have been diagnosed with a less serious illness that is more compatible with everyday life. Due to a lack of resources, I was unable to get into such institutions for the purpose of collecting data, where I could meet more individuals who correspond to the criteria. For this and the reasons mentioned above, I consider it important to supplement the current database in the future.

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Laura Luksik – Psychology MA student
luksiklaura1@gmail.com

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Validation of the Brief Autism Mealtime Behavior Inventory (BAMBI) on a Hungarian sample

Focusing on the eating behavior of
children with autism and their siblings

Bettina Trixler [1]
Henriette Pusztafalvi [2]

1: Doctoral School of Health Sciences,
Faculty of Health Sciences, University of Pécs
2: Department of Health Promotion and Public Health,
Faculty of Health Sciences, University of Pécs

ABSTRACT

In children diagnosed with autism spectrum, mealtimes are often marked by complex behavioral and sensory difficulties. Selective eating, mealtime rituals, and the refusal of new foods are common characteristics that significantly burden families and impact children's nutrient intake, growth, and development. The aim of this study was to translate the Brief Autism Mealtime Behavior Inventory (BAMBI) into Hungarian, culturally adapt it, and examine its psychometric properties, with particular focus on reliability and validity. The validation of the instrument was based on responses from parents of autistic children aged 3 to 11 years. The internal consistency analysis initially revealed a low Cronbach's alpha value ($\alpha = 0.367$), which increased to 0.743 after the removal of problematic items. Exploratory factor analysis identified four thematically distinct factors, accounting for a total explained variance of 50.5%. Thus, the structural validity of the questionnaire was partially supported, although the reliability of certain subscales may require further refinement. A unique feature of this study is that, in addition to the validation procedure, it also included qualitative and quantitative data collection on the eating behavior of neurotypical siblings. According to parental reports, the behavior of the autistic sibling appeared to influence the family's mealtime routines as well as the habits of the neurotypical sibling. Based on the questionnaire results, a statistically significant difference ($p < 0.001$) was found between the eating behaviors of autistic and neurotypical children across all examined scales. These findings suggest that the BAMBI questionnaire could be applicable within the Hungarian population, although further studies are needed to more accurately determine the scale's sensitivity and diagnostic applicability, especially regarding the family context.

Keywords: autism spectrum, nutrition, validation, sibling

Introduction

Autism spectrum is a pervasive neurodevelopmental condition characterized by persistent and significant deficits in social interaction and communication skills, as well as restricted, repetitive patterns of behavior, interests, or activities (APA, 2022). Epidemiological data estimate its prevalence to be between 1–2%, with a male-to-female ratio of approximately 4:1 (Baio et al., 2018). As a lifelong condition, it entails complex care needs (Rixon et al., 2025). The development of various feeding behavior problems observed in children with autism may be influenced by the characteristics of the condition, such as inflexible behavioral organization, heightened sensory sensitivity, and stereotyped, repetitive interests (Johnson et al., 2014).

Difficulties related to eating are among the most frequently reported problems in individuals with autism, with their origins attributed to multiple factors, including behavioral, cognitive, and environmental causes (Vissoker et al., 2015). Unusual eating patterns may involve sensitivities to certain textures and smells, refusal of specific foods, and limited dietary variety (Castro et al., 2016), which are often observed regardless of age or cognitive functioning (Carruth & Skinner, 2000). Selective eating is observed in up to 70% of children with autism (Cermak et al., 2010), and the prevalence of feeding disorders ranges from 46% to 89%, compared to 25% in the neurotypical population (Johnson et al., 2014). Common difficulties include food selectivity, food refusal, the presence of mealtime rituals, reduced appetite, consumption of non-food items, and challenging behaviors during meals (Attlee et al., 2015). The formation of eating habits is also influenced by repetitive behavior patterns and rituals, fear of novelty, inflexible behavioral organization, and hypersensitivity or hyposensitivity to sensory stimuli (Klintwall et al., 2011).

