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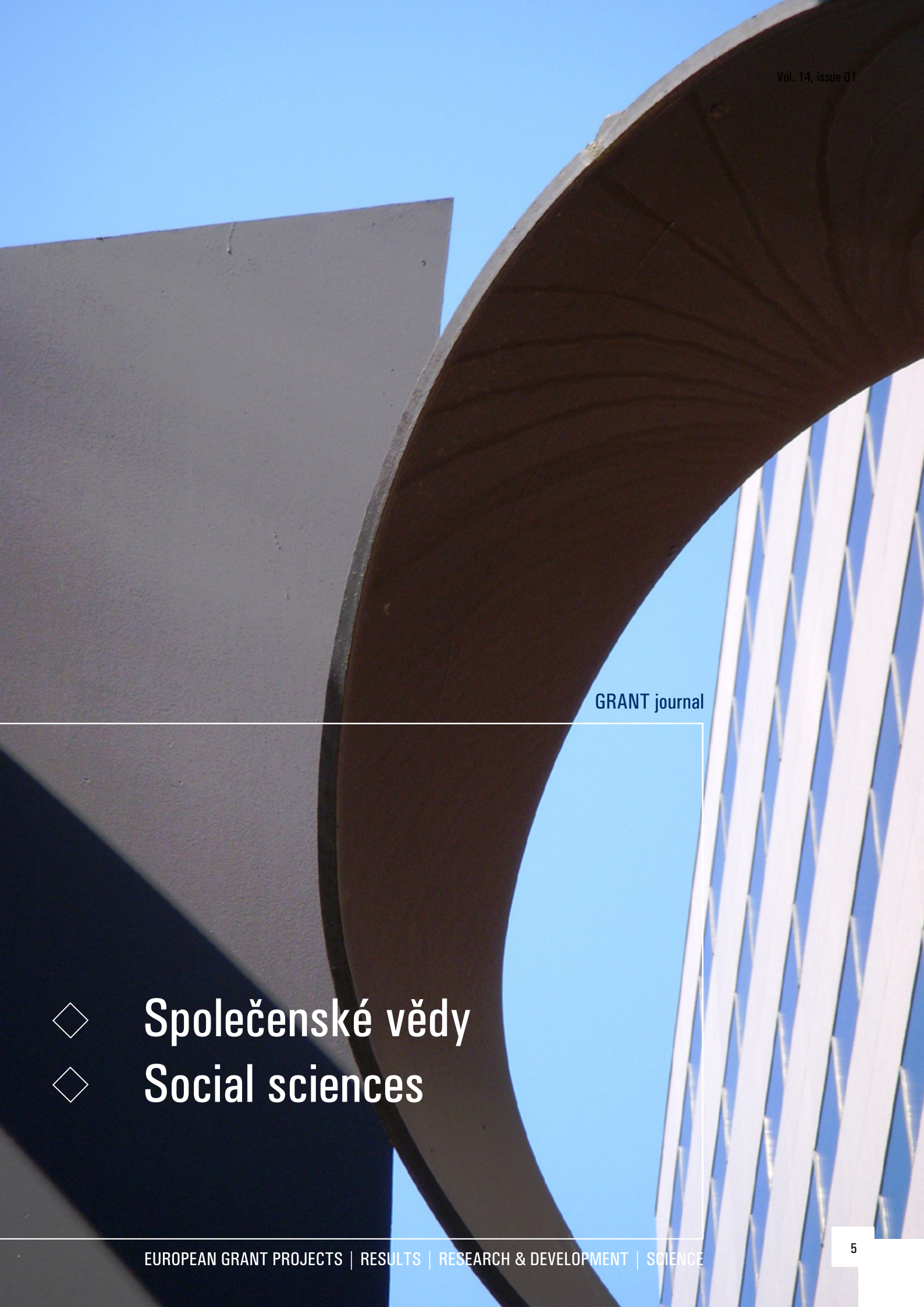

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The Impact of Job Demands on Burnout Syndrome in Child and Family Centre Workers

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Abstract The aim of this paper is to find out whether there is a statistically significant relationship between burnout syndrome and job demands among workers in Child and Family Centres in Slovakia. The research sample consisted of 105 workers of Child and Family Centres. Burnout assessment tool and Job demand resources questionnaires were used for data collection. By analyzing the research data, we found that workers exhibit moderate levels of burnout and identified correlations between the burnout syndrome dimensions and the job demands dimensions.

Klíčová slova burnout, job demands, social workers, child protection

1. INTRODUCTION

The need to perform gainful activity brings with it both positive and negative phenomena. When performing any type of work and any job position, periods full of success, rewards, peace, a sense of satisfaction from a job well done usually alternate with periods full of stress, falls, failures or the need to solve various problems and crisis situations. It is important for every person to experience a certain level of stress because it represents a catalyst for them, motivating them to act, or also protecting them in threatening situations. If the working environment and working conditions represent a long-term and unmanageable stressor for a person, this can lead to a decrease in work performance, disgust with their own work or profession or even to the so-called burnout syndrome.

1.1 Definition, origin and symptoms of burnout syndrome

The term “burnout” was first used in the 1970s by the American psychologist Herbert Freudenberger. In general, this term is used to describe an unfavorable state of an individual as a response to the inability to cope with the effects of long-term workload (Parker et al., 2022; Morovicsová, 2016; Leiter, Bakker, Maslach, 2014). The World Health Organization (2019) included burnout in the 11th revision of the International Classification of Diseases as an occupational phenomenon characterized by three dimensions:

- feelings of energy depletion or exhaustion,
- increased mental distance from one’s job, or feelings of negativism or cynicism related to one's job,
- reduced professional efficacy.

The authors Leiter, Bakker and Maslach (2014) state that the presence of the following phenomena most often contributes to the development of burnout syndrome: workload, perceived lack of control, lack of reward and recognition, poor relationships, lack of fairness and value mismatch. Thus, burnout does not occur unexpectedly and randomly, but is triggered and influenced by specific factors in combination with the individual's ability to face them, deal with them and respond appropriately to them. The whole process of burnout syndrome has several phases. The first is the enthusiasm with which a person comes to a new job. The second phase is stagnation, representing the confrontation of the individual's expectations and ideals with the presence of negative or demotivating factors and job demands. If the individual fails to successfully accept and adapt to this negative reality, the frustration phase comes next, characterised by experiencing physical and mental exhaustion and dealing with the existential question - what is the meaning of my work? An important aspect at this stage is also reciprocity, i.e. whether the individual feels sufficiently rewarded for his or her work performance. If there is no change in job demands or change in the individual's attitude, the apathy phase occurs, in which the individual identifies with the premise that there is no point in trying hard at work, being proactive or doing activities beyond the scope of his or her job, which is the final step towards the onset of the last phase, the burnout syndrome itself (Haskovcova, 2007; Rush, 2003). However, we encounter various models of burnout in the literature. Given the differences between the individual models, we will not describe them in more detail, but only offer an overview in the following table:

Table 1: Models of Burnout (compiled by Nuallalong, 2012)

Freudenberger, North (1986)	Girdin et al. (1996)	Milles, Smith (1993)
1. A compulsion to prove oneself 2. Working harder 3. Neglecting their needs 4. Displacement of conflicts 5. Revision of values 6. Denial of emerging problems 7. Withdrawal 8. Obvious behavioral	1. Stress arousal 2. Energy conservation 3. Exhaustion	1. The Honeymoon 2. The Awakening 3. Brownout 4. Full Scale Burnout 5. The Phoenix Phenomenon

changes 9. Depersonalization 10. Inner emptiness 11. Depression 12. Burnout syndrome		

We also find differences in the perception of burnout syndrome in discussions about categorizing its symptoms (See Table 2). To approach and better understand them, we have chosen the concept of the authors Schaufeli and Enzman (1998), who talk about burnout syndrome being manifested in five levels - physical, affective, cognitive, behavioral, motivational.

Table 2 List of burnout symptoms according to different authors

Schaufeli, Enzman (1998)	Poschkamp (2013)	Freudberger (1981)	Maslach, Jackson (1981)
physical, affective, cognitive, behavioral, motivational	physical, cognitive, emotional, behavioral	feelings of general exhaustion, alienation and isolation, cynicism, emptiness, impatience and irritability, distrust and suspicion, loss of purpose, direction and motivation, various psychosomatic phenomena, depression	emotional exhaustion, depersonalization, feelings of low performance

Physical symptoms of burnout can include, for example, loss of energy, fatigue, insomnia, problems falling asleep, digestive problems or migraines, but also more serious diseases such as diabetes, weakened immunity, high blood pressure and others. (Poschkamp, 2013; Melamed et al., 2006a; Melamed et al., 2006b). Affective symptoms include depressive mood, anxiety, being oversensitive, agression, decreased emotional control and others (Schaufeli, Enzman, 1998). The category of cognitive problems includes forgetfulness, lack of concentration, insufficient ability to solve problems or more complex tasks, suspiciousness, paranoia, a feeling of being unappreciated, etc. (Poschkamp, 2013; Schaufeli, Enzman, 1998). At the behavioral level, problems such as tendencies towards hyperactivity, procrastination, increased incidence of interpersonal conflicts due to the individual's aggression, frequent absence from the workplace, reduced work performance, excessive alcohol consumption or overeating usually occur (Morovicsová, 2016; Poschkamp, 2013; Schaufeli, Enzman, 1998). The category of motivational symptoms includes problems such as resignation, demoralization, loss of interest, loss of work motivation, or aversion to the job (Nuallalong, 2012).

1.2 Burnout syndrome and helping professions

The American Psychological Association (2022) found in its research that 79% of working American adults have experienced work-related stress in the past month. Many of them report a lack of interest in work, lack of motivation, and a decrease in energy as negative consequences of this work stress. More than 35% of them also reported cognitive fatigue, 32% emotional exhaustion, and 44% reported physical fatigue. Similar findings were also reported by Gallup (2020), which reports that 76% of employees experience burnout at work at least sometimes and 28% of employees say they are burned out at work very often or always.

Several authors (Fuseini, 2024; Szilagyi, 2021; Stosic, et al., 2021; Skovholt, Trotther-Mathison, 2016 and others) have focused their research on measuring burnout syndrome among helping professionals because their work is specific in that they work with people on a daily basis and help them resolve often very difficult life situations. The authors Köverová and Ráczová (2017), in relation to the performance of the helping profession, report an increased risk of burnout syndrome due to work stress, compassion fatigue and long-term performance of the helping profession. Their research findings confirmed that burnout syndrome is more likely to occur in helping professionals with longer experience. At the same time, the authors Zat'kova and Gažiková (2024) came up with the finding that burnout syndrome is more common in younger helping professionals, specifically in the age group of 22 to 35 years old.

In the existing scientific knowledge, we also encounter the premise that burnout syndrome can be caused or influenced by the work environment and the work demands that are placed on workers. Based on this, it can be argued that phenomena such as workplace bullying (Munn, L. T. et al. 2024; Sochos, Rossiter, 2024), inadequate social support in the workplace, work overload, poor workplace relationships, inadequate resources, etc. (McFadden, Campbell, Taylor, 2014) can be predictors of burnout syndrome.

On the basis of the above mentioned facts, we set the aim of our paper to find out whether there is a statistically significant relationship between burnout syndrome and job demands among Child and Family Centres workers in Slovakia.

2. METHODS

We used the Burnout Assessment Tool (BAT) questionnaire developed by Schaufeli et al. (2020) to collect the research data. This questionnaire maps two symptom domains of burnout syndrome - core symptoms (exhaustion, mental distance, cognitive impairment, emotional impairment) and secondary symptoms (psychological complaints, psychosomatic complaints). We chose the Job Demand Resources (JDR) questionnaire (Bakker and Demerouti, 2017) to investigate the status of job demands placed on staff at Child and Family Centres, which are considered predictors of burnout syndrome. In both sections, respondents rated each variable on a 5-point Likert scale (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always).

In analyzing data we used Crombach's alpha reliability test and Spearman's correlation test. We used both tests in accordance with the nature of the particular data appearing in it. Statistical analysis was performed using SPSS 22 software.

We sent an electronic questionnaire to 111 Child and Family Centres in the Slovak Republic. We sent emails to the directors of the facilities with a request to distribute them among the professional staff of the facility.

The research sample consisted of 105 respondents (n=100 women, n=5 men) with an average age of 45.03 years, with the youngest respondent being 24 years old and the oldest being 69 years old.. The largest group in the sample in terms of region were respondents from the Košice region, who made up 29.5% of the sample. Conversely, the smallest group were respondents from the Trnava region, who made up 4.8% of the sample. The majority of respondents work in an institution established by the Office of

Labour, Social Affairs and Family (77.1%), a smaller proportion of respondents work in an institution established by an accredited entity (14.3%), and the smallest group were respondents who work in an institution established by a local government (8,6%). In terms of length of experience in the current job, the sample averaged 11.6 years. The shortest experience was less than a year and the longest was 40 years.

3. RESULTS

Before proceeding to test our research question, we calculated the reliability of each dimension of both parts of the questionnaire. Based on the reliability test conducted, we found that all items of the BAT questionnaire in the respective dimensions have very good coherence ($\alpha > 0.8$). In the case of the JDR questionnaire, the coherence is lower ($\alpha < 0.8$). Significantly lower reliability was found for the items "emotional, mental and physical demands" ($\alpha = 0.487$) and "harassment" ($\alpha = 0.335$).

Table 3 Reliability test of dimensions

	Crombach's Alpha (α)	N of items
BAT Dimensions		
Exhaustion	0,882	8
Mental Distance	0,804	5
Cognitive Impairment	0,873	5
Emotional Impairment	0,824	5
Psychological Complaints	0,813	5
Psychosomatic Complaints	0,833	5
JDR Dimensions		
Work overload	0,801	4
Emotional, mental and physical demands	0,487	3
Bureaucracy	0,704	3
Role Conflict	0,768	3
Harassment	0,335	4
Role clarity	0,792	3
Team spirit	0,912	2

Descriptive analysis was conducted to better understand the structure of the data obtained using the BAT and JDR questionnaires. The following table summarizes the basic statistical characteristics for each dimension of both parts of the questionnaire.

Table 4 Descriptive analysis results

	N	M	Md	SD	Sk	Ku	R	Min	Max
BAT Dimensions									
Exhaustion	105	2,6544	2,5714	,65638	,604	1,468	4,0	1,00	5,00
Mental Distance	105	1,6038	1,4000	,61205	1,215	,827	2,4	1,00	3,40
Cognitive Impairment	105	1,7695	1,8000	,56757	,423	-,429	2,2	1,00	3,20
Emotional Impairment	105	1,6629	1,6000	,51315	1,018	1,569	2,4	1,00	3,40
Psychological Complaints	105	2,0114	2,000	,73161	,853	,507	3,2	1,00	4,20
Psychosomatic Complaints	105	1,9638	1,8000	,76449	1,038	1,022	3,8	1,00	4,80
JDR Dimensions									
Work overload	105	3,4929	3,5000	,78481	,053	-,326	3,5	1,50	5,00
Emotional, mental and physical demands	105	3,6095	3,6667	,62610	-,359	,177	3,33	1,67	5,00
Burreaucracy	105	3,3333	3,3333	,90582	-,293	-,587	4,00	1,00	5,00
Role Conflict	105	2,7619	2,6667	,92301	,143	-,776	4,00	1,00	5,00
Personal Conflict	105	1,8000	2,0000	,97468	1,176	,433	3,00	1,00	4,00
Harassment	105	1,1143	1,0000	,19312	1,549	1,385	,75	1,00	1,75
Reciprocity	105	2,8857	3,0000	1,13776	-,251	-,972	4,00	1,00	5,00
Role clarity	105	4,6476	5,0000	,57145	-1,859	3,418	2,67	2,33	5,00
Team spirit	105	4,1571	4,5000	,91545	-,890	-,217	3,00	2,00	5,00

(N = number of observations, m = mean, Md = median, SD = standard deviation, Sk = Skewness, Ku = Kurtosis, R = range, Min = minimum, Max = maximum)

The results show that respondents report higher mean score within the BAT questionnaire in the "exhaustion" dimension (M=2,6544), in which they expressed their agreement or disagreement with statements such as "At work, I feel mentally exhausted", "When I exert myself at work, I quickly get tired", "At the end of my working day, I feel mentally exhausted and drained" etc. The second variable with a higher mean score is the "psychological complaints" dimension (M=2.0114), in which respondents confirmed the presence of stress, worry or panic attacks. Higher scores were also observed in the "psychosomatic complaints" dimension (M=1.9638), which includes symptoms such as frequent illness, headache, muscle pain, indigestion, etc.

Within the dimensions mapping the status of job demands, the items "role clarity" (M=4.6476) and "team spirit" (M=4.1571) reached the highest value, which can be considered as a positive and desirable phenomenon in the workplace. On the contrary, among the negative phenomena, "emotional, mental and physical demands" (M=3.6095), "work overload" (M=3.4929) and "burreaucracy" (M=3.3333) had the highest scores.

As mentioned above, the main objective of our paper is to determine whether there is a statistically significant relationship between the burnout dimensions measured by the BAT questionnaire and the job requirement dimensions measured by the JD-R questionnaire. For further analysis, after taking into account the tests of normality of the data distribution and the nature of the variables, we used the non-parametric Spearman's correlation test, the results of which are presented in the table below.

Table 5 Spearman's rank correlation coefficient

		Exhaustion (BAT)	Mental distance (BAT)	Cognitive impairment (BAT)	Emotional Impairment (BAT)	Psychological complaints (BAT)	Psychosomatic complaints (BAT)
Work overload (JD-R)	Correlation Coefficient	,504	,317	,326	,249	,351	,356
	Sig. (2-tailed)	,000	,001	,001	,011	,000	,000
	N	105	105	105	105	105	105
Emotional, mental and physical demands (JD-R)	Correlation Coefficient	,228	,083	,055	,054	,125	,172
	Sig. (2-tailed)	,019	,402	,578	,588	,202	,079
	N	105	105	105	105	105	105
Bureaucracy (JD-R)	Correlation Coefficient	,251	,284	,122	,282	,119	,131
	Sig. (2-tailed)	,010	,003	,214	,004	,227	,183
	N	105	105	105	105	105	105
Role Conflict (JD-R)	Correlation Coefficient	,286	,312	,153	,194	,138	,098
	Sig. (2-tailed)	,003	,001	,119	,047	,162	,319
	N	105	105	105	105	105	105
Personal conflict (JD-R)	Correlation Coefficient	,248	,325	,243	,300	,149	,141
	Sig. (2-tailed)	,011	,001	,012	,002	,130	,151
	N	105	105	105	105	105	105
Harassment (JD-R)	Correlation Coefficient	,094	,209	,105	,101	,200	,078
	Sig. (2-tailed)	,339	,033	,287	,303	,041	,426
	N	105	105	105	105	105	105
Reciprocity (JD-R)	Correlation Coefficient	-,095	-,112	-,060	-,053	-,088	-,118
	Sig. (2-tailed)	,336	,256	,545	,588	,374	,230
	N	105	105	105	105	105	105
Role clarity (JD-R)	Correlation Coefficient	-,267	-,380	-,351	-,207	-,188	-,165
	Sig. (2-tailed)	,006	,000	,000	,034	,055	,092

Team spirit (JD-R)	N	105	105	105	105	105	105
	Correlation Coefficient	-,254	-,329	-,246	-,349	-,190	-,197
	Sig. (2-tailed)	,009	,001	,011	,000	,052	,044
	N	105	105	105	105	105	105

We interpret the resulting correlation coefficients (ρ) reported in Table 5 in line with Hinkle, Wiersma, and Stephen (2003), with whom we can conclude that there is neither a very strong positive relationship (ρ = 0.90 to 1.0), a strong positive relationship (ρ = 0.7 to 0.9), a very strong negative relationship (ρ = -0.9 to -1.0), nor a strong negative relationship (ρ = od -0,7 do -0,9) between any of the BAT dimensions and the JDR dimension. The highest value we find in the table is between the dimensions "exhaustion" and "work overload" (ρ=.504), expressing a moderately strong positive relationship, which means that the higher the work overload a person experiences, the higher his level of exhaustion. The dimension "work overload" has a weak positive relationship with several dimensions of BAT – „mental distance“ (ρ=,317), „cognitive impairment“ (ρ=,326), „psychological complaints“ (ρ=,351), „psychosomatic complaints“ (ρ=,356). A weak positive correlation also exists between the "personal conflict" dimension and the "mental distance" dimension (ρ=325) and „emotional impairment“ (ρ=300). A low negative correlation exists between the dimension "role clarity" and the dimensions "mental distance" (ρ=-.380) and "cognitive impairment" (ρ=-.351), and also between the dimension "team spirit" with the dimensions "mental distance" (ρ=-.329) and "emotional impairment" (ρ=-.349).

4. CONCLUSION

The aim of our paper was to find out whether there is a statistically significant relationship between burnout syndrome and the work demands placed on the Child and Family Centres workers in Slovakia. The results of the research show that the prevalence of burnout syndrome among Child and Family Centres workers is at a medium level in the area of exhaustion and psychological complaints and at a lower level in the area of psychosomatic complaints, cognitive impairment, emotional impairment and mental distance. In relation to work demands in the Child and Family Centres workers, the variables role clarity and team spirit were positively assessed. On the contrary, emotional, mental and physical demands, work overload and bureaucracy are considered negative factors.Correlation analysis also identified a moderate positive relationship between exhaustion and work overload, a low positive relationship between work overload and mental distance, cognitive impairment, psychological complaints, psychosomatic complaints, and also between personal conflict and mental distance and emotional impairment. A low negative correlation exists between role clarity and mental distance and cognitive impairment, and also between team spirit and mental distance and emotional impairment. We believe that the results of our research have at least partially contributed to the existing knowledge about the prevalence of burnout syndrome among helping professionals and will contribute to the development and expansion of the system of prevention of this phenomenon.

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The importance of complex tasks for the development of pupils' competences in science subjects

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Abstract Contextual tasks in science education are essential for students' development and their ability to apply knowledge to solving real-world problems while utilizing scientific principles. Based on the ongoing PISA results, new curricular documents, and teachers' perspectives, it is evident that these tasks support not only critical thinking but also an interdisciplinary approach, creativity, and problem-solving skills. Teachers face significant challenges in implementing these tasks, which requires adequate support, training, and sufficient time resources. The presented article showcases part of the results of an electronic questionnaire-based research study involving science teachers from primary and secondary schools in Slovakia. The aim of the article was to conduct a quantitative analysis of the actual implementation of complex contextual tasks in the teaching process from the perspective of science teachers. The research findings indicate that teachers strive to integrate complex tasks into their lessons, as evidenced by their methodological approaches in designing and applying these tasks in teaching. However, the study also identified weaknesses that need to be addressed in the teaching process to improve science education.

Keywords complex tasks, science education, competencies, interdisciplinarity

1. THEORETICAL BACKGROUND

In Slovakia, in recent years, there have been several reforms and changes in the field of education, which also concern science education. New curriculum documents that have been implemented or are in the process of implementation aim to modernise and streamline the teaching of science subjects.

One of the most important documents is the New the State Educational Programme (SVP), which has been updated at various stages to respond to current challenges in education. This programme focuses on creating a quality and flexible education system that should be oriented towards the development of critical thinking, problem-solving, and preparing pupils for life in the 21st century (SVP 2024).

Curriculum changes in science education are focused on different key areas. One of these is the integration of science subjects, whereby education in areas such as physics, chemistry, biology, geography and other natural sciences is increasingly interconnected in an attempt to create a comprehensive picture of natural processes and phenomena. An important area is the development of critical thinking and the scientific approach. Here the emphasis is on experimentation, observation and analysis, which seeks to develop pupils' ability to apply scientific ways of thinking. One way of developing the scientific approach is to implement complex contextual tasks in the teaching process.

A contextual task refers to an assignment in which a context of interest to students, preferably real-life, is followed by several tasks, usually of increasing difficulty.

A characteristic feature of complex tasks is a longer introductory text, which may be of a different nature, be it a newspaper article, an etiquette, an information leaflet. It should essentially be a text that pupils encounter in everyday life. It should take the form of a coherent or less coherent text, which may include various tables, graphs, maps, pictures, etc. When solving the questions or sub-problems that follow the introductory text, which are of different types, the pupils' task is to read and understand the text and use it to find the answers to the sub-problems. Real-life contextual tasks usually motivate pupils more than ‘classic’ word problems. In addition, they can often be solved in different ways, which teaches pupils to think independently and creatively, and they require explanations as well as results, thus teaching pupils to argue.

Complex contextual tasks in science education are tasks that integrate multiple science disciplines (e.g. chemistry, physics, biology, geology, etc.) and require students to apply their knowledge and skills in real-world or practical contexts. These tasks often involve a problem that is related to everyday life or current issues and is not solvable by the application of one simple formula or fact. Characteristics of complex contextual tasks:

1. Multidisciplinary in nature: these tasks typically require students to apply knowledge from different science domains in a way that reflects the interconnectedness of these disciplines.

2. Problem-based approach: the task is based on solving a specific problem that is relevant or realistic, whether it is an environmental, technological or social topic. For example, the question of how to reduce CO_2 emissions or how to clean up polluted water.
3. 3.Creative and critical thinking: Students must analyse a problem, find solutions, design experiments or procedures, interpret results, and critically evaluate their answers.
4. Applying theory to practice: tasks often require pupils to apply specific theoretical knowledge to solve practical problems. This means that these are real-life situations that are not just pure theory but are linked to practical applications in everyday life.
5. Collaboration and Communication: In many cases, these tasks are designed to have students work in groups and discuss different approaches and solutions, which supports their skills in teamwork and effective communication.

Tasks of this type have recently come to the forefront of interest among teachers and experts in the field of didactics, they are called variously, e.g. complex tasks, multicomponent tasks or contextual tasks.

The aim of the presented contribution is to analyse their real implementation in the teaching process from the perspective of science teachers, based on the need and use of complex contextual tasks.

2. THE NEED TO CREATE COMPLEX CONTEXTUAL TASKS FROM A PISA PERSPECTIVE

Interim results of PISA (Programme for International Student Assessment) show a steady decline in the science literacy of Slovak pupils. PISA emphasises not only memorisation of facts, but also the ability to apply knowledge and skills in real, complex situations (OECD 2020).

Analyses of the PISA tests have shown that pupils have problems linking theoretical knowledge with practical problems. This finding suggests that there is a need to focus on creating complex contextual tasks that motivate pupils to apply the principles they have learned in real-life situations (OECD 2018). Such tasks should:

1. Connect multiple science fields - students should be able to integrate knowledge from physics, chemistry, biology and other sciences to solve real-world problems (e.g. problems related to environmental issues or challenges related to new technologies).
2. Promote critical thinking and analysis - pupils should be able to assess different possible solutions and identify the most effective approaches, using knowledge from the natural sciences.
3. Innovative approaches in assessment - traditional forms of testing are increasingly being replaced by tasks that test pupils' ability to work with complex problems, explore hypotheses, design experiments and interpret results.
4. Consideration of real-world problems - tasks should reflect the challenges facing contemporary society, such as climate change, energy efficiency, pollution, health and nutrition, biotechnology and others.

The creation and implementation of complex contextual tasks could make a significant contribution to improving this literacy and prepare students for the challenges they face in a rapidly changing and technologically advanced world (Dillon, Worsnop 2011).

3. THE NEED TO CREATE COMPLEX CONTEXTUAL TASKS IN THE LIGHT OF NEW CURRICULUM DOCUMENTS

The focus of Slovak education in the 21st century is shifting from memorising lessons and memorising isolated facts to systematic and deliberate development of versatile and functional literacy in accordance with the requirements of society, which can be applied in everyday personal and social life and in meeting personal, educational, cultural and social needs. This is because the breadth of knowledge acquired is no longer sufficient. Teachers and pupils face more demanding challenges: the depth of learning, the ability to put things into context. This is what will enable 21st century people to engage in complex challenges, adapt to new situations, take responsibility and solve complex problems, critically engage with information, create and collaborate in diverse teams.

In the first and second cycles, the learning area takes the form of a science-focused integrated subject. In the third cycle, the school has the option of continuing with full or partial integration of science or teaching separate subjects (SVP 2024).

The main aim of the learning area is to develop science literacy so that pupils can identify the science aspects of many complex situations and apply not only science knowledge, skills and attitudes but also the principles of cognition in science to these situations. Pupils should be able to investigate and then make appropriate links between knowledge and critical thinking by the end of Cycle 3. With science literacy thus developed, they will be able to compare, select, evaluate, justify and formulate explanations based on critical analysis of results and reasoning.

It is crucial for teachers and curriculum designers to create tasks that develop not only factual knowledge but also the ability to apply this knowledge in different contexts. To this end, it is necessary to:

- Improve school materials and textbooks - these should contain not only theoretical knowledge but also tasks that support application in practice.
- Provide support to teachers in the development of complex tasks - professional development of teachers is important for the implementation of new methodologies in teaching.
- Incorporate project-based and research methods - the use of project-based methods, experiments and science papers can help students better understand and apply science principles.

4. CREATING COMPLEX TASKS FROM TEACHERS' PERSPECTIVES

When solving the questions or sub-problems that follow the introductory text, which are of different types, the pupils' task is to read and understand the text and use it to find the answers to the sub-problems. Important prerequisites for the inclusion of complex tasks in the classroom that must be fulfilled are, first of all, the mastery of the reading technique, then the ability to understand the text, evaluate what has been read, and solve a complex learning task based on the text, which focuses on science literacy (Bellová 2018).

In solving these tasks, pupils apply reading literacy skills, which is a prerequisite for the development of science literacy (Vasilová, Prokša 2013). Currently, reading literacy is considered a key competence that affects not only the level of reading, but also the level and possibilities of pupils' education in all subjects (Koršňaková, Kováčová, Heldová 2010). Also, according to the new curriculum, reading literacy is emphasised as a cross-cutting supporting literacy for comprehension of different types of text, at

several levels - from explicit meanings through inferring implicit meanings to critical evaluation of the text.

Complex tasks can be used not only as classical test tasks in the diagnostic phase of teaching, but also as learning tasks during the access and fixation of new material. The difference is that test tasks of a complex nature serve for classical verification of pupils' knowledge and learning tasks help to deepen and broaden pupils' knowledge, thus also serving as supplementary learning.

Tasks can be of the following types:

- multiple-choice tasks - pupils choose one correct answer from a choice of four or five options.
- complex multiple-choice tasks - pupils select one of the YES/NO answers in a set of at least two questions.
- closed-ended multiple-choice questions - pupils construct their own answer, but it is a one- or multiple-word answer.
- open-ended questions with answer formation - pupils answer in their own words, it is a broad answer (Mandíková, Houfková 2012).

5. COMPETENCES DEVELOPED THROUGH COMPLEX CONTEXTUAL TASKS

Complex tasks often require a multidimensional approach, critical thinking, creative analysis and synthesis, and are aimed at developing multiple student competencies. These competences are crucial for students' success in today's society, which requires not only factual knowledge but also the ability to apply this knowledge in different contexts. Complex tasks therefore often focus on the development of the following competences:

- Critical thinking and problem-solving pupils must analyse a problem, identify relevant information and apply theoretical knowledge to a concrete situation. Complex tasks promote the ability to reason about different solutions and evaluate their effectiveness (Zohar 2013).
- Interdisciplinary thinking: complex tasks often involve different areas of knowledge (e.g., combining physics, biology, mathematics, and chemistry), which allows students to see the connections between the different subjects and gain a broader perspective on the problem (Leschinsky 2017).
- Soft skills: In many cases, complex problems are solved in groups, which promotes teamwork, effective communication, and the sharing of ideas among students (Rosen 2017).
- Application and interpretation of knowledge: Complex tasks allow pupils to apply theoretical knowledge to concrete real-life situations. This transfer of knowledge from theory to practice is essential for developing real-life problem-solving skills (OECD 2018).
- Increase motivation and interest in the subject: complex and contextually interesting tasks can increase pupils' motivation by showing them how science is used in the real world. When pupils see that what they are learning has practical value and a direct impact on their lives, they can be more engaged and motivated to learn. In this way, they develop a stronger relationship with the subject, which becomes more interesting and relevant.
- Independence and self-reflection: Solving complex problems requires pupils to work independently, set goals, plan their actions and evaluate their results. This promotes their capacity for self-reflection and autonomy in learning (Hattie 2009).

6. RESEARCH METHODOLOGY

In order to meet the above objective, we needed to investigate several aspects, which we set out in our research questions (RQs):

RQ1: What methodological approaches do science educators use to implement complex contextual tasks in their teaching to support students' cognitive and applied development?

RQ2: Which pupils' competences are developed during the teaching process when solving complex tasks?

We have chosen a quantitative method in the form of an electronic questionnaire. The created questionnaire was electronically distributed to different types of schools, which we obtained in the database of the Centre of Scientific and Technical Information of the Slovak Republic (2023). We preferred random sampling as schools were not selected, the questionnaire was sent to schools without any preference. The first questions of the questionnaire contained identification questions that helped us to further characterize the sample of respondents (type of school, grades in which they teach, subjects of interest). The research sample consisted of 95 science teachers, of whom 70 teachers (74%) were from second cycle primary schools, 17 (18%) from secondary schools and only 8 (9%) from eight-year grammar schools.

The content questions in the questionnaire took different forms. We included closed-ended multiple-choice questions for the sake of precision, and their results were evaluated in terms of percentages, using a five-point Likert scale. In some questions, there was the possibility of ticking boxes, giving respondents the opportunity to tick multiple answers as well as to express their own opinion or add their own answer.

7. RESEARCH RESULTS AND DISCUSSION

To answer the two research questions (RQ1, RQ2), we created 8 items in the content section of the questionnaire.

RQ1: What methodological approaches do science educators use to implement complex contextual tasks in their teaching in order to support students' cognitive and applied development?

The first research question concerned the following items:

1. Are contextual complex tasks part of your teaching? (choose from 5 options)
2. At which stages of the lesson do you most often implement them in your teaching? (comma boxes, choice of 4 options)
3. Your contextual tasks are in the nature of the following activities: (comma boxes, choice from 6 options + other...).
4. Do your complex tasks contain: (comma boxes, choice of 5 options + other).

From the first question, where we investigated the frequency of including complex tasks in the classroom, we noted a positive finding. The majority of educators reported that complex contextual tasks are part of their teaching (93% overall - 73% definitely yes, 20% sometimes yes), indicating a positive attitude towards the use of these tasks in the school process. This high percentage indicates that teachers recognise the benefits of these tasks for pupils' development.

From the second question, we found that they most often implement these tasks in the fixation phase of the teaching process (67%), i.e. when practicing the material, this approach supports students'

cognitive development through repetition and application of the learned material in real, practical contexts. In addition to the fixation phase, teachers also use tasks in the diagnostic phase (39%), where they are used to determine the level of learning, and in the exposure phase (28%) when introducing new material. These approaches indicate that complex tasks can be an effective tool for assessing and developing prior knowledge, while also serving as a bridge between new information and prior knowledge. The finding that complex tasks are used less frequently in the motivation phase (22%) suggests that educators are not likely to use these tasks as a primary tool to motivate students, but rather to support them in other phases of instruction where learning is being developed, practiced, or diagnosed. Most teachers took the opportunity to indicate multiple responses.

In the next two questions, we were interested in the form of the tasks, what is the nature of most of their assignments in terms of embedded activities and what elements they contain. Figure 1 shows that the most common tasks are those where a variety of combined information is given (80%). This approach is effective because it stimulates students to analyse and synthesize different types of data and information, which promotes their critical thinking and ability to apply knowledge in the context of real-world problems. A high proportion (over 83%) of the tasks contain experiments of different types, which is very beneficial for the development of pupils' practical skills and experimental thinking. Experiments allow pupils to gain direct experience and a deeper understanding of science principles. Tasks that include demonstration experiments are used by the teacher to visually interpret natural phenomena. These experiments are important for developing pupils' imagination and understanding of phenomena that are difficult to perceive without practical demonstration. On the other hand, teachers also encourage tasks that involve pupil experiments, where pupils undertake the majority of the activity, promoting independence, experimental skills and developing pupils' ability to work with real life science problems.

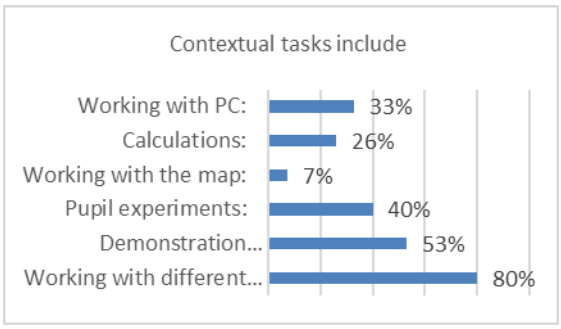

Figure 1 Visualisation of how complex tasks are divided according to different types of learning activities

The low percentage of teachers who reported activities such as PC work (33% of teachers), calculations (26%) and map work (7%) may have several reasons:

- Insufficient technical equipment - not all schools have enough computers or software to work effectively with PCs in the context of teaching.
- Limited digital skills of teachers - some teachers do not have sufficient experience in using digital tools for teaching and therefore do not use them frequently.
- Traditional teaching methods - many teachers still prefer traditional teaching methods (lecturing, writing on the board), which reduces the space for interactive activities.
- •Time-consuming - preparing tasks involving PC work, calculations or map work can be more time-consuming than conventional teaching methods.
- Low support from the state or school management - if teachers do not have sufficient support (training, methodological materials), this can lead to lower implementation rates of these activities.
- Lack of teaching materials - if there are no quality and accessible resources, teachers may struggle to incorporate these activities into the classroom.