The eating characteristics observed in autism can increase the risk of developing comorbidities (Leader et al., 2022). An increasing number of studies highlight the importance of examining the type and extent of nutrient deficiencies, as well as the intake of macronutrients and micronutrients (Ranjan & Nasser, 2015), since the diet of individuals with autism is typically characterized by higher consumption of sugary drinks and snacks and lower intake of fruits and vegetables (Evans et al., 2012). Food consumption may be challenging at multiple points (e.g., shape, texture, sounds during chewing, prior experiences related to the food); therefore, it is of cardinal importance to identify early difficulties and factors related to sensory processing that may contribute to the development of feeding disorders (Kern et al., 2006). The atypical nature of eating habits may lead to long-term health problems, which impose a significant burden on both society and healthcare systems (Criado et al., 2017). Families may encounter difficulties in accessing appropriate services, and the lack of support can intensify negative psychological effects (Salgado, 2020). Without proper assistance and intervention, these issues and complaints may persist in the long term (Suarez et al., 2013). The use of specific assessment tools to measure feeding problems is necessary; however, most existing instruments were developed for use with neurotypical populations or are researcher-created tools that often have not been tested for validity and reliability (Baraskewich et al., 2021).

In children diagnosed with autism spectrum, difficulties related to eating can lead to malnutrition, the emergence of problematic behaviors, or rigid eating habits (Lukens & Linscheid, 2008), which can place an increased burden on family members. The atmosphere of shared mealtimes may become tense, as the child often requires special attention, support, or specially prepared meals. These behaviors may hinder the child's daily routine and integration into social environments (Nadon et al., 2010). A connection has been identified between eating behaviors and parental stress, which negatively affects the quality of family life (Thullen & Bonsall, 2017). Parents prioritize the management of their child's eating habits (Galpin et al., 2017). The duration of mealtimes may be altered, and oral motor difficulties should also be noted, along with issues such as drooling, gagging, or choking, which can result in negative experiences related to food consumption. Additionally, the child may only accept food presented in a specific manner (Provost et al., 2010). These challenges often lead to the development of atypical behaviors that manifest in maladaptive reactions (e.g., tantrums, food throwing, spitting), thereby altering the family's mealtime routines. Parents perceive dinnertime as burdensome; the child requires increased attention, and interactions among family members become restricted (Marquenie et al., 2011). Dietary differences are also observed among siblings, which highlights the need for interventions to take into account potential interactions between children with autism and their family members (Mathew et al., 2022). In the study by Marquenie et al. (2011), mothers reported that their autistic child's limited food preferences also influenced the eating habits of the rest of the family. Among typically developing siblings, involvement in supporting the autistic child's eating or in household responsibilities, as well as the need to follow frequently different mealtime rules, may lead to an increased rate of conflicts (Ausderau & Juarez, 2013). Given the rising prevalence and complex nature of autism, along with its impact on the family environment, it is especially important to assess the condition of siblings, as both child and parent characteristics and behavioral patterns influence the quality of sibling relationships and the siblings' adaptation (Petalas et al., 2009).

Mapping eating-related behaviors in children with autism is not only diagnostically relevant but also essential for planning individualized, family-centered interventions. The Brief Autism Mealtime Behavior Inventory (BAMBI) questionnaire offers a structured means to identify specific mealtime challenges, which can inform support strategies tailored to both the child's needs and the family's routines. Evidence-based practices emphasize that early recognition of atypical eating patterns allows for more targeted intervention goals and increases the likelihood of positive outcomes (Palmieri & Powers, 2013). These strategies often include structured meal environments, gradual exposure to new foods, and the use of visual aids. These approaches help reduce family stress and improve the child's nutritional intake. As highlighted by Havasi and Janoch (2009), feeding difficulties should be interpreted within the broader behavioral context of autism and seen as behaviors that can be shaped and supported through appropriate educational and therapeutic methods. Thus, the use of assessment tools such as BAMBI facilitates not only the identification of challenges but also the development of practical, operationalized goals that support both the child and their family in everyday life.

Data and Methods

The BAMBI Questionnaire

The development of the Brief Autism Mealtime Behavior Inventory (BAMBI) was aimed at enabling the synthesis of information regarding the mealtime behavior of individuals diagnosed with autism. The creation of a simple assessment tool for nutritional problems also made it possible to apply the instrument in clinical practice. The tool is intended to assess behaviors in the autistic population that are considered common, yet are often not addressed in sufficient detail by other questionnaires or within the clinical history. The earliest version of the questionnaire, developed in English, consisted of 20 items across 3 dimensions (Lukens, 2002).