As mentioned above, complex tasks should include a variety of motivational elements in addition to the continuous text, so we asked our respondents which elements are included in their tasks, and the following was found from the responses:

The majority of educators (93%) include images in their complex assignments, indicating that visual materials are seen as an important tool to promote student understanding and interest. Images are an effective way to make information accessible and support cognitive processes such as memorization and analysis. 73% of teachers reported using tables and 45% graphs. These elements are key to organizing information systematically and simplifying complex data. The use of tables and graphs supports students' analytical thinking and ability to interpret and present data. Video-cues are part of the assignments for 40% of educators. This format is useful for visualizing dynamic processes or phenomena that would be difficult to explain with text or pictures alone. Video-cues can help students better understand theoretical concepts through illustrative and interactive examples. Maps are used in only 7% of the tasks, indicating that their integration into the classroom is not common. Nevertheless, they can be useful, especially in subjects such as geography or biology, where it is important to understand spatial and geographical relationships. The 'other' option was not used by any teachers, suggesting that educators most often rely on traditional and well-established forms of visual and data materials such as images, tables, charts and video clues.

Evaluation of RQ1:
The majority of educators reported that complex contextual tasks are part of their teaching, indicating a positive approach to the use of these tasks in the school process, applying different activities such as working with information and different experiments in the tasks (see Figure 1).

Other findings show that educators prefer visual and data elements in the design of complex tasks, which promote understanding and increase students' motivation. The use of images and tables is very common, while video cues and maps are used less frequently, which may suggest scope for their wider inclusion in the classroom.

RQ2: Which competences are developed during the teaching process when pupils solve complex problems?

The second research question covered the following items:

1. Your contextual tasks focus on: (comma boxes, choice of 6 options + other).
2. In complex tasks, students develop the following competencies: (comma boxes, choice of 8 options + other).
3. Are your pupils able to understand the task/example - are they able to read comprehension in contextual tasks? (five-point bipolar Likert scale).
4. Are your contextual tasks interdisciplinary in nature? (five-point bipolar Likert scale).

The above items refer to the competences students develop during these tasks. Based on the percentage data, we created Table 1 to better visualize the responses and to evaluate the differences between the different aspects of the students' cognitive abilities and competencies. We asked which processes; competencies are targeted by the pupils' tasks.

Table 1 Responses to item 5

Evaluation aspect	Percentage (%)
Students' cognitive knowledge (content)	87
Practical skills and abilities	66
Competencies of scientific work, procedures of cognition (procedural)	27
Reasoning about knowledge produced by science (epistemic)	20
Formation and development of attitudes towards the environment	40
Metacognitive processes	20

Cognitive knowledge of students (87%) has the highest proportion, indicating that students show strong content knowledge. This aspect is clearly the strongest, indicating that pupils are strong in theoretical knowledge, information and memorization.

Practical skills and abilities (66%) are also at a reasonably good level, but there is room for improvement in the ability to apply knowledge to practical situations. This suggests that pupils have a good foundation but are not always able to use their knowledge effectively in practice.

Competences in scientific work, cognitive practices (27%) are at a low level, which means that pupils are hardly familiar with scientific research procedures, critical thinking, analysis and creation of new knowledge. This aspect is the weakness where there is the most room for improvement.

Reasoning about knowledge generated by science (20%) also indicates that students have weak skills in understanding and applying the scientific method and justifying theories, which is important for the development of scientific thinking and reasoning. Metacognitive processes (20%) is the lowest ranked aspect. This shows that pupils have large reserves in self-reflection and the ability to regulate their own learning process, which is crucial for the development of independent and effective learning.

The formation and development of attitudes towards the environment (40%) indicates that pupils have an average ability to develop critical and positive attitudes towards the world and society. There is potential for improvement in the area of values education and engagement with social issues.

In the next question, we were interested in the specific competencies pupils develop from the perspective of their teachers. We have neatly ordered the results in Table 2 and then analysed the individual responses.

Table 2 Responses to item 6

Competencies	Percentage (%)
Ability to develop and use scientific thinking and understanding to solve a variety of problems in everyday situations	80
Ability and willingness to explain natural phenomena using basic knowledge	60
Developing skills to ask questions and draw evidence-based conclusions	53
Ability to reflect on one's own personality	13
Manage time and information effectively	20
Work constructively with others	60
Interest in ethical issues	0
Promoting safety and environmental sustainability	33

The results highlight strengths and weaknesses in different competency areas. Ability to develop and use scientific thinking (80%) - this high percentage indicates that there is a good ability to apply scientific knowledge to solve problems in everyday life. This competence is key to analytical thinking and the ability to solve problems based on facts (OECD 2018).

Ability to explain natural phenomena (60%) - the result obtained shows a solid level of understanding of basic science principles and their application to interpret phenomena (Harlen 2018). Constructive collaboration (60%) - this outcome reflects the ability to work effectively in a team and collaborate with others, which is important for both professional and personal development (Johnson, Johnson 2017). Self-reflection (13%) - the low ability to reflect on one's own personality indicates the need to develop introspective skills, which are important for personal growth (Brown 2020).

Effective time and information management (20%) - this outcome indicates problems with work organization and information processing, which can negatively impact performance in a variety of areas (Covey 2019). Interest in ethical issues (0%) - a complete lack of interest in ethical issues indicates that this area is not perceived as important, despite its importance in society and in decision-making processes (Singer 2011).

Promoting safety and environmental sustainability (33%) - the result suggests low engagement with environmental and safety issues, which may be a risk factor in the current era of environmental challenges (Rockström et al. 2009).

The results suggest that pupils excel in applying scientific thinking to solve practical problems, but perform poorly in metacognitive processes, ethical issues and environmental sustainability. Based on these findings, there is a need to focus on improving these areas in order for pupils to become complex and responsible problem solvers.

As pupils need to analyse a problem, identify relevant information and apply theoretical knowledge to a specific situation when solving complex problems, they need to understand the text, be able to read with comprehension, so we have included a multiple choice question in the competency interview, "Are your pupils able to understand the task/example - can they read with comprehension in context tasks?" 72% of the teachers gave an affirmative answer, only 6% disagreed and 22% gave a negative answer.

The majority of teachers (72%) reported that pupils are able to understand the task, with 6% answering 'definitely yes' and 66% 'sometimes yes'. This result suggests that in the vast majority of cases pupils are able to read and understand the tasks, but that this is not always a full understanding in every case. The answer 'sometimes yes' may indicate that pupils can read with understanding in some cases, but in other situations they may struggle, such as in the case of more complex tasks, ambiguous instructions or multi-step tasks.

Only a small percentage of teachers (6%) were undecided, which may indicate that in some cases they did not have enough information or observations to give a clear answer. This may also indicate a diversity in teachers' experiences in different classrooms where pupils' reading comprehension skills may vary.

Almost a fifth of teachers reported that pupils were unable to fully understand the task, with 16% indicating a response of 'probably not' and 6% 'definitely not'. This negative view may be an indicator of various factors such as the inadequacy of the task, the complexity of the task, the ambiguity of the task, the language difficulty, the teaching methods, and so on.

The final questions that can illuminate our answers to VO2 focus on students' interdisciplinary thinking that can promote understanding of science concepts (Bellova; Culkova, 2024). We asked, "Are your contextual tasks interdisciplinary in nature?"

The finding that 27.8% of teachers say they definitely use interdisciplinary relationships suggests that some educators are actively integrating a variety of subjects into their teaching. This approach promotes a broader understanding of the curriculum and its application in different contexts. As many as 72.2% of teachers reported that they sometimes use interdisciplinary relationships. This means that the majority of educators perceive interdisciplinary connections as a useful tool but seem to apply them in specific situations or when needed. This approach shows that teachers have some flexibility in implementing interdisciplinary connections, but they are not necessary for them in every task.

No one reported ever using interdisciplinary relationships, suggesting that most teachers perceive the value of combining subjects at least occasionally. This fact suggests a growing interest in subject interconnections, which is important for comprehensive understanding and real-world application of knowledge.

Evaluation of RQ2:
Based on the evaluation of the four items (focused on RQ2), it is evident that students excel in cognitive knowledge (87%) and practical skills (66%) while solving complex problems. However, significantly weaker scores are given in the areas of metacognition, scientific practices and epistemic processes, where intensive improvement is needed. The overall picture suggests that more attention needs to be paid to developing students' ability to think critically, regulate their learning and apply their knowledge in scientific and practical contexts.

Based on the assessment of pupils' competence in complex tasks, it is evident that pupils have strong skills in applying scientific thinking to solve everyday problems (80%). However, in other areas such as critical thinking, self-reflection, time management and effective collaboration, more attention and development of these competencies is needed. Significantly low scores in the areas of ethical issues (0%) and the ability to reflect on one's own personality (13%) indicate a need to focus on improving these aspects, which are key to complex problem solving and responsible decision making.

We can also state that most pupils are able to read with comprehension in contextual tasks, but this is not always a seamless understanding. Around 22% of teachers reported problems with pupils' reading comprehension skills, which may be due to the complexity of the tasks, the difficulty of the language or the lack of clarity of the task. These findings support research on reading comprehension, which suggests that it is a skill that requires systematic practice and support from teachers.

From the last item, we found that although the full and regular use of interdisciplinary relationships is not entirely common among all teachers, most educators integrate them into their teaching at least occasionally. This suggests that interdisciplinarity is perceived as a valuable tool to support students' holistic development.

Research limitations:
The research results presented here are only part of a quantitative research study focusing on contextual tasks, their design, implementation, advantages, disadvantages and barriers from the teachers' perspectives. Further evaluation will include comparison with published research by Slovak and foreign authors. Also, a combination of quantitative and qualitative methods would be very beneficial, which can give us a more comprehensive view of the effectiveness of using contextual tasks in science teaching. Such as conducting interviews or focus groups with science teachers to identify effective methodological approaches.

8. CONCLUSION

Incorporating complex contextual tasks into science teaching is key to developing the competencies needed for the 21st century, such as critical thinking, problem solving, collaboration and interdisciplinary thinking. These tasks not only foster a better understanding of science concepts but also prepare students for the real-world challenges they will encounter in their personal and professional lives. As several studies and scholarly articles have shown, the implementation of complex tasks has a positive impact on student learning and engagement.

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Teacher and Formative Assessment in Primary Education

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Abstract The requirements of present-day international educational policy call for the use of effective assessment, the aim of which is to support the development of every learner and improve their learning process. In the educational process of primary education, one of the options for meeting these goals is formative assessment, which is considered an assessment for learning and not an assessment of learning. The presented paper deals with formative assessment at the primary level of education and its aim is to present the results of research dealing with the awareness of primary education teachers about formative assessment and its application in the educational process.

Keywords Formative assessment, primary education, teacher

INTRODUCTION

Assessment is a key tool that teachers can use to influence the development of learners' personalities, their motivation and their ability for lifelong learning. It is an essential part of the educational process and has a motivational, informative, comparative, and corrective function, while it should also positively support learners' healthy self-confidence. In this context, it is therefore important that assessment is not limited to checking the results achieved, but that it becomes primarily a way to support and discover the potential of students. Traditional approaches to school assessment, which have dominated in Slovakia, emphasise summative assessment of the results of the students' learning process in the majority of cases. This focus restricts the understanding of a learner's current developmental stage and the identification of particular areas needing improvement, thus resulting in a lack of clarity for both the student and their legal representatives regarding potential areas for improvement.

In the rapidly changing cultural and social conditions, it is essential that our education system brings about changes that will significantly affect assessment in accordance with current global trends in the assessment of the results of the teaching process, focusing on comprehensive assessment of the student, on the involvement of the student in the assessment process, and the equalization of classification and verbal assessment (Hipkins, Cameron, 2018). Thus, the notion of formative assessment has risen in importance over the past few years, deserving a vital position in primary education.

1. FORMATIVE ASSESSMENT

The concept of formative assessment itself remains somewhat ambiguous even nowadays, despite Bloom being considered as its originator. According to Bloom et al. (1971), formative assessment can be understood as feedback that is associated with the possibility of correcting the teaching and learning process. This feedback enables the identification of how students learn, as well as the diagnosis of shortcomings, errors, difficulties and their causes in learning, with the aim of eliminating them and enhancing the efficiency of students' learning activities (Petlák, 2014). Formative assessment provides students with information about opportunities to improve while also shaping their personal development (Bell, Cowie, 2001; Allal, Lopez, 2005; Hattie, Timperley, 2007; Brookhart, 2008; Fluckiger et al., 2010; Wiliam, 2010; Flórez, Sammons, 2013). Through formative assessment, students learn to evaluate themselves, their classmates, and the facts around them (Ganajová et al., 2022). The OECD's definition of formative assessment from 2005 emphasizes the importance of monitoring student progress, identifying their needs and learning challenges, and adjusting the educational approach accordingly. The primary goal of formative assessment is to showcase students' strengths while also pinpointing areas of weakness, thereby facilitating targeted interventions during the assessed activity (Pávová and Váňová, 2020).

Formative assessment is often also called learning-supportive assessment (Jančová et al., 2024) or developmental assessment (Szarka, Szabó, 2024). Unlike grading, this type of assessment provides direct support, which is intended to help both students to improve their performance and teachers to discover the most appropriate ways of learning. This assessment has two important parts. First of all, the student becomes aware of the differences between the goal they are supposed to achieve and their current level of knowledge and skills. Moreover, they seek and acquire

ways to eliminate this difference. In this case, the assessment is not only a report for the student about what they have managed to achieve, but also an impulse for the teacher to regulate activities in the classroom (Jančová et al., 2024). The purpose of this type of assessment is to improve the students' learning and the teachers' teaching, diagnose the students' difficulties, and help the students understand the goals and processes of learning throughout the entire educational process. In parallel, answers are sought to the questions - *What has worked? What needs to be improved? How can we improve it?* (Shewbridge et al. 2014). Formative assessment relies on activities that offer insights into a student's current position in the learning journey, the desired goals, and the most effective strategies to achieve these goals. This means that formative assessment does not only focus on *what* and *with what* result students learn, but also *how* they learn. Black and Wiliam (2005) further emphasize that self-assessment is essential for effective learning and that students are more willing to accept criticism from each other than from their teachers.

The above information show that formative assessment represents a planned process (Popham, 2008), requiring two-way feedback, from teacher to student, or from student to teacher (Harlen, 2013). Its basic principles focus on learning; its aim is to determine students' knowledge, comprehension, and learning styles. It offers prompt feedback and identifies the educational requirements of each student, allowing for subsequent adjustments in teaching methods. "*Formative assessment helps students learn better and learn more. It is any assessment that provides useful information about the current state of a student's knowledge and skills. It is useful primarily in the sense that they will know where they are and what they need to do to learn something more*." (Starý, Laufková et al., 2016:12). However, as Flórez and Sammons (2013) or Bennet (2011) state, the application of formative assessment is particularly effective for students in primary education, as a positive impact of formative assessment on results in summative tests has been noted. The authors highlight its positive impact on the development of the students' personality, understanding of the students' learning progress, and the effectiveness of their education (Hattie, Clarke, 2018; Pane et al., 2015; Parr, 2016; Perry, 2015; Wiliam, 2011). Formative assessment deserves more attention, as the success or failure of a student cannot be determined based on the results of a half-yearly assessment of knowledge. On the contrary, the final assessment should be based on information about the students' daily performance and progress, and it is this information that should determine their progress in the educational process (Stiggins, 2002). Formative assessment plays a crucial role in primary education, as it facilitates continuous daily feedback, discussions, and support from both the teacher and students who assess themselves and their classmates. (Pitkänen, 2022).

1.1 Forms and techniques of formative assessment

There are three basic forms to formative assessment – self-assessment, peer assessment, and teacher assessment (Starý, Laufková et al., 2016), which should be applied in the educational process with equal distribution.

Self-assessment represents an autonomous evaluative process undertaken by the student, where the individual takes responsibility for themselves, their own learning, assesses their progress based on their personal standards, and seeks feedback for reflecting on their own activities, considering not only the curriculum standards and external assessment criteria, but also their own principles. It should be an everyday part of the student's learning at school (Pitkänen, 2022).

Peer assessment, on the other hand, consists of the assessment of a student by other students, whereby the student is more willing to observe and assess the work of others than his or her own and at the same time better understands its goals and quality criteria (Čtvrtníčková, Procházková, 2020).

Formative assessment of a student by a teacher, last but not least, is important for both parts in the teaching process. With the help of the teacher's assessment, the student finds out how they are thriving and progressing in education, while the teacher, on the other hand, reflects on the quality of their work and the level of their professional competences.

By applying the above forms of formative assessment in the educational process of primary education, the development of mutual social relations between students and teachers is positively influenced, the quality of students' abilities is influenced, the internal need of the student to improve is activated, and the student is stimulated to overcome problems and eliminate their shortcomings (Weissová - Bistáková, 2006).

Teachers can integrate individual forms of formative assessment into the teaching process using several techniques. The professional literature lists and describes a number of techniques applicable in the educational process of primary education. Since the aim of our paper is not to characterize individual techniques, we present them only as examples - Two Stars One Wish, Dot at the End of the Line, Traffic Light, Peer Assessment of Homework, Prediction Card (Jančová et al., 2024), Self-Assessment Sheets, Self-Assessment Cards, Metacognition, Departure Ticket, Concept Maps, Summary, Portfolio (Orosová et al., 2019), Symbols, Rationale, Modeling, Coat of Arms, Evaluative Communicative Circle (Čtvrtníčková, Procházková, 2020).

1.2 Formative assessment in Slovakia

The preference for summative over formative assessment is evidenced by the conclusions of the OECD Report on Evaluation and Assessment in Education: Slovak Republic 2014. The aforementioned OECD report calls for the application of formative assessment techniques in the educational system of the Slovak Republic (Shewbridge et al, 2014). These findings are also in alignment with the conclusions of the research conducted by Orosová et al. (2019), which show that teachers have strong preferences towards summative assessment in the educational process. Similarly, the international study TALIS OECD 2018, in its findings on the use of assessment to support skills for the 21st century, states that it is necessary to implement formative assessment in the educational system of the Slovak Republic, which is an impetus for the development of key competences of students (Rychnavská, Pappová, 2019). We would like to state that the results of the latest TALIS 2024 measurement, which also included the Slovak Republic, are not yet available, while, as stated by the OECD, their publication is planned for October 2025.

In accordance with the recommendations and global trends in the field of evaluation, some progress has already been taking place in the primary education system of the Slovak Republic at the level of school policy. As part of the current school reform, there is a significant shift from the traditional view of evaluating acquired information to an assessment that verifies the development of critical thinking, application of knowledge, and the development of competences. At the same time, greater emphasis is placed on other, alternative forms and methods of assessment, such as classification or verbal assessment. As part of the school reform, the key legislative curricular document of which is the State Educational

Program for Primary Education from 2023, formative assessment, including peer assessment and self-assessment, is gradually coming to the fore, using various techniques that provide students with the opportunity to evaluate their own progress. As we have already mentioned above, these methods allow students to monitor and evaluate their own performance and learning processes, compare them with previous results, all supporting personal growth and independent learning.

Although we view this shift as beneficial, we sought to understand how well-informed primary education teachers are about formative assessment, and whether they incorporate it into their teaching on a regular basis. It is crucial to understand that regardless of the y expectations of the school policy, the reality within classroom an often deviate from these expectations.

2. METHOD

The subject of this qualitative-quantitative (QUAL-quan) oriented research (Cameron, 2009) was the awareness of primary education teachers about formative assessment and its application in the educational process. Due to the subject of the research, our research group consisted of teachers of the primary level (teachers of grades 1-4). Altogether 50 participants joined the research, whose selection was carried out via purposive sampling. Obtaining research data in order to answer the set research questions - *What is the knowledge of primary education teachers about formative assessment*?; *Do primary education teachers apply formative assessment in the educational process?* was carried out through a structured interview with open-ended questions ensuring relatively equal conditions for all participants (Bačíková, Janovská, 2018). The collected research data was analysed via content analysis of the text, within which we analyzed ad hoc materials (Gavora, 2015) - interview protocols. We applied content analysis of the text in both quantitative and qualitative forms. In case of quantitative content analysis of the interview protocols, we analyzed manifest content, which expressed the frequency of responses, and in case of qualitative content analysis of the text, we focused on latent content revealing hidden meanings (Greguš, 2024). This process allowed us to obtain results that not only quantify the knowledge of primary education teachers about formative assessment, but also explore and explain it in more depth.

3. RESULTS

This report outlines the results of our investigation with a focus on analysis and interpretation of data obtained through interviews with teachers teaching at the primary level of education. To facilitate a better understanding of formative assessment, our research findings are depicted in the following graphical representations.

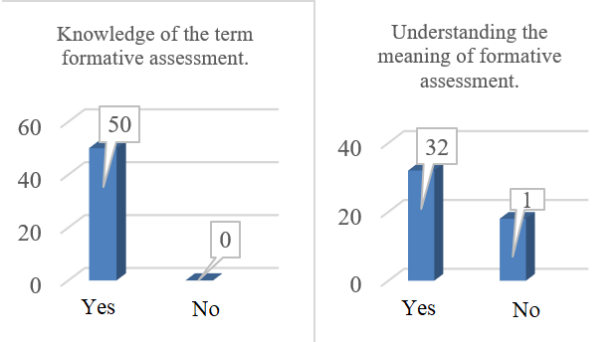

Figure 1: Knowledge and understanding of formative assessment

Figure 1 demonstrates that 100% of teachers (N=50) recognize the term formative assessment itself, or have already heard of it. Nevertheless, when inquired about their comprehension of its meaning, the outcomes varied. As the second graph of figure 1 illustrates, only 32 of the 50 teachers provided a positive response, which constitutes 64% of the total participants. Another 28 teachers expressed uncertainty regarding the definition of formative assessment.

These quantified data were further supported with qualitative data, which demonstrate that out of 32 teachers knowing the meaning of the term formative assessment, only 25% of participants (N=8) were able to clearly and unambiguously define it, and provide a concise description of formative assessment. They clarified that - "*it helps students improve their learning, provides some feedback on the basis of which the student can improve*", "*it is not about measuring results, but rather about the process of assessment so that they know where in their progress they are situated and how to improve*", "*it is developmental, the student has feedback from the teacher, from other students, which will help them in learning*", "*with its help I actually give the student information about their progress*". Another 75% of participants (N=24) were able to formulate only a sketchy and fragmented explanations such as "*it is creative assessment, but I do not know anything else*", "*it has something to do with improving learning*", "*that is how they assess themselves, and I assess them*", "*it is related to the development of the student, but I cannot describe it more specifically*".

Among the 28 teachers that declared unfamiliarity with the term, 7 (25%) had an internal lack of interest in the issue, as evidenced by their answers – "*I keep hearing about it, but I do not pay attention to it*", "*I know that it is also mentioned in connection with the new state educational program, but until it is mandatory, I do not pay attention to it*", "*if we did not have a million other obligations, I could pay attention to it, but like this…*", "*it is everywhere, it is used everywhere, but no one has told me what to do with it*", "*grades are grades, they have a better informative value*". For the remaining 75% (N=21) of the teachers, lack of familiarity with the meaning of formative assessment was found to be caused by ambiguity and lack of clarity in the literature and teacher support materials. Evidence of these are the following statements of teachers - "*I did read about it but I got lost in the whole thing*", "*when I looked for it, I found a lot about it, but I could not find anything written clearly and understandably for a teacher that would explain what exactly it is*", "*even when I did look something up, there were just such general descriptions, nothing specific*", "*what I saw, it is called differently everywhere, everybody understands it differently, and I can only deduce from that what it probably means*", "*only the methods are described specifically, but I did not find clearly defined formative assessment, it is just so roundabout*", "*I have been to training too, but everything was explained in a manner too difficult to understand*".

Subsequently, we focused on finding out whether teachers were familiar with the forms and techniques of formative assessment. The quantified research data are presented in the graphs below.

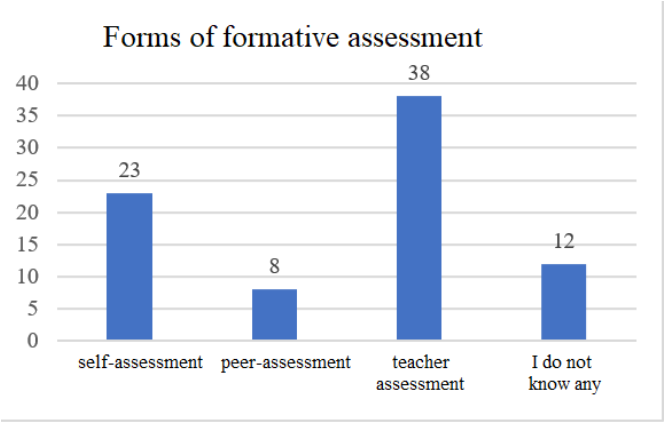

Figure 2: Forms of formative assessment

As we can see in the graph above, the most represented form was teacher evaluation, which was reported by 76% of participants (N=38). Subsequently, 46% teachers (N=23) included student self-assessment as a form of formative assessment and 16% (N=8) identified peer assessment as a form of formative assessment. As many as 24% (N=12) indicated that they did not know any forms of formative assessment. Analysis of the research data also revealed that only 25% (N=8) were familiar with all the three basic forms of formative assessment, whose statements indicated a clear understanding of the subject matter. This data is also consistent with our previous findings, which declared that 8 teachers were able to clearly describe the meaning of formative assessment. We would highlight that of the remaining 30 teachers identifying teacher evaluation as one of the forms of formative assessment, 76.70% (N=23) of the responses were uncertain and rather guessing in nature, which is confirmed by the following statements of the teachers – "*so, it is an assessment, some form, that could be teacher evaluation*", "*probably teacher evaluation*", "*I can see that the teacher could evaluate the pupils here*", "*I will try teacher evaluation*". It is also important to note that a similar trend was observed in the self-assessment responses, with 65.20% (N=15) of the 23 responses being based on guessing.

Following the forms of formative assessment, our research further focused on primary teachers' knowledge of formative assessment techniques. We present our findings in the graph below, which is subsequently interpreted.

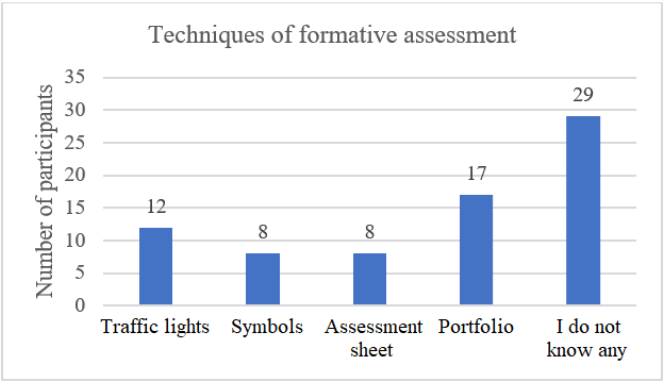

Figure 3: Techniques of formative assessment

Based on the analysis of the research data, it was found that as many as 58% (N=29) of the teachers do not know any formative assessment techniques. In contrast, portfolio had the highest representation, yet only 34% (N=17), with only 8 teachers responding unequivocally to this form of formative assessment. An additional 22% (N=11) of the responses were also speculative in nature, such as - "*I could say portfolio at this point, that one fits everywhere*", "*a portfolio will definitely fit here*", "*I would guess that one technique would probably be a portfolio*". Only 16% (N=8) of the teachers referred to alternative formative assessment techniques, such as symbols and the assessment sheet. These teachers are the same individuals who, as previously noted, possess knowledge regarding formative assessment. Traffic lights was mentioned by 24% (N=12) of the participants, while 9 responses were unambiguous and the other 3 were based on speculation, as shown by the following statements - "*I think I have read about something like traffic lights*", "*in the training they talked about some kind of traffic lights, but I only remember the name*", "*I think traffic lights, I have heard about it somewhere*".

By the end of our research, we were also interested in examining how teachers utilize formative assessment in the educational context. The outcomes of our study are depicted in the graph below.

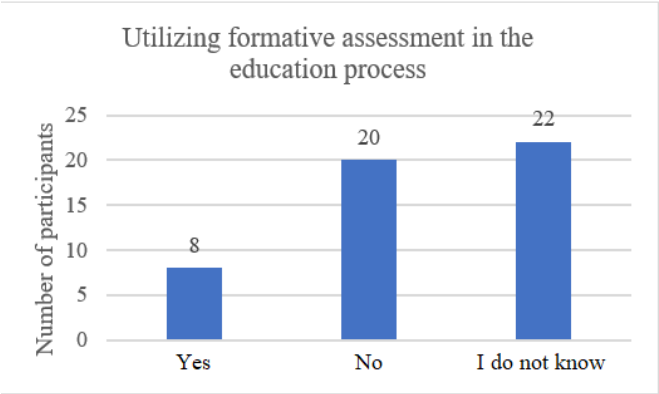

Figure 4: Utilizing formative assessment at the primary level of education

It was found that only 16% (N=8) of teachers apply different forms and techniques of formative assessment in the education process, which is supported by their following statements - "*yes, I try to give feedback all the time, how they worked, what they could improve*", "*in every lesson I include some form, sometimes I have the pupils evaluate the pupil, other times I use them to evaluate themselves either by using cards or evaluation sheets or verbally, it depends on the type of lesson and the time*", "*almost every lesson has some element of formative assessment, the pupils are happy to evaluate themselves or evaluate another pupil*", "*yes I do. I have smiley faces displayed in my classroom, we use them as symbols for different types of assessment*", "*yes, all pupils have their own traffic lights and at the end of the lesson they display their individual colours*". Moreover, the graph illustrates that 40% (N=20) of the teachers claimed they did not engage in formative assessments during the education process. However, insights from our qualitative inquiry - *What assessment forms do you implement*? demonstrated that despite teachers' beliefs of not using formative assessments, the evidence suggests otherwise, with 65% (N=13) of them using them actively, which is also supported by the following statements - "*no I don not use formative assessment, I tend to assess them verbally, their progress and of course with grades*", "*I do not use formative assessment, but we do portfolios, which we assess*", "*I do not apply formative assessment, I use summative assessment and assessment when the pupils assess each other, or they assess themselves, or I assess them*", "*no, we have learnt that after each lesson the pupils pick up a card which symbolises how they have understood the material*". The following category, the I do not know response, was reported by 44% (N=20) of the teachers. Nevertheless, similar to the previously mentioned no response, the answers to the supplementary question revealed that while teachers may be unaware of their use of specific forms and techniques of formative assessment, our analysis

indicates otherwise, as we found elements of formative assessment present in the statements of all 20 teachers.

4. CONCLUSION

Contemporary society calls for assessment to be not limited to only checking pupils' achievements, but above all to become a way of supporting and discovering their potential. One way of developing the pupil through assessment is to apply formative assessment in the educational process.

The objective of this research was to assess the level of knowledge and understanding of formative assessment among primary school teachers and to evaluate whether they incorporate formative assessment into their educational methodologies. We recognize that the results of our study may not be universally applicable, given the small sample size; however, they yield qualitative data that can inform subsequent research. Notably, it has been found that teachers' familiarity with formative assessment is lacking, despite its prominence in current educational discussions.

Our research revealed that while teachers recognize the term, 84% (N=42) do not fully understand its meaning. Additionally, 14% (N=7) of teachers indicated that their unfamiliarity with formative assessment is due to a personal disinterest in the topic, whereas 42% (N=21) attribute their confusion to the unclear information presented in literature, support resources, and training programmes.

Additionally, our research revealed that a significant number of teachers lack familiarity with the various forms and techniques of formative assessment, as only 16% (N=8) were able to accurately identify these forms. A notable 76% (N=38) of the responses were based on guessing. In terms of formative assessment techniques, we discovered that 58% (N=29) of teachers were unaware of any specific techniques. Among the few techniques mentioned, only four—traffic lights, symbols, assessment sheet, and portfolio—were identified, with the portfolio being the most frequently referred to. However, it is important to note that 22% (N=11) of the responses regarding the portfolio were also speculative in nature.

According to the analysis of the manifest content of the text, it was determined that merely 16% (N=8) of educators implement formative assessment within their teaching practices. However, a deeper examination of the latent content revealed that among the teachers who reported either not applying or being uncertain about their use of formative assessment (N=42), a significant 66% (N=33) inadvertently engage in formative assessment during primary education. We view these findings as encouraging in light of contemporary educational standards, yet it is clear that there is a pressing need to enhance primary education teachers' understanding of formative assessment, both theoretically and practically. Consequently, in light of the ongoing reforms, we advocate for in-service training providers to include training on this subject and to develop courses that emphasize the application of forms and techniques of formative assessment in primary education.

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Bibliotherapeutic Potential of Autobiographical Narratives: Analysis of a Manuscript by a Person with Muscular Dystrophy

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Abstract This study examines the bibliotherapy potential of autobiographical narratives using the manuscript “When the Soul Speaks”, which is currently in the process of being developed. The work analyzes how the personal narrative of a person with muscular dystrophy can serve as a therapeutic tool not only for the author himself but also for readers with a similar experience. The research is grounded in the theoretical concepts of bibliotherapy, autobiographical memory, and narrative identity. Methodologically, it is based on a qualitative analysis of available parts of the text with an emphasis on identifying key therapeutic elements. The results show that even an unfinished autobiographical narrative can significantly contribute to the process of coping with a chronic illness, building resilience, and finding meaning in challenging life situations.

Keywords bibliotherapy, autobiographical narrative, muscular dystrophy, coping strategies, identity reconstruction

1. INTRODUCTION

Bibliotherapy, a therapeutic method that utilizes reading and writing for therapeutic purposes, has been gaining increasing attention from the professional community in recent decades. A special place in this context is occupied by autobiographical narratives of people with chronic illnesses or disabilities, which can serve as a bridge between personal experience and broader social understanding. This study focuses on the analysis of the manuscript “When the Soul Speaks”, which represents an autobiographical narrative of a person with muscular dystrophy.

A notable aspect of this study is that the manuscript under analysis remains unfinished. This circumstance, however, does not constitute an obstacle to the research but, on the contrary, offers a unique opportunity to explore the bibliotherapy potential of the text during its creation. As Rubery (2022) notes, the writing process can be as important as the final product, especially in the context of therapeutic writing. The unfinished nature of the manuscript is a reflection of its authentic quality, reflecting the ongoing nature of coping with a chronic illness.

The research aims to identify and analyze bibliotherapy elements in this narrative and assess their potential benefits for both the author and readers with a similar experience. The study asks the following research questions:

What bibliotherapy elements can be identified in the accessible parts of the autobiographical narrative of a person with muscular dystrophy? How does the process of autobiographical writing contribute to coping with a chronic illness? How can even an unfinished narrative be utilized in the context of formal or informal bibliotherapy?

2. THEORETICAL FOUNDATIONS

Bibliotherapy is a therapeutic approach that uses reading and writing to achieve positive changes in an individual's thinking, emotions, and behavior. Isawi, Gavin, and Wickman (2025) define bibliotherapy as the purposeful use of literature to promote mental health and personal growth. The authors emphasize that bibliotherapy can be an effective tool for developing self-awareness, empathy, and resilience. In the context of working with individuals who have chronic illnesses or disabilities, bibliotherapy assumes particular significance. As Cossali and Rampani (2023) state, writing can serve as a means of processing traumatic experiences, building a positive identity, and finding meaning in challenging life situations. The authors emphasize that writing one's own story allows an individual to gain distance from their experience and see it from a new perspective.

Autobiographical memory is a specific type of episodic memory that involves memories of personal experiences and events from one's own life. Raeder, Clayton, and Boeckle (2023) emphasize in their meta-analysis that narrative processing of autobiographical memories can have a significant therapeutic effect, especially for people with traumatic experiences. The concept of narrative identity, as described by Nicholes (2022), is based on the assumption that people construct their identity through the stories they tell about themselves. These stories help integrate diverse experiences into a coherent whole, giving life meaning and continuity. In the case of people with chronic illness, narrative reconstruction of identity can represent an important adaptation mechanism.

An interesting perspective for our study is offered by research into the therapeutic potential of unfinished narratives. As Leese, Crouthamel, and Köhne (2021) suggest, unfinished or fragmentary narratives may reflect the nature of traumatic experience, which often defies linear narrative and closure. The authors argue that the "openness" of such texts may paradoxically better capture the complexity and unfinished nature of the process of coping with trauma or chronic illness. Rolston (2021) emphasizes in her analysis

of autobiographical texts that the process of writing itself can have a therapeutic effect, regardless of whether the text is completed. The author notes that writing as a process can be as important as writing as a product. This notion is particularly relevant to our analysis of the unfinished manuscript, where we can observe the therapeutic potential of the autobiographical writing process itself.

A study by Hanáková et al. (2024) on the self-concept of individuals with neuromuscular diseases revealed that those with muscular dystrophy exhibit distinct patterns of self-evaluation across various life domains. The study, which included 29 respondents with neuromuscular diseases, revealed that the highest average score was recorded in the area of social adaptability (55.76 points), while the lowest was in the area of physical appearance (39.17 points). These findings suggest that individuals with neuromuscular diseases tend to perceive themselves as well-adapted in social situations yet may experience lower satisfaction with their physical appearance. The study also showed slightly below-average ratings in the area of meaning and self-actualization (average 45.69 points), which may indicate that respondents feel some limitations in their possibilities for self-actualization and fulfillment of life goals. These findings are relevant to our analysis of the autobiographical narrative of a person with muscular dystrophy, as they provide a broader context for understanding the psychosocial aspects of life with this disease.