The questionnaire was revised, and the modified version consists of 18 items and uses a Likert scale to measure the frequency of behaviors. A score of 1 indicates that the behavior never occurs, while a score of 5 means that the behavior described in the item always occurs. The total score is the sum of the results from three separate subscales, with higher scores indicating a greater degree of problematic behavior. For four items (Statements 3, 9, 10, and 15), reverse scoring is applied to account for the assessment of positive eating behaviors. The minimum possible total score is 18, while the maximum is 90. The Limited Variety subscale (Items 10, 11, 13, 14, 15, 16, 17, and 18) measures willingness to try new foods. The Food Refusal subscale (Items 1, 2, 4, 7, and 8) targets behavioral problems that occur during food refusal. The Features of Autism factor (Items 3, 5, 6, 9, and 12) includes behavioral characteristics typically associated with autism, such as stereotypical behavior and self-injurious actions. The questionnaire is completed by parents or caregivers based on their observations and experiences. The instrument was validated among children aged 3–11 years with and without autism spectrum. Internal consistency reliability was confirmed by a Cronbach's alpha of 0.88. For the individual subscales, the values were 0.87 (Limited Variety), 0.76 (Food Refusal), and 0.63 (Features of Autism). Test–retest reliability showed a high value ($r = 0.87$), and interrater reliability was also strong ($r = 0.78$; Lukens & Linscheid, 2008).

The BAMBI questionnaire has been validated in Brazilian Portuguese, taking into account linguistic and cultural adaptation aspects (Castro et al., 2019), and a version suitable for use in research has also been developed in Italian (Lamboglia et al., 2023). Meral and Fidan (2014) developed the Turkish version, while Huong and her research team (2022) translated the instrument into Vietnamese.

Objectives

The primary aim of the present study is to translate the English-language Brief Autism Mealtime Behavior Inventory (BAMBI) into Hungarian, culturally adapt it, and examine its psychometric properties—particularly its reliability and validity—based on parent-reported data from children with autism aged 3 to 11 years.

As the second pillar of the research, we aim to present data related to neurotypical siblings, with a particular focus on how the eating behavior of a child with autism may influence the family's mealtime habits and the nutritional behavior of siblings.

The third objective of the study is to compare the BAMBI scores of children with autism and their similarly aged neurotypical siblings (or children with siblings). In addition to the quantitative comparative analysis, we also examine similarities and differences in eating behavior patterns qualitatively, with special attention to uncovering the mutual influences within the family context.

Validation Process

As the first step of the validation process (Boateng et al., 2018), the authors of the BAMBI questionnaire were contacted via email. Colleen Taylor Lukens (Pediatric Feeding and Swallowing Center and Department of Child and Adolescent Psychiatry and Behavioral Sciences at Children's Hospital of Philadelphia/USA) provided official written permission to conduct the study on March 21, 2025. The research followed the internationally accepted protocol and was carried out in full compliance with the GDPR in force within the European Union. The original questionnaire was independently translated by a fluent English-speaking researcher, a translator, and a professional language specialist. Differences in translation were resolved through a professional discussion with the help of a coordinating language specialist, resulting in a consensus version. Due to the self-administered nature of the questionnaire, the main focus was on conceptual equivalence, ease of completion, and clear, lightly interpretable wording of the questions. As expected, some discrepancies arose between the translations of the subject-matter expert and the language specialist, particularly in the adaptation of domain-specific terminology. The resulting consensus version was back-translated into English by another professional translator and a researcher who is a native English speaker. Neither had access to the original version of the questionnaire, and had not previously been involved in the study. The two researchers conducting the study and all the translators discussed any potential differences between the versions of the questionnaire to finalize the test version. Using the snowball method, the researchers recruited participants from their immediate surroundings who met the future inclusion criteria, asking them to complete the questionnaire and provide qualitative feedback on the clarity of the items. Eighteen individuals participated in this feedback process after providing informed consent. They were not involved as participants in the main study. Based on the feedback, the wording of a few items was modified to ensure that the language and content would be clear and appropriate for the target population. During the pilot assessment, all participants rated the questionnaire items as comprehensible. The time required to complete the form ranged from 10 to 15 minutes. No suggestions were made regarding substantial content modifications.

The finalized version of the questionnaire was completed by parents and caregivers. Data collection took place in April 2025 using a purposive sampling method over a period of one month. A nationwide cross-sectional data collection was conducted. The questionnaire was distributed in online format through civil organizations, educational institutions, and parent groups. In addition to the BAMBI questionnaire, we included questions about sociodemographic data (gender, age, educational background, place of residence) and the autistic child's sibling, in order to examine sibling influences and compare behavioral patterns, as limited information is available on this topic in the literature. Preprocessing and summarizing of the data (descriptive statistics) were carried out using Microsoft Excel 2019, and statistical analyses (Cronbach's alpha, factor analysis) were performed with IBM SPSS Statistics version 27.0.