3. METHODOLOGY

For this study, a qualitative research design using narrative analysis was chosen. This approach enables an in-depth examination of the meanings, structures, and functions of autobiographical narratives (Kuiken & Jacobs, 2021). Narrative analysis focuses on how people construct and interpret their experiences through stories, making it a suitable method for exploring the potential of bibliotherapy in autobiographical texts.

The primary research material is the unfinished manuscript “When the Soul Speaks”, which is an autobiographical narrative of a person with muscular dystrophy.

The manuscript's available parts comprise six chapters that capture key moments of the author's life, from childhood to adulthood, with a special emphasis on the experience of living with a progressive neuromuscular disease. The text combines chronological narration with reflective passages and also features interactive elements, including a space for the reader's affirmations at the end of each chapter. The fact that the manuscript is unfinished was taken into account in the methodological approach. The analysis focused not only on the content of the available parts but also on identifying potential directions for further development of the text and its therapeutic potential in its current, incomplete form.

Data analysis was conducted in three phases: thematic analysis, structural analysis, and functional analysis. Through thematic analysis, we first extracted the main themes from the text. These include, for example, love and relationships, acceptance of fate, family heritage, finding meaning in life, loss and death, strength and resilience, working with energy, appreciating beauty in everyday life, discovering a life path, and cultivating gratitude. Each theme is briefly described and illustrated by its manifestation in the text.

In the structural analysis, we focused on the formal division of the text. Through functional analysis, we ultimately identified the primary functions of the individual parts of the text. The text fulfills the following functions: emotional (expresses feelings and emotions), motivational (inspires the reader), therapeutic (helps to process difficult emotions), informative (explains facts), aesthetic (uses poetic means), appellative (calls the reader to action), and reflective (stimulates thought).

4. RESULTS

4.1 Thematic analysis

Several key thematic areas have been identified in the manuscript “When the Soul Speaks” that have significant bibliotherapy potential:

4.1.1 Accepting the diagnosis and coping with disease progression

The text captures the process of accepting a diagnosis of muscular dystrophy from both the author's and her parents' perspectives. Particularly impressive are the passages describing the different perceptions of the disease by the child and the parents:

“I looked at him with a slight smile that bordered on mockery. It was strange to see my dad so broken when, to me, the disease was something as natural as breathing. 'What are you talking about, Dad?' I said with sincere incomprehension. To me, muscular dystrophy was simply a part of life, something I was born with, even if it did not manifest until later.”

This excerpt illustrates an important psychological phenomenon: a child with a congenital or early acquired disability does not perceive his condition as a loss but as normality. This insight can be valuable for both parents of children with disabilities and professionals working with this target group.

4.1.2 Transforming vulnerability into strength

A significant theme of the manuscript is the transformation of apparent weakness into strength. The author repeatedly describes how the experience of living with limitations taught her to see value in aspects of life that she might otherwise overlook:

“Failures became my daily reality, but I learned to see them differently. They were not just moments of weakness, but opportunities to meet, to break down barriers between people, to create moments of authentic connection.”

This transformation motif corresponds to the concept of posttraumatic growth, which describes positive psychological changes resulting from coping with highly challenging life circumstances (Raeder, Clayton & Boeckle, 2023).

4.1.3 The search for meaning and the spiritual dimension

The text contains a strong spiritual dimension, especially in the chapter “When the Soul Speaks”, which describes a transcendental experience during craniosacral therapy:

“I feel tears running down my face, mixing with the amniotic fluid. 'But what should I do?' 'You just BE and create,' he says with infinite love. 'Spread joy and do what makes you and others happy!'”

This passage illustrates how autobiographical writing can serve as a means of articulating and integrating spiritual experiences into a

personal narrative, thereby contributing to finding deeper meaning in challenging life situations.

4.2 Structural analysis

4.2.1 Narrative structure and temporal organization

The manuscript combines a chronological narrative with reflective passages that offer more profound insight into the author's inner world. This structure allows the reader to follow not only external events but also the internal process of coping with the illness and its integration into the author's identity.

The alternation of time planes is particularly effective, as the author connects childhood memories with reflections from the perspective of adulthood:

“Today, when I am forty-one, I look back and see what a difficult journey my parents had to go through. From the initial shock and denial, through the search for miracle healers, to the final acceptance of reality.”

This narrative strategy enables both the author and the reader to gain distance from immediate experience and view it within the broader context of the life story.

4.2.2 Interactive elements

A significant structural element of the manuscript is the interactive passages at the end of each chapter, which invite readers to formulate their affirmations:

“Space for your affirmation: 'I accept my life as it is, with all its challenges and gifts. Every day is a new opportunity to see beauty even in the most difficult moments.'”

This element transforms passive reading into an active process of self-reflection, significantly enhancing the therapeutic effect of the text. As Isawi, Gavin, and Wickman (2025) state, active reader engagement is a key factor in the effectiveness of bibliotherapy interventions.

4.3 Functional analysis

A functional analysis of the manuscript “When the Soul Speaks” revealed that the text fulfills several therapeutic functions, both for the author herself and potentially for readers with similar life experiences.

4.3.1 Therapeutic functions for the author

The text demonstrates that autobiographical writing is a crucial therapeutic tool for the author. Writing allows her to integrate the challenging experiences associated with a progressive illness into a coherent life story, which can contribute to better coping with and accepting this life challenge. Through storytelling, the author reconstructs her identity in a way that incorporates the illness as a significant part of her life, yet it is not entirely defined by it. This process of narrative identity reconstruction may be significant for people with chronic illness, as it helps them build a self-concept that is not reduced to the role of the patient.

Another important therapeutic aspect of writing is its potential for finding and articulating meaning in a life with limitations. The text reflects the author's search for and discovery of meaning in challenging life situations, which aligns with Frankl's concept of the “will to meaning.” This existential dimension of autobiographical writing can be a valuable source of resilience and well-being in the face of chronic illness.

Ultimately, writing enables the author to share her experiences with others, which can contribute to a sense of meaning and social connectedness. Knowing that her story can be a source of inspiration and comfort for others can strengthen the author's sense of belonging and give her experience a transcendent meaning.

4.3.2 Potential therapeutic functions for readers

Even in its unfinished form, the manuscript of “When the Soul Speaks” has the potential to serve several therapeutic functions for readers, especially those who have similar experiences with chronic illness or disability.

Readers with similar life experiences may find confirmation in the text that their emotions and reactions are normal and shared by others. This process of identification and normalization can be especially valuable in the context of rare diseases, where a patient may feel lonely and isolated with their diagnosis. Finding that their experiences resonate with those of someone else can bring significant relief and a sense of belonging.

The text also provides models of adaptive ways to cope with chronic illness. The author's coping strategies, attitudes, and values can serve as inspiration and a source of practical ideas for readers facing similar challenges. The author's story of living a whole and meaningful life despite a serious illness can be a source of hope and motivation for others.

Finally, the interactive elements of the text, such as passages that invite readers to formulate their affirmations, encourage the reader's self-reflection and active engagement in the therapeutic process. These elements transform passive reading into an active process of self-exploration and personal growth, significantly enhancing the therapeutic potential of the text.

Overall, the manuscript “When the Soul Speaks” represents a valuable bibliotherapy tool that can contribute to better coping and acceptance of chronic illness, identity reconstruction, finding meaning, and strengthening social connections. Its incompleteness not only does not diminish its therapeutic potential but may, on the contrary, reflect the authentic nature of the experience of living with a progressive illness.

5. DISCUSSION

The analysis reveals that “accepting fate” is the most common theme in the text, indicating a strong motif of coping with life's challenges.

Topic	Number of occurrences
Love and relationships	9
Accepting fate	32
Family heritage	8
Searching for meaning	12

Loss and death	12
Strength and durability	10
Working with energy	4
Beauty in everyday life	21
Finding a way	11
Spiritual wisdom	9

Table 1: Frequency of theme occurrence in the manuscript „When the Soul Speaks“

The following table presents the topic with examples of individual statements.

Topic	Sample
Love and relationships	•And sometimes true love is not the one that dazzles you at first sight, but the one that gradually, day after day, transforms you into a better person. •Love comes in many forms and often from unexpected directions. •And now, as Armstrong's voice sang about how beautiful this world was, I felt that Dad, even though he had decided to end his life, saw the world as a place full of beauty, trees, and even though he was gone, his love for life and nature was genuine and deep.
Accepting fate	•None of us have any idea what cards fate will deal us. •We were both suddenly faced with the same diagnosis, as if fate had decided that it wouldn't let us go through this hell gradually, but would strike all at once, full force. •That even if fate takes away our ability to run, it cannot take away our ability to love.
Family heritage	•Memories of grandparents have a special ability - they are like old photographs that do not lose their color over time, but instead acquire new shades that we were unable to perceive as children. •Grandparents are like trees - their roots reach deep into the past, their branches provide shade on the hot days of life, and their fruits nourish future generations. •Our most valuable heritage is not in what our grandparents left us materially, but in the values they passed on to us.
Searching for meaning	•Because fate has a sense of irony, and sometimes the best teachers come in a guise you least expect. •What's the point? •But in that special space between waking and dreaming that craniosacral therapy opened up, I received an answer that was neither logical nor rational, yet made perfect sense: “Because I like it when everything is not the same.”
Loss and death	•That for us it is not a loss, but simply life, as it is. •The loss of a child, and then the diagnosis of two more. •Every loss reminds me how precious life is and how important it is to live it to the fullest.
Strength and durability	•That strength is not in our muscles, but in our spirit. •And perhaps its strength lies in this simplicity. •Every fall was like a moment of helplessness, when I was at the mercy of circumstances and the people around me.
Working with energy	•I had this profound experience during craniosacral therapy, which I tried as part of comprehensive care for my body. •Craniosacral therapy works with the subtle rhythm of cerebrospinal fluid that pulsates around the brain and spinal cord. •During therapy, I entered a state that I would describe as deep meditation.
Beauty in everyday life	•It wasn't the beauty of a movie star, but a kind of essence that attracted me internally. •You can write here a positive thought that came to you while reading, a personal encouragement for days when it's hard to find strength, gratitude for something life has given you, wisdom gained from your own experience, or a promise to yourself about how you want to approach life's challenges. •I also felt gratitude.
Finding a way	•It is the journey of one girl, a woman who was born with a body that decided to go its own way. •A path that has not always been straight or easy, but which has led me here – to the moment when I can share my thoughts with you. •It was not a straight or easy path, but it led them to understand that even with illness, one can live a dignified and fulfilling life, that a person's value lies not in how fast they can run, but in what they carry in their heart.
Spiritual wisdom	•These are words I would have liked to have told them back then, if I had the wisdom I have today. •You can write here a positive thought that came to you while reading, a personal encouragement for days when it's hard to find strength, gratitude for something life has given you, wisdom gained from your own experience, or a promise to yourself about how you want to approach life's challenges. •Their wisdom is not that they have all the answers, but that they know how to live with questions.

Table 2: Examples of statements for individual themes in the manuscript „When the Soul Speaks“

The results of the manuscript analysis, “When the Soul Speaks,” confirm the significant potential for bibliotherapy in autobiographical narratives from individuals with chronic illnesses. This potential manifests itself on several levels.

The process of autobiographical writing can serve as an effective tool for processing traumatic experiences and reconstructing identity. As Raeder, Clayton, and Boeckle (2023) suggest, the narrative processing of autobiographical memories can significantly contribute to the integration of challenging life events into a coherent life story. In the analyzed manuscript, this process is particularly evident in passages where the author reflects on her experience with the progression of the disease and transforms it into an opportunity for personal growth.

Autobiographical narratives serve as a bridge between personal experience and broader societal understanding. Franssen (2020) emphasizes that personal narratives about the experience of chronic

illness can contribute to destigmatization and raising awareness about living with the condition. The manuscript "When the Soul Speaks" offers a genuine insight into life with muscular dystrophy, which can be valuable for both the lay public and professionals working with this target group.

Interactive elements in the manuscript that invite readers to formulate their affirmations represent an innovative approach to bibliotherapy. This approach transforms passive reading into an active process of self-reflection, significantly enhancing the therapeutic effect of the text. As Isawi, Gavin, and Wickman (2025) state, active reader engagement is a key factor in the effectiveness of bibliotherapy interventions.

The results of this study have several practical implications. For clinical practice, supporting autobiographical writing can be a valuable component of psychosocial interventions for individuals with chronic illnesses. For the education of professionals in helping professions, autobiographical texts can serve as an authentic source of information about the subjective experience of living with a given illness. Ultimately, for the broader public, such texts can contribute to a deeper understanding and destigmatization of chronic illness and disability.

However, several limitations of this study should be noted. The analysis focused on a single autobiographical text, which limits the generalizability of the results. Furthermore, the assessment of the therapeutic potential of the text was based on theoretical analysis, without empirical verification of its actual effects on the reader. Future research could focus on empirically examining the effects of reading autobiographical texts on the psychological well-being of readers with similar experiences.

6. CONCLUSION

This study investigated the potential of bibliotherapy through autobiographical narratives, utilizing the manuscript “When the Soul Speaks”. The analysis revealed that the text contains several elements with significant therapeutic potential, including themes of accepting a diagnosis, transforming vulnerability into strength, and searching for meaning. Structural analysis highlighted the effective use of narrative strategies and interactive elements that can enhance the therapeutic impact of the text.

The results suggest that autobiographical writing can serve as an effective tool for processing traumatic experiences, reconstructing identity, and finding meaning in life with a chronic illness. At the same time, such writing can also serve as an important therapeutic function for readers, especially those who have had similar experiences.

These findings support the broader use of autobiographical writing and reading in the context of formal and informal bibliotherapy, while also highlighting the value of personal narratives as authentic sources of information about the subjective experience of living with a chronic illness or disability.

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Challenges of implementing artificial intelligence in higher education in the Czech republic

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Abstract Generative Artificial Intelligence (Gen AI) opens up new possibilities in the field of education, but its implementation poses significant legal and ethical challenges. This paper focuses on privacy, copyright, and academic integrity issues related to the use of Gen AI in educational settings. The study focuses on analyzing the approaches of the University of Hradec Kralove, Charles University, and Masaryk University to the regulation and implementation of AI. The results show that even when universities formulate positions for the use of AI, they often lack long-term sustainability strategies and mechanisms to ensure a level playing field for students when using AI tools. The lack of involvement of academia in decision-making processes and the absence of mechanisms to continuously update the rules may lead to ineffective regulation of the use of AI in education, which could hinder its optimal integration and limit its contribution to the innovation of the educational and scientific process.

Keywords: Generative Artificial Intelligence, Artificial Intelligence in Education, Plagiarism, Academic Integrity

1. INTRODUCTION

Generative artificial intelligence (Gen AI) is a subset of artificial intelligence that is capable of creating new text, images, sounds, and other forms of content based on input data and prior learning (Zhihan, 2023). As reported by Okaiyeto et al. (2023), Gen AI utilizes large-scale language models and deep neural networks to simulate human creativity, and its applications extend beyond academia to other fields, including the arts, healthcare, and business. In education, this technology opens up new possibilities in personalized learning, automated assessment, and academic writing support (Baidoo-Anu & Ansah 2023).

At the same time, however, fundamental legal and ethical questions arise that require the attention of the professional community. Dabis and Csáki (2024) note that universities around the world are beginning to formulate initial responses to the spread of Gen AI. The primary challenges include protecting students' data, addressing copyright issues in the use of AI-generated materials, and maintaining academic integrity in the context of automated text generation. In addition, Mayana et al. (2024) identify legal uncertainties associated with ownership and liability for AI-generated content.
This paper focuses on the analysis of the legal and ethical challenges associated with the implementation of Gen AI in major educational institutions in the Czech Republic. It focuses on issues of data protection, copyright and academic integrity. Based on an analysis of existing measures of universities, it will offer a comparative overview of strategies for the use of AI in the academic environment. The aim is not to formulate specific recommendations for educational institutions, but to highlight potential risks and problematic aspects associated with the integration of AI into the educational practice of universities.

2. LEGAL AND ETHICAL IMPLICATIONS OF THE USE OF ARTIFICIAL INTELLIGENCE IN EDUCATION

With the increasing integration of generative AI into adult education, new legal and ethical challenges are emerging that need to be addressed. Gen AI is currently one of the fastest-growing technological tools that is significantly impacting the educational process. Key aspects to consider in this context include data protection, copyright issues and maintaining academic integrity. However, current advances are accompanied by a number of challenges, including lack of regulation, risks of algorithmic bias, and the need to strengthen students' critical thinking skills so that they can use AI technologies ethically (Prepera, 2023).

One of the most important legal aspects of the use of generative AI in education is the protection of personal data. As stated by Nartey (2024), many educational institutions are currently faced with the question of how to effectively ensure that the use of AI systems complies with legislative standards such as the General Data Protection Regulation (GDPR). This is Regulation (EU) 2016/679 of the European Parliament and of the Council, which was adopted on 27. The GDPR sets out uniform rules for the protection of personal data across the European Union (EU) and the European Economic Area (EEA), and applies to all entities that process personal data of EU citizens, even if they are based outside the EU.

The Regulation regulates the rights of individuals to the protection of personal data, the obligations of data controllers and data processors, the rules on consent to data processing, data protection measures, and sanctions for breaches (GDPR; European Union, 2016). The GDPR also applies to the use of artificial intelligence when this technology processes personal data, for example, in the analysis of user behaviour or automated decision-making (Directive; European Union, 2019).

In the Czech Republic, personal data protection is regulated by Act No. 110/2019 Coll., on the processing of personal data, which adapts the General Data Protection Regulation (GDPR) to the Czech

legal system. This Act specifies the rights and obligations when processing personal data and defines the competence of the Office for Personal Data Protection (Act No. 110/2019 Coll., 2019). Using Gen AI in an academic setting often means processing sensitive personal data of students and educators, including their learning outcomes, preferences, and interactions with digital learning tools. In order to minimize the risks of misuse of this information, it is essential to establish clear guidelines for handling the data and to ensure that it is securely stored and anonymized.

Another key issue related to Gen AI is the issue of copyright and ownership of the generated content. Mayana et al. (2024) point out that the current legislative framework does not contain clear rules regarding ownership and liability for AI-generated content. In the educational context, this problem is manifested, for example, in the use of AI-generated materials in teaching or academic papers. The lack of clear legal provisions raises questions about whether generated content is considered an original work, whether it needs to be cited, or how the authorship of such output should be defined.