Results

Sociodemographic Characteristics of Caregivers and Children with Autism

A total of 70 individuals completed the questionnaire; however, due to age-related data variation, the responses of caregivers for 49 children were included in the final analysis. Among the respondents, 47 were female caregivers. Their average age was 38.08 ± 6.81 years. In terms of educational attainment, 21 had completed vocational secondary school or general secondary school, 9 held vocational training, trade school, or OKJ qualifications, 18 had college or university degrees, and 1 respondent had only completed primary school. Regarding place of residence, 23 families lived in towns, while 13 resided in villages. The number of families living in county seats and the capital was 7 and 6, respectively. On average, 3.90 ± 1.07 individuals lived together in each household. In 29 families, members ate together multiple times a day, while in 2 families, there was at least one shared meal per day. In 5 families, meals were irregular and generally eaten separately, and 12 children ate with only one parent. In 56.6% of families, no food allergies were reported. Food allergies, intolerances, or special dietary needs were documented in 9.4% of autistic children, 7.5% of siblings, and in 26.4% of other family members.

The average age of the autistic children was 6.69 ± 2.34 years, with a gender distribution of 38 boys and 11 girls. Three children received nursery care, 29 attended kindergarten, 16 were enrolled in school, and 1 child had completed primary school. A total of 18 children received services in special education institutions, while 31 children participated in daily activities within inclusive settings. In 41 cases, both parents were involved in the child's upbringing, while in 8 cases, one parent raised the child alone. Sixteen autistic children had an older sibling, thirteen had a younger sibling, and the sample also included one set of twins.

Results of the Questionnaire Validation

The reliability of the BAMBI questionnaire was assessed using the Cronbach's alpha coefficient. The initial Cronbach's alpha value for the total scale proved to be low ($\alpha = 0.367$), indicating weak internal consistency. Based on the analysis of item-total correlations, two problematic items were identified (Item 11: -0.055 and Item 17: -0.254). After removing Item 17, the alpha value increased to 0.74, which is considered an acceptable level of

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reliability. To explore the internal structure of the questionnaire, we conducted an exploratory factor analysis (Principal Axis Factoring), supplemented by Varimax rotation to maximize interpretability. The sample's suitability for factor analysis was confirmed by the Kaiser-Meyer-Olkin measure (0.706) and the Bartlett's test of sphericity, the latter yielding a significant result ($p < 0.001$), thereby supporting the feasibility of factor analysis. In our study, five principal components were identified, collectively explaining 52.3% of the total variance. Based on the rotated factor matrix (see Table 1), several distinct thematic dimensions emerged. Items in the first factor were related to food selectivity and preference for familiar foods. The second factor reflected rigid preferences, imitation, and inflexible behaviors. The third factor captured situations involving tension and behavioral issues. The fourth factor grouped ritualistic and stereotypical mealtime behaviors, while the fifth factor referred to preferences associated with sensory sensitivity. Several items did not clearly load on any single factor or had weak associations with multiple factors, suggesting that they lacked specific factorial alignment. These items may be considered for exclusion from further analyses or examined separately. Their weak structural fit may potentially compromise the construct validity of the questionnaire.

Table 1
Summary Table of the Factor Analysis

Item	Highest Loading	Assigned Factor
Item 1	0.755	Factor 3
Item 2	0.520	Factor 1
Item 3	0.751	Factor 1
Item 4	0.389	Not clear (removal may be considered)
Item 5	0.794	Factor 5
Item 6	0.542	Factor 4
Item 7	0.611	Factor 3 (may appear in multiple factors, strongest here)
Item 8	0.462	Factor 3
Item 9	0.517	Factor 1
Item 10	0.856	Factor 1
Item 11	0.491	Factor 1 (may appear in multiple factors, strongest here)
Item 12	0.300	Factor 4 (usefulness questionable due to weakness)
Item 13	0.832	Factor 2
Item 14	0.497	Factor 2
Item 15	0.533	Factor 1
Item 16	0.402	Factor 2
Item 17	-	Removed
Item 18	0.733	Factor 4

With the removal of the questionable items, the Cronbach's alpha value increased to 0.719. After the deletion of Items 4, 12, and 17, the structural coherence of the questionnaire improved, internal consistency reached an acceptable level, and the factor structure became more interpretable. The value of the Kaiser-Meyer-Olkin measure was 0.699, and Bartlett's test yielded a significant result ($p < 0.001$). The four identified factors jointly explained 50.5% of the total variance, with the first factor accounting for the largest proportion (25.25%). Item 9 did not show a sufficiently strong correlation with any factor (see Table 2).

Table 2
Factor Analysis After Removal of Items 4, 12, and 17

Item	Highest Loading	Assigned Factor
Item 1	0.674	Factor 2
Item 2	0.707	Factor 1
Item 3	0.637	Factor 1
Item 5	0.843	Factor 4
Item 6	0.721	Factor 3
Item 7	0.613	Factor 2
Item 8	0.740	Factor 2
Item 9	0.355	Cannot be clearly assigned
Item 10	0.681	Factor 1
Item 11	0.547	Factor 1
Item 13	0.677	Factor 1
Item 14	0.736	Factor 1
Item 15	0.701	Factor 1
Item 16	0.538	Factor 1
Item 18	0.652	Factor 3

After the removal of Items 4, 9, 12, and 17, the revised 14-item version of the scale yielded a reliability coefficient of 0.702. Item 18 showed a negative item–total correlation (-0.116), which may indicate that this item deviated from the general pattern of the scale. Table 3 summarizes the changes in reliability for each subscale, while Table 4 presents the results following the factor analysis.

Table 3
Changes in Subscale Reliability with Different Item Exclusions

Scale Version	Limited Variety α	Food Refusal α	Features of Autism α	Total α
Full Scale (18 items)	-0.480	0.579	0.394	0.367
Without Item 17	0.585	0.579	0.394	0.743
Without Items 4, 12, and 17	0.585	0.545	0.447	0.719
Without Items 4, 9, 12, and 17	0.585	0.545	0.278	0.702

Table 4
Changes in Subscale Reliability Values After Different Factor Analyses

Scale Version	Factor 1 α	Factor 2 α	Factor 3 α	Factor 4 α	Factor 5 α	Total α
Without Item 17 (Item 4 was difficult to assign)	0.807	0.713	0.634	0.41	not relevant (1 item)	0.727
Without Items 4, 12, and 17 (Item 9 not assigned)	0.852	0.634	0.387	not relevant (1 item)	not available	0.720

For certain items of the BAMBI questionnaire, parents were also asked to indicate whether the given eating behavior was perceived as problematic for them. However, the response rate for these yes/no options was low in the sample, and analyzing them could have significantly distorted the results. For children with autism, the number of yes/no responses ranged from a minimum of 10 to a maximum of 29, with an average response rate of 38.21% (out of 49 respondents). Regarding the eating behavior of neurotypical siblings, the number of responses to the yes/no questions ranged from 4 to 24 (out of 29 respondents), with an average response rate of 45.02%.

Statements Regarding Neurotypical Siblings

In the study, data were also collected from the 3–11 age group of neurotypical siblings of autistic children. In addition to completing a specific questionnaire, qualitative data were gathered through open-ended items to explore similarities in behavioral manifestations between the sibling and the autistic child. In total, 29 responses were received from caregivers regarding the sibling component of the study, of which 15 referred to female siblings. The average age of the neurotypical siblings was 6.59 ± 2.86 years. Four children attended nursery, 11 attended kindergarten, 11 attended school, and 3 had completed primary education. Seventeen neurotypical siblings were younger than their autistic sibling, one sibling pair was of the same age, and in 11 cases the sibling was older than the autistic child. Thirteen families lived in towns, eight in villages, and four families each lived in county seats or the capital. On average, 4.38 ± 0.90 individuals lived in each household. In 54.8% of the families, no food allergies were reported. Among neurotypical siblings, food sensitivities were present in 9.7% of cases, while for their autistic siblings, this figure was 12.9%. Among other family members, the issue was reported in 22.6% of cases. In 17 families, meals were shared multiple times a day; in 3 families, one meal was shared daily. In 3 cases, meals were eaten irregularly and separately, and in 6 families, one parent ate separately with the autistic child. The average age of the autistic siblings was 6.93 ± 2.99 years, with a gender distribution of 23 boys and 6 girls. In 22 cases, both parents were involved in raising the child.

The demographic data of the caregivers who completed the questionnaire were as follows: among the respondents, 28 were female caregivers or parents, with an average age of 38.17 ± 5.76 years. Of the participants, 14 had completed vocational secondary school or general secondary school, 9 held a college or university degree, and 6 had vocational training, trade school, or OKJ certification.