At the legislative level, copyright in the Czech Republic is regulated by Act No. 121/2000 Coll., on Copyright, on Rights Related to Copyright and on Amendments to Certain Acts (Copyright Act). This Act defines a work of authorship as the unique result of the creative activity of the author, who can only be a natural person (Czech Republic, 2000). This means that content created by artificial intelligence cannot be considered a work of authorship within the meaning of this Act because it lacks a human creative element. The issue of ownership of content created by AI is currently the subject of intense legal debate. It follows that works created purely by AI, without human creative input, are not considered works of authorship and are not subject to copyright protection. AI tool providers specify in their terms of use who acquires rights (not in the sense of authorship) to the generated content.

Therefore, universities and academic institutions need to formulate clear policies for the use of AI in the educational process and ensure that students and educators have clear guidelines for working with the generated materials. At the same time, it is necessary to keep an eye on the development of legislation at the European level, as the issue of copyright of AI-generated content is subject to expert debate within the EU and may be subject to future legislative changes (European Union, 2019). The legal framework regarding the authorship and ownership of AI-generated content can be expected to evolve in the future.

Another important challenge is to maintain academic integrity and prevent plagiarism in the context of the increasing use of generative AI in academic writing. Costa et al. (2024) point out that the proliferation of AI tools such as ChatGPT has led to an increase in instances of unethical behavior, including plagiarism and inadequate assistance to students in academic writing. The use of Gen AI complicates traditional definitions of originality and authorial contribution, requiring a revision of current academic ethics rules (Plata et al., 2023). In order to ensure fair and transparent use of AI in academic settings, it is necessary to establish appropriate control mechanisms and clear guidelines for its use.

Some universities have already responded to these developments by modifying their assessment criteria and strengthening their emphasis on the procedural aspects of academic production rather than simply evaluating the final text.

Given these challenges, educational institutions must take an active role in developing regulations and recommendations to ensure the ethical and legally compliant use of Gen AI in academic settings. At the same time, it is important to support the development of digital literacy among students and educators to be able to critically evaluate AI outputs and effectively integrate them into their educational process, thus ensuring a balance between innovation and academic responsibility.

3. COMPARISON OF AI IMPLEMENTATION APPROACHES OF SELECTED UNIVERSITIES IN THE CZECH REPUBLIC

Higher education is undergoing dynamic changes, with one of the most significant trends in recent years being the use of Gen AI in education. Czech universities are realising the potential of AI in education. They emphasize its ethical and responsible use. A key ethical dilemma for educational institutions is the decision whether to promote or restrict the use of generative AI tools (Rana, 2025).
The paper analyses and compares the strategies of selected Czech universities in the field of the implementation of artificial intelligence in teaching. It focuses on how they are adapting to the advent of Gen AI, what obstacles they face in its implementation and how educational strategies can be optimized to reflect both pedagogical needs and institutional frameworks.

The comparison of the different strategies of the selected universities is based on a combination of descriptive analysis and critical comparison based on available data. This method is inspired by theoretical models of educational innovation management (Fullan, 2015) and concepts of digitalisation in education (Selwyn, 2016). Fullan's model of change (2015) shows that the implementation of new technologies such as AI requires both a structured approach from the top and the active involvement of lecturers and students in order to anchor sustained support for change. Vision sharing is seen as an outcome of a successful change process rather than a prerequisite for success. Selwyn's analysis of digital education (2016) highlights that access to technology in universities is often conditioned by ethical, economic and institutional factors, which directly affects the implementation of Gen AI.Higher education institutions face challenges in integrating Gen AI into the learning process, with methodological frameworks for managing educational innovation and digitising learning playing a key role. Thematic content analysis was conducted by systematically searching for codes in the texts of university documents and comparatively comparing the results between universities according to each category (Mayring, 2014; Scheier, 2012). Coding followed a deductive approach based on theoretical frameworks (Fullan, Selwyn) and complemented by inductive coding of newly identified themes, see Table 1 Coding matrix according to the proposed scheme.

Table 1 Code matrix of the proposed scheme

Code	Category	Description
K1	*Ethical Regulation*	Standards, recommendations, rules for responsible use of AI
K2	*Participation*	Involvement of teachers and students in strategy development, consultation
K3	*Innovation Support*	AI as a tool to improve teaching, creativity, personalization
K4	*Equal Access*	Availability of AI tools to all students, efforts toward inclusion
K5	*Strategy Sustainability*	Planning of revisions, long-term direction, adaptability of strategies

Source: own processing

Based on the available official documents, three leading universities were selected – University of Hradec Králové (UHK), Charles University (UK) and Masaryk University (MU).The primary documents of the universities were: internal guidelines, recommendations and opinions on the use of AI in teaching (UHK,

UK, MU) and secondary literature: professional articles, legislative frameworks, and theoretical background.

The documents of the **University of Hradec Králové (UHK)** 'The Use of Artificial Intelligence in Education' (n.d.) and 'Guidelines for the Use of Artificial Intelligence in Written Works at UHK' reflect the institutional approach to regulating the use of AI in education (Univerzita Hradec Králové, 2024). They clearly define ethical standards, reducing the risk of inconsistent approaches among lecturers as well as for students. They highlight the potential uses of AI, which fulfils Fullan's (2015) premise of promoting innovation through specific application in teaching. On the other hand, these statements lack a clear strategy for active involvement of teachers and students in the decision-making process in the field of AI. Participatory mechanisms such as workshops or consultations with academia are missing. The documents mentioned do not mention a long-term strategy to respond to technological developments. The University of Hradec Kralove does not address how students who do not have access to the same technological skills or AI tools outside the university environment will be supported. Selwyn (2016) emphasises that digitalisation must not widen the gap between students. UHK regulates the use of AI in education, but does not bring a deeper discussion of how AI could change teaching strategies (e.g., personalized learning, adaptive testing).

UHK emphasizes ethical regulation (K1), which is clearly and standardized. On the other hand, there is a complete lack of participation (K2) - the university does not provide any tools for involving teachers or students in the development or revision of strategies. Support for innovation (K3) is only outlined in a framework, without concrete proposals for didactic integration of AI. The issue of equity of access (K4) is completely omitted, as is the sustainability of strategies (K5) - the documents lack dynamic updating mechanisms or long-term planning.

Charles University has developed a set of documents aimed at integrating AI into different areas of the academic environment, including teaching, research and administration (Univerzita Karlova, 2025). The UK strategy provides structured recommendations for different target groups (teachers, students, researchers), indicating a thoughtful approach to implementing AI in education. Transparency, accountability and safety in the use of AI are emphasised. Recommendations for educators include integrating AI into teaching, fostering students' creativity and critical thinking, reflecting the potential of AI to innovate teaching methods in line with Fullan's theory of managing educational innovation (2015). The University actively supports its members in adapting to new technologies. However, it also lacks procedures for regularly updating these documents in response to the rapid evolution of AI technologies in terms of long-term sustainability. The issue of access to AI tools for all students is not consistently addressed, which can lead to widening digital inequalities (Selwyn, 2016).

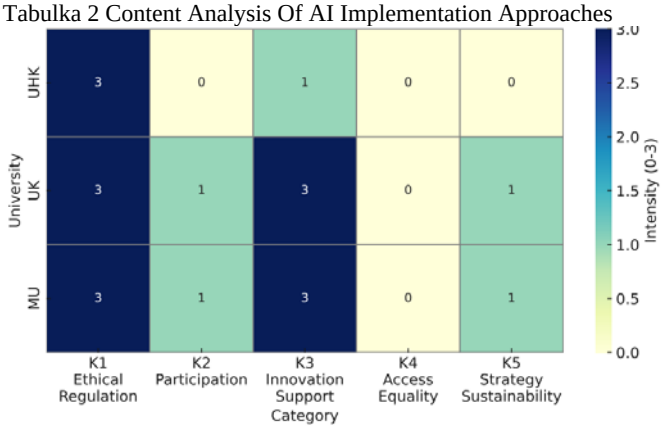
UK presents a comprehensive approach to ethical regulation (K1), reflecting the needs of different academic groups (students, teachers, researchers). However, participation (K2) is only implicitly represented - it is not clear whether the wider academic community contributed to the development of the documents. Support for innovation (K3) is strongly developed, where AI is seen as a means to develop teaching methods and student competencies. The area of equity of access (K4) is, as at UHK, completely absent. Sustainability of strategies (K5) remains unaddressed as the documents do not include mechanisms for continuous revision or adaptation to technological developments.

Masaryk University (MU) has developed several documents on the use of artificial intelligence (AI) in education, including "Statement on the Use of AI in Teaching at Masaryk University" (Masarykova univerzita, 2024), "Recommendations on the Use of AI in Teaching" (2024), and "Artificial Intelligence in Questions and Answers" (MU, n.d.), which provide structured recommendations for the use of AI in teaching, thus providing a coherent strategy for the implementation of these technologies. The university actively supports its faculty and students in adapting to new technologies, which is consistent with Fullan's (2015) emphasis on institutional support. Recommendations for lecturers include integrating AI into teaching, encouraging students' creativity and critical thinking, and reflecting the potential of AI to innovate pedagogical methods (Selwyn, 2016). As with the universities above, there is no clear strategy for regularly updating these documents in response to the rapid development of AI technologies, nor does it address the accessibility of AI for all students.

The MU presents a consistently defined framework for ethical regulation (K1), with clear recommendations for individual actors. Participation (K2) is outlined similarly to the UK, but without specific tools for its implementation. A strength is the promotion of innovation (K3) - the university encourages the use of AI to enhance creativity and critical thinking. Equality of access (K4) is not reflected in the documents, which may lead to the reproduction of digital inequalities. A long-term framework or plan for updating is not present here either, weakening the sustainability dimension of the strategies (K5).

Table 2 Content Analysis Of AI Implementation Approaches (based on Coding Scheme) visualizes the results of the content analysis in the form of a heatmap. The intensity (0-3) represents the degree of presence of each category: 3 = strong presence, 1 = partial or implicit mention, 0 = absence.

Tabulka 2 Content Analysis Of AI Implementation Approaches



Source: own processing

In summary, all three institutions show a strong orientation towards ethical regulation (K1) and to some extent towards the innovation potential of AI (K3). In contrast, the areas of participation (K2), equity (K4), and sustainability (K5) remain underdeveloped in the current strategies. For a comprehensive and inclusive implementation of AI in higher education, these areas will need to be systematically developed in line with the framework of educational innovation (Fullan, 2015) and critical digitisation (Selwyn, 2016).

Despite the differences, three key common threads emerge in universities' strategies. All institutions support the integration of AI while maintaining ethical standards in education and recognise its importance in modernising teaching. Educational institutions face

the challenge of balancing innovation while maintaining the integrity of the academic process. Creating ethical frameworks with an emphasis on critical thinking appears to be important.

4. DISCUSSION AND CONCLUSION

The leading Czech universities – University of Hradec Králové (UHK), Charles University (UK) and Masaryk University (MU) - approach the regulation of artificial intelligence (AI) in education in different ways, but share some challenges that need to be addressed.
An analysis of the strategic documents of the three Czech universities, revealed different approaches to the implementation of generative artificial intelligence (Gen AI) in higher education, in line with the five key categories defined in the coding scheme.

All three universities are defining rules for the use of AI in teaching and academic work, thereby ensuring that academic integrity is upheld. The universities' documents include ethical guidelines and warn of potential risks of misuse of AI, particularly about plagiarism and mismanagement of generated content. The emphasis on transparency and accountability in the use of AI is thus a common element across the three institutions. Another common strength is supporting educators in the process of adapting AI to education. Each university provides recommendations or guidelines for implementing AI in the classroom, with UK and MU emphasizing critical thinking when working with AI. In addition, UK tries to systematically regulate different areas of AI use, which gives it a more comprehensive framework compared to UHK and MU, which focus more on specific recommendations for teaching.

However, the main challenge remains the absence of a long-term strategy for the sustainability of the rules. None of the universities specify how their guidelines and rules will be updated in response to the rapid technological evolution of AI. This can lead to rules becoming outdated and needing to be adapted ad hoc without a clear methodological framework.
Another shortcoming is the lack of reflection on digital inequalities. The documents primarily focus on the technical and ethical aspects of AI but do not address the issue of equal access to these technologies for students. Universities do not cite specific measures to ensure that all students have an equal opportunity to use AI tools, which can lead to an uneven playing field in the academic environment.

The limited involvement of the academic community in the rule-making process is also a major weakness. Although universities are setting frameworks for the use of AI, it is not clear to what extent students and faculty have been involved in their development. The absence of a participatory approach may affect the adoption of these rules in practice and reduce their effectiveness.

In conclusion, universities agree on the need to regulate AI, focus on protecting academic integrity and promoting the development of innovative teaching methods, but neglect the long-term sustainability of the rules, the issue of digital inequalities, and the involvement of academics in the decision-making process. To promote inclusivity and diversity in research and education, it would be desirable to make Gen AI technologies accessible to educators and students, e.g. through institutional accounts. By discussing the ethical implications of using AI or through workshops and seminars on the responsible use of AI, institutions can promote a culture of accountability and integrity. To improve the regulation of AI in education, it is essential to focus on these areas and ensure that the rules are not only up-to-date but also fair and sustainable in the long term.

Given the cultural and institutional diversity of the higher education community, there is no one-size-fits-all solution, but it would be advisable to encourage interdisciplinary collaboration between universities to develop a common methodological framework for the use of AI in higher education.

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The Symbiotic Relationship Between Good Governance and Country Branding

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Abstract A nation's social cohesion, economic progress, and prosperity depend on its good governance. Country branding is a strategic governance instrument through which governments aim to shape favourable international perceptions, particularly among foreign investors and tourists. However, there is still a lack of research on the connection between branding and governance, especially in the context of European countries. The purpose of this paper is to close this gap by examining how governance practices support nation branding initiatives and vice versa. This study examines the relationship between good governance and nation branding practices, focusing on three European countries: Norway, Switzerland, and Estonia, to understand the symbiotic relationship between branded country image, governance, and governance effectiveness. Paper adopted qualitative multi-sample research approach to review policy documents, media articles, and governance measures such as the World Bank's Global Governance Indicators and the Anholt-Ipsos Nation Brands Index. The analysis shows that these two phenomena reinforce each other, creating a symbiotic relationship where good governance strengthens the country brand, and in its turn effective country branding strengthens the international perceptions of country's governance. Each case study illustrates this interaction in different cultural and historical contexts. This article examines good governance and nation branding and argues their linkage, that contribute to policy-making and managing international practices. The analysis shows that these two phenomena reinforce each other, creating a symbiotic relationship, where good governance strengthens the country brand and, in turn, effective country branding strengthens international perceptions of the country's governance. Each case study illustrates this interplay in different cultural and historical contexts. This article examines good governance and country branding and discusses their relationship, which contributes to policy-making and international governance practices.

Keywords Country branding; good governance; European nations; nation branding; international relations

1. INTRODUCTION

Every nation has a distinct national image that forms the cornerstone of their country branding efforts, whether they regulate their image or not. Improving the image of a nation is a complex and long-term task. The primary sources that shape the image of a country include its economy, politics, history, society, environment, architecture, science, and geography. In addition, the image of a nation is influenced by its historical heritage, role in global history, and current position in the international community. This image is created by synthesizing these various elements formed by the unique traditions of the people (Dinnie, 2008). Therefore, the image of the country is formed from the characteristics obtained from these sources.

Good governance and country branding are pivotal in contemporary nation-building and international relations. Generally, good governance involves managing a country's resources and affairs in an efficient, accountable, and transparent way (Islam, 2018). Good governance is linked to maintaining political stability, the rule of law, the absence of corruption, quality public services, and one's adherence to democratic norms. In contrast, country branding refers to efforts by a state to influence how a nation is seen globally, using tools based on diplomacy, international communication, and reputation management.

Nation brands that are strongly built and protected cover global narratives as competition for skilled labour, trade and export markets increases (Kaneva, 2011). The aim of this study is to offer new perspectives on the relationship between nation branding and good governance, which may have significant implications for international narratives.

1.1 Research problem and objective

There is a lack of literature on linking good governance and country branding. Scholars have focused on researching the correlation of nation branding to public diplomacy (Szondi, 2008), cultural diplomacy (Hurn & Tomalin, 2013), and soft power (Fan, 2008), and this gap needs to be filled. Enhancing understanding of the nexus between good governance and nation branding may greatly benefit policymakers during their strategic planning, international relations, and public diplomacy initiatives. It is plausible that effective governance will strengthen a nation's reputation abroad by building trust and credibility, while good nation branding can sustain governance domestically by garnering public and resource support for pro-good governance policies.

This study aims to understand how good governance interacts with nation branding and reverse. In particular, this paper investigates whether well-governed countries can create stronger nation brands and whether targeted nation branding campaigns can constructively change international perceptions of governments.

1.2 Theoretical Framework

The term "governance" stands for all forms of government, as institutions, processes, and decision-making procedures. The World Bank first introduced the idea of good governance in its 1992 report "Governance and Development", emphasizing it as one of the critical components considered in conjunction with a nation's economic strategy. Good governance addresses the processes and structures through which a government ensures that political, social, and economic priorities are achieved in a thorough, efficient, transparent, just, and accountable manner. Because of its wide-ranging nature, there is no single authoritative definition of good governance (Gisselquist, 2012).

Nonetheless, international institutions and scholars have identified key dimensions that define effective governance. For example, the World Bank's influential Governance and Development Report (1992) described governance as the way in which authority is exercised to manage a nation's economic and social affairs for developmental purposes. Similarly, the Office of the High Commissioner for Human Rights (OHCHR) of the United Nations emphasizes that "The true test of good governance is the extent to which it delivers on the promise of human rights– civil, cultural, economic, political and social rights" (OHCHR, n.d.).

Fukuyama (2013) suggests that the effectiveness of governance depends on two main factors as state's capacity and autonomy of its bureaucracy. Minimal oversight is achievable through bureaucratic autonomy. Conversely, states with low capacity need tighter controls and less autonomy. This view suggests that regarding institutional capacity and context, "good" governance is relative, though, in general, a compromise between autonomy and oversight is required to function optimally (Fukuyama, 2013). From an empirical perspective, these would include stable economic growth alongside low levels of corruption, the rule of law, public services of high standard (education, healthcare, security, etc.), the insurance of property and human rights, and an inclusive and participatory process for citizens in politics (Rotberg, 2014).

In its 1992 report on "Governance and Development," the World Bank also states that if uncertainty is to be reduced or eliminated from the system, good performance of public institutions must occur since this will provide consumers with what they need for their lives in a way that firms find it more difficult to have competitive prices (Kaufmann & Kraay, 2002). This report expresses governance as how authority supervises economic and social resources so the country grows. Sound development management is what good governance means. According to the Bank's observation, programs or projects help to finance technically correct ones but, unfortunately, do not provide anticipated outcomes due to the government's poor performance (Preston, 1992).