Regarding the eating behavior of the neurotypical child, 14 parents reported no difficulties. However, in 5 cases, they noted selective eating behaviors, such as the child refusing foods they disliked. Three respondents stated that *"the sibling imitates the autistic child"* (mother, 40), while another 3 reported signs of overeating. Two parents mentioned conflicts during meals: *"It bothers him when his sibling has tantrums during meals"* (mother, 38); *"He becomes nervous and restless in such situations"* (mother, 45).
In 11 cases, the typically developing child did not imitate their autistic sibling's behaviors, but 6 parents indicated some degree of mimicry: *"Behavioral patterns, he says he wants to be autistic and have ADHD"* (mother, 35); *"He even imitates wearing diapers"* (mother, 28); *"The younger sibling adopts many things that aren't good"* (mother, 40). Parents observed imitation not only in general behaviors but also in eating habits: *"He has also become picky"* (mother, 45); *"He rejects certain foods just as intensely as his sibling does"* (mother, 39); *"He asks for the same foods as his sibling"* (mother, 40). Conversely, one parent reported the opposite: *"He tries more foods and enjoys eating with his sibling"* (mother, 30).

In terms of differences between the children, 14 parents mentioned food preferences and selective eating: *"The autistic sibling is picky and eats very little"* (mother, 28); *"The neurotypical child eats a lot more vegetables and fruits and eats anything without being selective"* (mother, 35); *"The autistic child won't eat cubed meat"* (mother, 26). Seven parents noted that the sibling was more open to new things: *"The neurotypical child is willing to try new foods"* (mother, 45). Regarding food quantity, 5 parents responded, but the data were contradictory: *"The neurotypical child is picky and eats less"* (mother, 28); *"The NT (neurotypical) children eat more than the autistic ones"* (mother, 40). Three parents highlighted a key difference, being that their autistic child prefers to eat alone. One parent reported no behavioral differences between the children. Concerning behavior during meals, accounts from 3 parents also revealed inconsistencies: *"The autistic child eats* *calmly, while the other one fidgets"* (mother, 30); *"The sibling is more flexible"* (mother, 37).

In 9 families, the eating behavior of the autistic child did not influence the family's routines. Two parents described the behavior as temporary. However, in 15 families, challenges were reported in areas such as organization, behavior management, meal preparation, and emotional atmosphere: *"We can't eat at the same time—someone always has to take care of him"* (mother, 38); *"Foods meant to be eaten by hand must be picked up for him and placed in his mouth piece by piece"* (mother, 28); *"We have to cook several different meals because of selective eating"* (mother, 39); *"Mealtime is always complete chaos"* (mother, 28).

Regarding the neurotypical child's adaptation, 9 parents stated that their child does not need to adapt to their autistic sibling: *"It's rather the autistic one who adapts to the younger sibling"* (mother, 30); *"They don't have to, but often imitate by choice"* (mother, 40). Four respondents felt that the sibling has to adapt partially: *"We try to consider the habits of all three children"* (mother, 40); *"In terms of eating, no adaptation is needed, but in other areas, yes"* (mother, 34). In the majority of families (13 respondents), adaptation was related to seating arrangements, rigid routines, patience, emotional burden, and the notion of fairness: *"The autistic sibling gets served first because otherwise there's a meltdown"* (mother, 33); *„It requires great patience, lost time, and it harms his sense of fairness"* (mother, 44); *"We always try to please the autistic one to avoid tantrums—it's very hard because the other ends up being sidelined"* (mother, 38). Fifteen parents reported no tension or sense of unfairness between the siblings during mealtimes, while three mentioned mild tension. Six parents described clear signs of tension: *"Because of the seating arrangement, the sibling always has to adapt"* (mother, 42); *"Yes, it feels bad that the typically developing child doesn't get as much attention"* (mother, 38); *"But I try to be fair"* (mother, 28).

Parents also reported a variety of personal emotional responses due to their children's differing needs. Four respondents expressed a conscious effort to understand and empathize with their child: *"I was force-fed in elementary school, so I know what it's like and I don't want my son to go through that"* (mother, 28); *"I understand and accept it"* (mother, 45). Acceptance and adaptation appeared in the responses of 9 participants: *"I got used to it"* (mother, 34); *"We accept it"* (mother, 37). However, four parents expressed strong concerns and uncertainty: *"It's hard to see them eat like that, and it's exhausting to always think of everything to make sure there's food on the table that everyone can eat"* (mother, 40); *"Sometimes I worry about whether my autistic child is getting the right nutrients"* (mother, 33).