The World Bank sponsors the Worldwide Governance Indicators (WGI) program (Kaufmann & Kraay, 2007) to evaluate governance quality within 200 nations. Governance evaluation by WGI is based on six criteria: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption:

- Voice and Accountability (VA): Measures how freely citizens can engage in political processes, including elections, freedom of expression, association, and access to independent media.
- Political Stability and Absence of Violence (PS): Evaluate the likelihood of political unrest, violence, or terrorism that could destabilize the government (World Bank, 2023.).
- Government Effectiveness (GE): Focuses on the quality and reliability of government services, the competence of civil servants, and the government's ability to formulate and implement sound policies (Guisan, 2009).
- Regulatory Quality (QR): Assesses how well the government develops and implements policies and regulations that support private sector development.
- Rule of Law (RL): Examines how much people trust the legal system, including how well laws are enforced, property rights are protected, and the justice system functions.
- Control of Corruption (CC): Looks at the extent to which power is exercised for private gain, including both petty and grand forms of corruption.

The WGI database is an important source of information for academics and public policy experts in public administration, political science, and institutional development. Strong performance on these six indicators is often seen as a sign of democratic stability, effective governance, institutional trust, and administrative capacity. Such environments are relatively more capable and politically more willing to deliver reliable public services, protect civil liberties, and support sustainable socio-economic development. The indicators also reflect systemic factors that influence governance outcomes around the world.

1.3 Country Branding: Concepts and Models

As Anholt (2007) suggests, country branding revolves around the attempt to capture its individuality and, therefore, use it as a competitive advantage on a global scale. However, Aronczyk (2013) highlights the cultural and political dimension of nation branding, highlighting its impact on the perception and experience of citizenship, sovereignty, and national identity.

In Dinnie's (2008) conceptualization, nation branding is a strategic process encompassing identity construction, image projection, and reputation management (Dinnie, 2008). These background ideas make it possible to comprehend how country branding currently works globally. Historically, nations have had to rebrand themselves to reflect the changing times, just like corporations. The branding process ensures that nations coordinate their internal realities with their current identity or circumstances (Olins, 2002). Nation branding is more complex than product branding in improving a nation's image.

The concept of country branding is based on Anholt's model (Fan, 2006) as in Figure 1, which outlines six dimensions of nation image, i.e., governance, culture and heritage, people, tourism, exports, and investment/immigration. These dimensions together give an overall impression of the global country image (Anholt, 2007):

- Governance: Covers global perceptions of a country's leadership and its level of competence, fairness, commitment to democracy, environmental sustainability, and social justice.
- Exports: Covers the perception and attractiveness of a country's services and goods in the international market. Their quality and appeal to consumers are also captured.
- Tourism: Evaluates how much a country is appreciated and recognized for its natural features, vibrant cultural heritage, historical landmarks, and other notable attractions.
- Culture and Heritage: This includes appreciation of a country's contribution to global society and acknowledgment of its past and present culture in the form of art, literature, music, and sports.
- People: Analyses whether the rest of the world perceives a country's citizens as hospitable, educated, open-minded, and a wholesome personality.

- Investment and Immigration: Measures the perception of a country in terms of mobility, investment, employment, education, and economic opportunities.

Figure 1. Nation Brand Hexagon (Anholt, 2007)

The theory of Nation Brand Hexagon (Figure 1) is based on the concept of branding, which applies marketing principles to countries. Anholt contends that nations have brands like corporations that influence their international relations and economic performance. A strong national brand can attract tourists, investors, skilled migrants, and global partners, while a weak or negative.

These dimensions are quantified through the National Brand Index (NBI), an annual survey-based index created by Anholt. The NBI polls thousands of respondents worldwide to gauge perceptions of various countries regarding the six facets discussed above (TPBO, 2024) Each country's scores can be visualized on a hexagon diagram (Figure 1), which succinctly captures its strengths and weaknesses in each category.

According to Anholt's framework, the nation's brand is not entirely under the control of its government but is co-created through the actions, accomplishments, and attitudes of its people, businesses, and organizations.

Scholars have discussed different approaches to nation branding. Anholt's approach focuses on competitiveness and identity and how nations globally brand themselves and compete. Aronczyk's (2013) perspective is more critical, examining the cultural and political aspects of nation branding. She argues that nation branding campaigns attempt to redefine national identity and can be fundamentally political and economic. In the same spirit, Wally Olins (2002) offers a historical perspective, stating that countries have always managed their images. However, the formalized concept of "branding" is a recent development due to globalization and competition for investment. "Nation branding" is placed by Keith Dinnie (2008) within the context of an overarching strategy that involves the creation of a national identity, the construction of a national image, and the management of national reputation, and therefore should be coordinated at all levels of government, private, and non-profit organizations.

As with any growing area that requires more scholarly attention, voicing concerns regarding the effectiveness of nation branding is not uncommon, especially when deep-seated traces of national identity are set in stone and cannot be "rebranded" through mere advertising efforts. Fan (2006) questioned the issue, pointing out that branding will remain pointless until fundamental tactical shifts are made to the country's governance, economy, culture, and societal products. Consequently, one of the more vital takeaways from the literature is that nation branding requires substance; a nation's image can only improve if there are actual improvements or strengths in factors that the nation's observers care about, like governance, culture, or economic opportunities.

1.4 Conceptual Framework and Hypotheses

Drawing on theoretical foundations, we argue that good governance and nation branding have a symbiotic relationship characterized by mutual reinforcement. Figure 1 (Nation Brand Hexagon) already points to governance as a key aspect of nation branding. Our framework suggests that countries that excel in governance indicators also tend to excel in cultivating a positive nation brand and that well-designed nation branding initiatives can enhance the positive impact of good governance on international perceptions. Nonetheless, we also recognize that such interplay might vary across contexts; the historical and cultural background may influence the translation of governance into a brand image.

This framework leads us to propose the following three hypotheses:

- H1: Countries with higher governance quality (especially in government effectiveness, rule of law, and control of corruption) achieve stronger nation branding outcomes.
- H2: Active and positive nation branding efforts lead to improved international government perception.
- H3: Good governance and country branding are context-dependent, varying across different cultural and historical contexts.

Comparative case studies have been utilized to test the given hypotheses. While H1 and H2 posit a generally positive two-way relationship, H3 allows for nuance – suggesting that one size may not fit all when linking governance and branding in practice.

1.5 Methodology

A qualitative multi-centered research design was adopted to investigate the above hypotheses. Case studies are beneficial for the in-depth exploration of complex phenomena in real-life contexts where the boundaries between phenomenon and context are unclear. According to Yin (2018), case study methodology is suitable for investigating contemporary phenomena over which the researcher has little control and allows for multiple sources of evidence. By examining multiple cases, we can also engage in comparative analysis that strengthens the generalizability of findings through analytical replication (each case confirms or refutes patterns observed in the others).

Case selection: The cases selected for this study are Norway, Switzerland, and Estonia. Although these countries were selected through purposive sampling to capture differences in governance models and branding strategies, they are all somewhat successful. Norway and Switzerland are consistent leaders in governance indicators (having high democracy and institutional stability) and have well-known national branding or a strong international image. On the other hand, Estonia represents a smaller post-Soviet European state that has made significant progress in governance (especially governance) and has actively branded itself over the past two decades. Estonia also adds historical and contextual diversity to help test H3 (contextual differences). All three countries are located in Europe, which controls for some broad regional factors but differ in governance, culture, branding, and focus.

Data Sources: The data collection utilized both qualitative and quantitative data for triangulation as follows:

- Qualitative data: Policy documents and media coverage related to communication policies concerning each country's branding strategy were gathered and studied. Based on availability, national branding strategy documents were analyzed as information from the official branding website or a campaign such as "Brand Norway," Presence Switzerland programs, or the e-Estonia branding platform. The case study chapters were constructed relying on secondary data.
- Quantitative Data: To evaluate governance processes, data was leveraged from the Wold Governance Indicators (WGI) for 2021 and 2022, based on data availability. WGI value for Norway, Switzerland, and Estonia for all six constituent dimensions (VA, PS, GE, RQ, RL, CC) was retrieved accordingly. The Anholt-Ipsos Nation Brands Index (NBI) reports for 2021 and 2022 were explored for country branding outcomes. The Good Country Index and other rankings on tourism competitiveness were also used to broaden the picture of the country's reputation. The credibility of this research is enhanced by using multiple sources in this way.

Analysis approach: Each case study was first analyzed individually (within-case analysis) to document the governance context, national branding strategy, and any evidence of interactions between the two. Then, a cross-analysis (comparative discussion) was conducted to identify commonalities and differences. This comparative step was critical to assessing H3 – to see how context influences the governance-branding relationship. Throughout the analysis, hypotheses were centered, and evidence was sought to support or refute each. Creswell and Poth's (2017) approach to qualitative research design guided the iterative coding and theme development process from the qualitative data, ensuring that research remained grounded in the data when interpreting the results. Key themes of interest (taken from our framework) include mutual reinforcement (where management initiatives enhance image or branding initiatives refer to management), tensions or trade-offs (perhaps where branding glosses over management issues or where management focus ignores branding) (cultural orientation, historical factors influencing values). The following sections present the results of each case study, followed by a discussion of how these findings support our hypotheses.

2. CASE STUDIES

2.1 Norway

Transparency, accountability, and social welfare policies are Norway's main features. Norway has high government effectiveness and low corruption as its governance model (Aarhus University 2024). Norway's branding has successfully capitalized on its natural resources, such as petroleum and gas, to project it as a sustainable, environmentally conscious (Norway - Green Technologies 2024) country. The "Norway brand" features nature conservation, innovation, and equalitarianism. This paper explores current practices and recent trends in sustainable business management and branding in Norway. In 2017, Erna Solberg, Prime Minister, urged the nation to strive towards "increased innovativeness as well as the adoption of smarter and greener lifestyles" (Blazhevska, 2017).

Specifically, the Norwegian Prime Minister sought to position the country as a global leader in green technology and sustainable innovation. This ambition gave rise to the development of Brand Norway—a renewed national image underpinned by strategic messaging and a forward-looking identity designed to highlight Norway's distinctiveness and strengthen its overall international brand presence.

Brand Norway was illustrated while acknowledging its contemporary features and traditional attributes (Norway—Green Technologies 2024).

Brand Norway was launched in 2022 by the Norwegian government and designed to enhance the competitiveness of the Norwegian business and industrial sector. The program that was established for this purpose is known as the "Norwegian Branding Labelling Programme," which provides for marking all products and services made in Norway with an acknowledged symbol indicating their origin as well as their status as far as sustainability, responsibility, and historical background are concerned (Norway - Green Technologies 2024). This government project aimed to "Capitalise on the many positive associations the world has of Norway as a country of origin" (Norway - Green Technologies 2024).

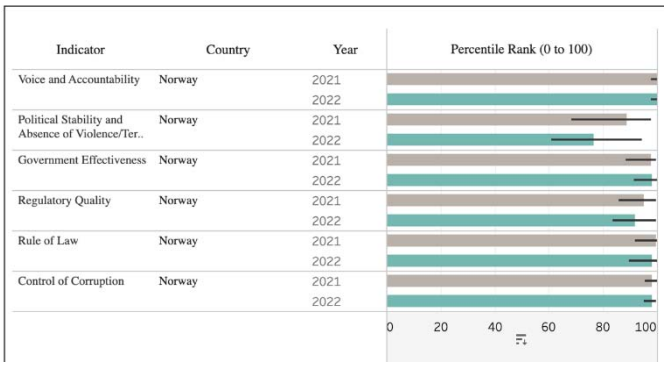
Norwegian tourism brand evolves around the "Norway -powered by nature" statement. The distinct landscape, rich historical background, local traditions, and food culture available in different regions of the country make for an enlightening trip accommodating every type of visitor (Scandinavian Design Group, 2021). In helping Norway's travel industry, the leading organization is Innovation Norway, which supports sustainability in tourism through cutting-edge solutions for the sector's businesses by assisting Visit Norway. This initiative is consistent with nature conservation and preservation of culturally significant artifacts since they serve as a basis for developing local community attitudes (Branding Norway with Sustainable Tourism (En) | ITC n.d.). Norway was positioned 22nd in the Nation Brand Index for 2021 and 2022 (McGrath & Bobev, 2023).

Considering using green technologies, sustainable resource management, and renewable energy, Norway and its Nordic neighbors are regarded as global leaders. Norway has complied with international obligations to cut emissions (including those from sulfur, NOX, and carbon dioxide) and has even gone above and beyond them (McGrath & Bobev, 2023). The Norwegian government's industrial policy launched in 2022 is called the "Green Industry Initiative." The policy has an initial roadmap highlighting seven priority sectors for green growth: offshore wind, hydrogen, batteries, marine industry, CO2 management, bioeconomy, and process industries (McGrath & Bobev, 2023).

Norway is popular not only for its natural environment but also for its higher education rate, equality standards (Larsen, Moss & Skjelsbæk, 2021), and effective socio-economic model. The Norwegian nation brand is also rooted in these characteristics (Larsen, Moss & Skjelsbæk, 2021).

Good Government has been the agenda of the Norwegian government for many years. Norway continuously ranks high on the World Bank's Good Governance Indicators due to its efficient and robust governance structure (Kaufmann & Kraay, 2023). The following are some of these indicators: (Figure 2)

Figure 2: World Bank Governance indicators – Norway in 2021 and 2022 (World Bank Group 2023)



VA: Norway scored a perfect 100, in this category for two consecutive years. The country's sovereignty in a hegemony emerged from its commitment to democracy whose heritage started long ago and from a high level of public involvement.

PS: In the year 2022, Norway's score dropped to 76.42 from 88.68 in the year before.

GE: There is no doubt that Norway has a great government based on its civil service quality, public service delivery, and level of protection against political pressures. Since 2021 and 2022, Norway has always placed higher than 97 indicating good governance.

RQ: Norway scored 95.24 in Regulatory Quality in 2021, a figure that marginally fell to 91.98 in 2022. Nonetheless, the country still ranks among the best in terms of regulatory environments that are favorable for doing business.

RL: The high ranking is based on Norway's strong judiciary system and low corruption rates, therefore enabling it to shine in this category with 99.52 in 2021 and 98.11 in 2022.

CC: Norway ranked 98.10 and 98.11 in 2021 and 2022 respectively with the integrity of its public institutions and effective anti-corruption measures in focus.

Norway's high rankings across the World Bank's Good Governance Indicators demonstrate its robust governance framework and effective public institutions.

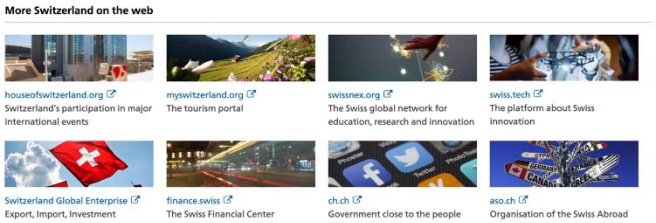
2.2 Switzerland

Switzerland is known worldwide for its positive clichés like chocolate, picturesque landscapes, and watches. Again, its reputation is solid when it comes to dependability and quality. Over the years, governments, global organizations like the Red Cross, multinational corporations including Roche, and athletes such as Roger Federer have shaped this image. The governing principle in Switzerland is anchored on other social aspects, including strong rule of law, direct democracy, and decentralized decision-making. Regarding branding, nothing much separates Switzerland from being perceived as a global financial epicentre that is also reputable as an innovative place on earth and a centre for international diplomacy. Terms like neutrality, precision, and reliability (BrandEquity, 2024) are usually used when mentioning the "Swiss brand."

Maintaining a positive national image requires constant effort. Adverse events can leave a lasting impression, which requires promoting Swiss values and continuous communication with key target groups and networks. The Swiss public and government have agreed that careful, consistent, and strategic communication is needed to give a country a worldwide stable, distinguished, and preferred image, such as a "national brand". Successful national branding, i.e., presenting a unique, flawless profile, sets a country apart. In this regard, national branding is an important investment in a country's future.

Presence.ch (Präsenz Schweiz – PRS n.d.), the official Swiss platform dedicated to cultivating and enhancing the nation brand provides insights into the Swiss government's priorities in nation branding. In the bottom part of the platform's homepage, eight websites are referenced, which deal with the different directions of the Swiss nation brand. (Figure 4)

Figure 3: Presence.ch referenced website (Präsenz Schweiz – PRS n.d.)



1. Houseofswitzerland.org: This website showcases Switzerland's involvement in global events and highlights the work Switzerland does to achieve its diplomatic objectives globally (House of Switzerland, n.d.).
2. Myswitzerland.org is the official travel website that provides extensive information on tourism and travel within Switzerland (Tourismus, n.d.).
3. Swissnex.org: This international network enhances the standing of Switzerland in areas such as education, research, and innovation. (Swissnex, n.d)
4. Swiss tech: The platform aims to better Switzerland's standing as an internationally acknowledged center of business innovation, highlighting its world-class deep tech and other firms and their superior research capabilities abroad (Swisstech, n.d.).
5. 5.
6. Switzerland Global Enterprise: This helps to make international business connections with its focus on investing, exporting, and importing ((Switzerland Global Enterprise, n.d.)
7. Financeswiss: This site presents how important Switzerland's role in global financial markets is as the financial capital of Switzerland has been promoted in this website (Finance.Swiss n.d.)
8. Ch.ch: This website details how the Swiss government implements the slogan "Government close to the people (Homepage Ch.ch - Official Information From the Authorities n.d.)
9. Aso.ch: The platform aims to maintain contact with Swiss people living abroad and defend them domestically (SwissCommunity, n.d.)

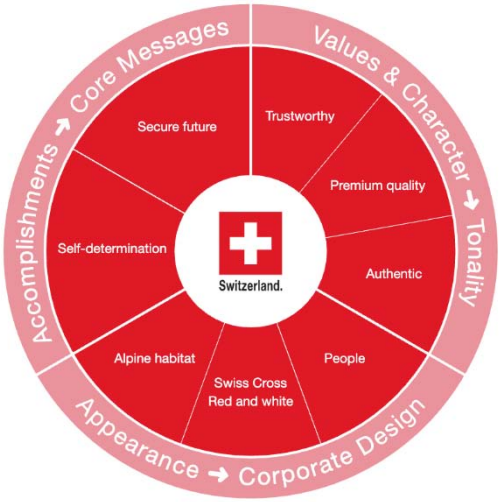
Since 2000 (Schweizer Tourismus Digitalisiert, n.d.) Presence Switzerland (PRS) has played an important role in ensuring that Switzerland's image remains credible and authentic. PRS does not only focus on aspects like quality of life and environmental friendliness, among others; the organization also emphasizes the already accepted practices, including innovation and educational system, as well as direct democracy, in addition to their promotion of less publicized strengths. Additionally, the

Houseofswitzerland.org portal offers a structured vision of Switzerland, featuring images, stories, and personalities that embody the Swiss brand, effectively leveraging clichés and stereotypes to reinforce national identity.