Negative emotions dominated in the responses of 8 parents: *"It's frustrating, but we try to adapt and avoid crises—sometimes it's just annoying"* (mother, 40); *"It's very disturbing and exhausting to always cook separately for my autistic son"* (mother, 39); *"Desperation and uncertainty"* (mother, 39). Finally, 9 parents reported trying to intervene to prevent the neurotypical siblings from adopting behavioral patterns: *"Yes, we tried, but so far with little success"* (mother, 39); *"I talk to the siblings, but they're still kids, and they* *copy each other"* (mother, 28); *"We try to explain things, but they're still quite young for that"* (mother, 40). In 14 cases, however, parents reported that such intervention was not necessary.

Comparative Analysis

During data processing, we compared the BAMBI scores from questionnaires completed by the parents of autistic and neurotypical children (see Table 5). The aim of our analysis was to examine whether there were statistically significant differences in eating behavior between the two groups in terms of the total BAMBI score and its subscales. As a first step, we used the Shapiro–Wilk test to assess the distribution of each variable by group. Based on the results, we applied an independent samples t-test for the total score and the Limited Variety subscale, and the Mann–Whitney U test for the Food Refusal and Features of Autism subscales. The comparison of scores between autistic and neurotypical children revealed statistically significant differences across all scales examined ($p < 0.001$). According to these findings, children with autism exhibited significantly different eating behaviors compared to their neurotypical peers.

Table 5
BAMBI Scores of Autistic (N = 49) and Neurotypical Siblings (N = 29)

	Autistic children				Neurotypical siblings			
	Limited variety	Food Refusal	Features of Autism	Total score	Limited variety	Food Refusal	Features of Autism	Total score
Mean	24.69	9.51	10.53	44.73	15.41	6.62	8.07	30.10
Standard deviation	± 6.26	± 3.70	± 3.30	± 10.96	± 3.15	± 2.24	± 2.70	± 5.92
Minimum	8	5	5	23	8	5	5	18
Maximum	37	21	21	77	21	13	15	43

Discussion

The Cronbach's alpha values obtained in the present Hungarian-language validation study differ in part from those reported in the international literature. While the internal consistency of the total scale (Cronbach's alpha = 0.743) falls within an acceptable range, the reliability indices of the subscales proved to be lower. This result contrasts, for example, with findings from the Vietnamese validation. That study, conducted in 2021 with the participation of parents of 198 children with autism aged 1–15 years, reported a Cronbach's alpha of 0.78 for the complete BAMBI scale, indicating acceptable consistency. The item-level Cronbach's alpha values ranged between 0.76 and 0.79. However, during exploratory factor analysis, four items were excluded from the model due to factor loadings that exceeded the accepted threshold. An alternative five-factor structure was developed based on 14 items (Huong et al., 2022). Similarly favorable outcomes were reported in the Italian study by Tofani & Galeoto (2023), which involved 131 children aged 6–10 years and examined their feeding habits and behaviors. The internal consistency was significant for both autistic and typically developing children, with Cronbach's alpha values ranging between 0.71 and 0.86. Test–retest reliability for individual BAMBI items yielded excellent results, falling within the range of 0.83 to 1.00. The study also explored differences by gender and body mass index, but no significant differences were found between groups for these variables. The Brazilian study by Castro and colleagues (2019), conducted between 2016 and 2018, included a total of 410 participants and recruited parents of autistic children aged 5 to 11. The scale was found to be homogeneous and reliable overall. Following the pilot study, the original authors of the BAMBI reduced the scale from 21 to 18 items. In their 2007 publication, they included caregivers of 40 typically developing and 68 autistic children aged 3 to 11. The full BAMBI scale yielded a Cronbach's alpha of 0.88, with subscale values of 0.87 for the Limited Variety factor, 0.76 for Food Refusal, and 0.63 for Features of Autism. The factor analysis showed good model fit based on RMSEA (0.076), and the test–retest correlation indicated very high reliability. Significant differences were found between the autistic and control groups in total scores and across all three factors. Inter-rater reliability was also high ($r(16) = 0.78$, $p < 0.01$; Lukens & Linscheid, 2008).

The discrepancies observed between our findings and international results may be attributed to several factors. First, the limited sample size and non-representative nature of the Hungarian sample may have lowered the internal consistency indicators. Second, linguistic and contextual differences arising during translation and cultural adaptation may have contributed to weaker cohesion between subscales. Furthermore, it is possible that some items may not align with the original factor structure when applied in the Hungarian context.

Overall, the reliability of the Hungarian version of the BAMBI can be considered satisfactory for the complete scale; however, the results of the factor analysis suggest that the subscale structures require revision.

Limitations

The interpretation of the study's findings may be influenced by several methodological and sampling factors, which can be considered potential limitations. Due to the non-representative and non-random voluntary online sampling method, certain social groups may have been overrepresented. The self-administered nature of the questionnaire may carry subjective biases. Additionally, respondents may interpret behaviors differently depending on their sociocultural context and parenting attitudes.

The psychometric evaluation of the questionnaire did not include an assessment of test–retest reliability, which limits the conclusions that can be drawn regarding the temporal stability of the instrument. The questionnaire alone is not capable of providing an in-depth analysis of the complexity of eating behaviors, so future qualitative research and complementary approaches may offer valuable directions. The sample size and its heterogeneity may also affect the generalizability of the results, especially in the comparison between the neurotypical and autistic groups, where the sample was not matched. Although the cultural adaptation of the questionnaire was carried out, the interpretation of certain items may still vary due to cultural specificities. The relatively small sample size may have contributed to fluctuations in reliability indices, including the Cronbach's alpha values. Small sample sizes are more sensitive to the distribution of responses, which may distort conclusions related to internal consistency. The validity of the responses may also be weakened if parents do not perceive a given item as applicable to themselves or their child, or if problematic behavior has a different meaning for them depending on cultural context. During the linguistic and cultural adaptation of the questionnaire, it is possible that certain items did not completely reflect local language use or parental vocabulary. Such discrepancies in content may hinder the clear interpretation of items, potentially reducing internal consistency and resulting in lower reliability indices.

Conclusion

To assess internal consistency reliability, we applied the Cronbach's alpha coefficient, which indicates the level of agreement between the items within the scale. For the original 18-item BAMBI questionnaire, the overall Cronbach's alpha value was low ($\alpha < 0.70$), thus requiring the identification of several potentially problematic items based on item–total correlations and the results of factor analysis. The removal of Item 17—which showed low item–total correlation—noticeably improved internal consistency, raising the new alpha value to 0.743. Subsequently, we also examined the removal of Items 4 and 12, which showed a weak fit from a factor-analytic perspective. The combined removal of these three items reduced the alpha value to 0.719, which falls within an acceptable range but indicated a slight decline in reliability. Based on the results, we concluded that removing only Item 17 yields the best reliability index, while the exclusion of Items 4 and 12 serves to improve the structural validity of the scale. Therefore, in making our decisions, we aimed to balance psychometric indicators and factor structure considerations. The negative value observed for Item 9 may indicate that it did not closely align with the main dimension of the scale. However, given its content relevance—and the fact that interpreting sensory-related items may contribute to identifying one of the core symptoms of autism—its retention requires further investigation. The questionnaire also emphasized the importance of parental perception, as it carries independent meaning. For this reason, it included dichotomous (yes/no) questions asking how parents perceive various problem areas. However, the analysis of these items fell outside the scope of the present study due to a low response rate. Investigating these variables in future studies, provided there is sufficient response data, may offer a new direction for research.

One of the key aims of the study was to explore the eating behavior of neurotypical siblings. Based on the responses and the comparative analysis, it became clear that while most siblings did not exhibit serious issues, parents frequently observed differences related to imitation, the emergence of selective eating, or the development of tensions within the family. The sibling is not merely a passive observer of the autistic child's behavior, but may also be an active shaper and indirect participant in the family's mealtime routines. In the qualitative responses, recurring themes included the notion of fairness, emotional burdens, and the ambivalent perception of parental intervention attempts. These findings suggest that family mealtime, as a space for social interaction, carries significant socio-emotional weight. The present results also indicate that examining the eating behavior of neurotypical siblings could be a relevant direction for future research—particularly in the development and validation of questionnaires that are sensitive to the more subtle nuances of the family context. Despite growing scientific interest in the topic, the related literature remains rather limited.

Overall, our study introduces new perspectives on the applicability of the BAMBI questionnaire in the Hungarian linguistic and cultural environment. While the reliability of the full scale proved to be acceptable, the individual subscales may require further refinement or revision. It is conceivable that the questionnaire could be used as a screening tool, but at this stage, detailed diagnostic conclusions should not and cannot be drawn based on the subscales. Further revision of the questionnaire is certainly warranted in light of the present findings.

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Bettina Trixler – PhD student
trixler.bettina@gmail.com
ORCID ID: 0000-0003-1700-1803

Henriette Pusztafalvi – Associate professor
henriette.tigyi@etk.pte.hu
ORCID ID: 0000-0001-9296-7160

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