As presented on myswitzerland.com website (Figure 4), the Swiss tourism brand promotes the "We need Switzerland" statement. Brand Switzerland guide, presented in 2010 to employees of the Federal Ministry of Foreign Affairs, partner organizations, and sponsors who carry out Swiss activities abroad in cooperation with Presence Switzerland, highlighted the brand communication of the rebranded Swiss nation brand. Swiss nation brand is anchored by:

1. Two core messages are a secure future and self-determination.
2. Values as trustworthiness, premium quality, and aestheticism.
3. Brand identity elements include alpine habitat, Swiss Cross – Red and White, and Swiss People.

Figure 4: Swiss nation brand scheme (myswitzerland.com, n.d)



In the NBI Index 2019 and 2020 (McGrath & Farkas, 2021), Switzerland was among the top 5 countries in the Governance and Immigration-Investment categories. In 2021 and 2022, despite the decrease in the general points, Switzerland still was one of the ten top countries (McGrath & Bobev, 2022)

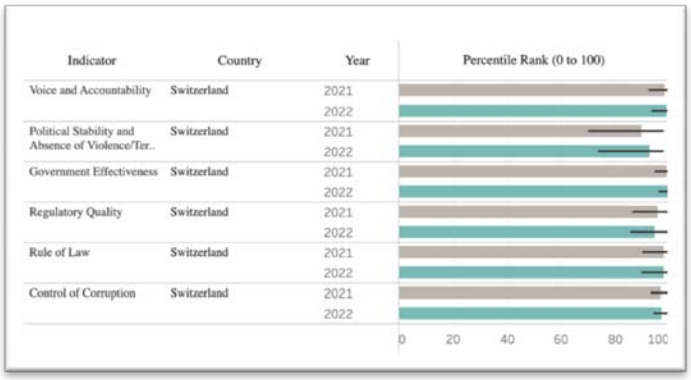
The Swiss government model is characterized by highly decentralized power, open democracy, and leadership through the people. It seeks power distribution and civic participation (Carson & Steiner, 2018)

As a federal state, 26 Swiss cantons can decide on the local governance structure (Debela, 2020). Owing to the historical progress of municipal autonomy, unique types of local government exist in regions. These models have strengths and drawbacks, yet all have been effective in practice.

Switzerland's (OECD, 2023) international cooperation efforts can be characterized by good governance. Swiss authorities embody the fundamental principle of competent and transparent public service performance, making governance inclusive, accountable, and effective. In addition, Switzerland has managed to excel in implementing good governance internally while also being a strong advocate for good governance initiatives worldwide through its various agencies (Läubli, 2017)

Switzerland's strong governance, as evidenced by its performance on the World Bank's Good Governance Indicators:

Figure 5: World Bank Governance indicators – Switzerland in 2021 and 2022 (World Bank Group 2023)



VA: The World Bank's good governance indicators show that Switzerland scored 98.1 in 2021 and 99 in 2022, thereby indicating strong participatory governance.
PS: This indicator registered 89.63 in 2021 but increased to 92.45 in 2022, thus indicating the same trend of peace and security.
GE: Swiss governance efficacy was confirmed in 2021 and 2022 when it scored 99.
RQ: Having scored 95.7 in 2021 and dropping by a slight margin to 94.3 in 2022, it is evident that Switzerland is strict on regulations.
RL: Switzerland has a highly efficient and equitable judicial system; the country achieved ratings above 97 in 2021 and 2022.
CC: The country has also been highly ranked in this area, according to data for 2021 (96.6) and 2022 (97.1).

The good governance indices reveal Switzerland's excellent governance performance, further proving that it has a good reputation for being efficient and transparent. Switzerland is not only competitive in terms of citizen welfare but is also a yardstick in global governance.

2.3 Estonia

After gaining its independence, Estonia underwent transformational changes and has become an innovation center in Europe. This transformation is characterized by e-governance initiatives, digitalization (Jansen, 2008), and a strong emphasis on innovation (Jansen, 2008) and entrepreneurship in governance. Case studies of Estonia feature how these initiatives have shaped its brand identity, both domestically and internationally (Tpbo, 2023)

Estonian nation branding campaigns began in 2001 when the country hosted the Eurovision Song Contest.

Through that event, Estonia managed to attract the attention of foreign media more than ever (Alimaskoski, 2022). In 2003, Brand Estonia was introduced at a tourism fair. For starting to form Estonia as a unique independent brand in the international arena, Enterprise Estonia has presented a hexagon logo with the words "Welcome to Estonia" and the slogan "Positively Transforming" to the public (Papp-Váry, 2018) Interbrand, which made the brand book, has defined five narratives: Fresh Perspective; A Radical, Reformative and Transformative Attitude; Nordic Temperament and Environment; Skilled Self-Starter by Nature; and the European Society.

Innovation and nature are two key points of the Estonian nation brand (Kentie P. 2023). The key areas of innovation are e-government, e-tax systems that include Skype, cyber defense, and e-banking. In addition, there is a deliberate attempt to merge education with science within the brand's storyline in line with broader developments in nation branding.

The idea behind Brand Estonia is to increase the confidence of foreign investors in Estonia as a hub for their investments, tourism, and exports. This takes into account the limited resource base in Estonia, which necessitates cooperation between sectors.
The Estonian Nation Brand campaign contained several strong slogans and strategic directions. Each campaign contributed uniquely to Estonia's global image, demonstrating effective place branding strategies that engaged and resonated with diverse audiences. (Figure 6)

Figure 6: The Estonian Nation Brand campaign contained several strong slogans and strategic directions. (Author's table based on literature review and analysis)

ampaign	Slogan	Objective	Key Elements
Welcome to Estonia	Positively Transforming	Highlight Estonia's transformation and investment readiness	Simple, strong message
ositively Surprising	Positively Surprising	Emphasize innovation, openness, and development	Collaboration with experts, updated visual identity
ntroduce Estonia	An Old Country in a Shiny Package	Promote tourism through cultural, city, nature, and wellness holidays	Symbols (objects, event phenomena, landmarks)
ust Estonishing	Just Estonishing	Promote Estonia's digital society and unique identity	EST-concept, wordplay (e.g., "smartest," "coolest")
Fresh and Forward-ooking Nation	A Fresh and Forward-Looking Nation	Target business environment	Constructive feedback and experience for improvement

Estonia. ee is the country's current national branding platform, which sticks to core themes and features slogans such as "Estonia is a place for independent minds" and "We always find a way."
The new brand aims to highlight Estonia's digital society and its international e-residency service while emphasizing its unspoiled nature. The main objective of this branding is to show that digitalization allows people to have more leisure time (Andero,2017) in Estonia. ee portal references below websites, which facilitate branding projects:

Figure 7: Estonia.ee website references

Visit Estonia	illustrates Estonia as a travel destination in addition to highlighting its nature and culture.
Settle in Estonia	provides information and resources for relocation.
Work in Estonia	emphasizes job opportunities for career development among both locals and expatriates.
Study in Estonia:	addresses the educational opportunities in the country.
Research in Estonia	highlights research facilities and research opportunities.
Education in Estonia	features Estonian education system and programs.
Trade with Estonia	showcases Estonian trade policies and opportunities.
Invest in Estonia	demonstrates showcasing Estonia's business-friendly environment.
e-Estonia	promotes Estonia's digitalization and e-government services.
e-Residency	displays e-Residency program which allows people from different countries to run an online business.

Even though the Simon Anholt Nation Brand Index does not measure or evaluate the Estonian national brand, the Campaign follows the national brand hexagon theory and demonstrates its elements.

Estonia has made significant improvements in governance, evident in the World Bank's Good Governance Indicators rankings:

1. VA: Estonia shows a strong commitment to democratic values, as depicted by its high scores in this category (88.4 in 2021 and 87.92 in 2022).
2. PS: Estonia scored over 70 in both 2021 and 2022 years.
3. GE: Estonia also scored higher in this measurement, with scores of 88.57 in 2021 and 89.62 in 2022.
4. RQ: Regulatory Quality: Estonia's regulatory environment is favorable for business, characterized by policies that encourage entrepreneurship and innovation. Its scores were around 92 in 2021 and 2022.
5. RL: Estonia boasts a strong legal framework, evidenced by high scores of 88 in 2021 and 89 in 2022.
6. CC: Estonia has made significant progress in controlling corruption, achieving scores above 90 in 2021 and 2022.
7. These indicators collectively show that Estonia is efficiently controlled and committed to a transparent, efficient, and democratic society development process.

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Význam medagogiky pre posilnenie zdravotnej gramotnosti

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Abstrakt Zdravotná gramotnosť je determinovaná zdravotným správaním, ako aj sociálno-politickým a zdravotným systémom. Nízka zdravotná gramotnosť sa premieta v náraste hospitalizácií a readmisií, non-adherencii k liečbe, vedie k vyššiemu výskytu komplikácií, k nedostatočnému selfmanažmentu chronických chorôb a k zanedbávaniu preventívnych aktivít. Predpokladom pre zlepšenie zdravotnej gramotnosti je efektívna komunikácia so zdravotníkmi, vzdelávanie a zdravotná starostlivosť smerom k aktívnej účasti a spoluzodpovednosti jednotlivcov a komunít na svojom zdraví. Dôraz na vzdelávanie, ako jednej z kľúčových oblastí, k posilneniu zdravotnej gramotnosti, v procese zdravotnej starostlivosti, prináša medagogika. Medagogika vychádza z princípov pedagogiky a andragogiky a predstavuje moderný, holistický a individuálny prístup, ktorý posúva tradičnú edukáciu v zdravotnej starostlivosti na vyššiu úroveň. Cieľom medagogiky je posilniť zdravotnú gramotnosť, aktívne učenie jednotlivcov a komunít k dlhodobému selfmanažmentu a zodpovednosti za svoje zdravie. Medagogika, pre rozvíjanie zdravotnej gramotnosti, akcentuje využívanie inovatívnych edukačných metód, akými sú interaktívne workshopy, vizualizácia informácií, simulácie a prípadové štúdie, ako aj digitálne technológie. Medagogika uznáva model edukácie, prispôsobený poskytovaniu štruktúrovaných informácií pre zdravie jednotlivca, rodiny a komunity. Model medagogiky, zohľadňuje v edukácii a rozvoji zdravotnej gramotnosti kľúčové princípy, ktorými sú individualizácia, aktívna účasť, podpora motivácie a dlhodobé ciele pre zdravie jednotlivcov a komunít.

Klíčová slova Zdravotná gramotnosť, Medagogika, Model PITS, Edukácia.

1. ÚVOD

Zdravotná gramotnosť je multidimenzionálny koncept, ktorý je kombináciou funkčnej, interaktívnej a kritickej úrovne gramotnosti, čo ovplyvňuje, ako jednotlivci interagujú so zdravotnou starostlivosťou a ako sa o nej rozhodujú (Mullan et al. 2017). Konkrétne sa to prejaví v tom, ako jednotlivci dokážu nájsť, pochopiť a použiť informácie a služby súvisiace so zdravím. Zdravotná gramotnosť umožňuje robiť informované rozhodnutia týkajúce sa zdravia a následne konať na základe týchto rozhodnutí, čo má vplyv na celkové zdravie a starostlivosť o seba a iných (Centers for Disease Control and Prevention 2021). Nízka zdravotná gramotnosť ovplyvňuje bezpečnosť a kvalitu zdravotnej starostlivosti. Zdravotná gramotnosť úzko súvisí so vzdelávaním, ktoré ovplyvňuje zdravie jednotlivca oveľa viac ako iné prediktory zdravotného stavu. Posilnenie zdravotnej gramotnosti môže podporiť aj koncept medagogiky, ktorá pracuje s princípmi pedagogiky a andragogiky (Stewart 2020).

2. ZDRAVOTNÁ GRAMOTNOSŤ

Zdravotná gramotnosť je ovplyvnená kultúrou, zdravotným správaním, ako aj sociálno-politickým a zdravotným systémom. Zdravotnou gramotnosťou rozumieme súbor kognitívnych a sociálnych zručností, ktoré určujú motiváciu a schopnosť jednotlivcov pristupovať k informáciám, rozumieť im a využívať ich spôsobom, ktorý podporuje ich zdravie. Zdravotná gramotnosť je dôležitým aspektom interakcií medzi pacientom a zdravotníkom a ovplyvňuje starostlivosť zameranú na pacienta. Vzťahuje sa nielen na schopnosť porozumieť zdravotným informáciám, ale aj komunikovať o nich, spracovávať ich a používať ich pri rozhodovaní o zdravotnej starostlivosti (Coleman et al. 2016).

Existujú korelácie medzi nízkou zdravotnou gramotnosťou a nárastom hospitalizácií a readmisií, non-adherenciou k liečbe, zvýšeným výskytom nežiadúcich účinkov medikácie, menšou účasťou na preventívnych aktivitách, vyššou prevalenciou zdravotných rizikových faktorov, horším selfmanažmentom chronických chorôb, menej efektívnou komunikáciou so zdravotníkmi, zvýšenými nákladmi na zdravotnú starostlivosť, zlým funkčným a celkovým zdravotným stavom vrátane zvýšenej mortality (Stewart 2020).

Výskum, zameraný na hodnotenie zdravotnej gramotnosti vo vybraných európskych krajinách, sa prvýkrát uskutočnil v roku 2014. V tomto výskume bol použitý nástroj *European Health Literacy Survey Questionnaire (HLS-EU-Q)*, ktorý zisťoval prístup, porozumenie, hodnotenie a využívanie informácií týkajúcich sa podpory zdravia a prevencii chorôb, zahŕňa aj otázky týkajúce sa

zdravia, správania, zdravotného stavu a socio-ekonomických faktorov (Sørensen et al. 2015). Nástroj vychádza z integrovaného modelu zdravotnej gramotnosti (Tab. 1), ktorý poskytuje zároveň návrh intervencií na zvýšenie zdravotnej gramotnosti (WHO 2013). Koncepčný rámec pre rozvoj zdravotnej gramotnosti kladie dôraz na prenos informácií cez ich poskytovanie až po reakciu pacienta v celom procese edukácie. Zdravotná gramotnosť je premostením medzi vzdelávaním a zdravím. Podľa WHO (2013) zdravotná výchova zahŕňa vedome vytvorené príležitosti na učenie zahŕňajúce určitú formu komunikácie, určenú na zlepšenie zdravotnej gramotnosti, vrátane zlepšenia vedomostí a rozvoja životných zručností, ktoré prispievajú k zdraviu jednotlivca a komunity.

Tab. 1: Model zdravotnej gramotnosti

Zdravotná gramotnosť	Vyhľadať zdravotné informácie	Porozumieť zdravotným informáciám	Vyhodnotiť zdravotné informácie	Použiť zdravotné informácie
Zdravotná starostlivosť	1. o chorobe a liečbe	2. o chorobe a liečbe	3. interpretovať a kriticky hodnotiť informácie o chorobe a liečbe	4. robiť informované rozhodnutia o chorobe a liečbe
Prevencia chorôb a ochrana zdravia	5. o zdravotných rizikách	6. o zdravotných rizikách	7. interpretovať a kriticky hodnotiť informácie o zdravotných rizikách	8. robiť informované rozhodnutia o zdravotných rizikách
Podpora zdravia	9. o zdravotných determinantoch	10. o zdravotných determinantoch	11. interpretovať a kriticky hodnotiť informácie o zdravotných determinantoch	12. robiť informované rozhodnutia o zdravotných determinantoch

Zdroj: WHO 2013

Zdravotná gramotnosť zahŕňa pozorovateľný súbor zručností, ktoré možno rozvíjať a zlepšovať prostredníctvom efektívnej komunikácie a vzdelávania (Nutbeam 2019). Tieto zručnosti sa počas života neustále rozvíjajú a zdokonaľujú, aby sa prispôsobili rôznym meniacim sa prostrediam, kontextom a sofistikovanosti modernej doby. Aktuálne potrebujeme viac prispôsobené prístupy a služby na uľahčenie získavania zručností v oblasti zdravotnej gramotnosti pre rôzne skupiny zdravých a chorých jednotlivcov a komunít. Kvalitné vzdelávanie a celoživotné vzdelávanie sú v tomto procese kľúčové. Vzdelávanie v oblasti zdravotnej gramotnosti by malo byť prioritou v širšom kontexte mnohých zainteresovaných strán smerom ku konkrétnym opatreniam na zlepšenie zdravia a zapojenie jednotlivcov, poskytovateľov a systémov (IUHPE 2018).

3. MEDAGOGIKA

Zdravotníci potrebujú pedagogické poznatky a nástroje na budovanie zdravotnej gramotnosti a na podporu dobrého zdravia a pohody, čo je dôležitý cieľ udržateľnosti a rozvoja zdravotníckej starostlivosti a služieb. Spoľahlivú metodiku, na individuálne a interdisciplinárne úsilie o zlepšenie zdravotnej gramotnosti pacientov, predstavuje medagogika. Medagogika je moderný, holistický a individuálny prístup, ktorý posúva tradičnú edukáciu na vyššiu úroveň, s cieľom zlepšiť zdravotnú gramotnosť, podporovať aktívne učenie jednotlivcov a komunít k dlhodobému selfmanažmentu a zodpovednosti za svoje zdravie. Edukácia pacienta je viac na prenos vedomostí a inštrukcií od zdravotníka k pacientovi, medagogika oproti tomu vyzdvihuje zameranie na podporu aktívneho učenia a spolupráce medzi pacientom a zdravotníkom. Rolu zdravotníka v edukácii zaujíma odborník, ktorý poskytuje informácie, a jeho rola je chápaná ako rola sprievodcu-facilitátora, ktorý pomáha pacientovi nachádzať riešenie. Dôležitá pritom je dôvera k zdravotníkovi, čo je základom úspešných výsledkov edukácie a očakávaných zmien správania jednotlivca / komunity (Kvangarsnes et al. 2023).

Metódy využívané v edukácii majú charakter jednosmernej komunikácie, kde prevažuje výklad a inštrukcie, medagogika pritom zdôrazňuje požiadavku dvojsmernej komunikácie, kde sú viac využívané metódy diskusie a kde je pacient vedený k formulovaniu vlastných záverov. Pacient v edukácii má skôr úlohu pasívneho príjemcu informácií, zatiaľ čo medagogika uznáva pacienta ako aktívneho partnera, ktorý v procese učenia rozhoduje o svojom zdraví. Zameranie edukácie je na konkrétnu diagnózu alebo liečbu, medagogika uprednostňuje holistický prístup, zahŕňajúci fyzické, psychické a sociálne aspekty zdravia. Cieľom edukácie je zlepšenie porozumenia zdravotnému problému a liečbe; medagogika uznáva posilnenie sebestačnosti, autonómie a motivácie pacienta (Stewart 2020). Jedným z modelov medagogiky pre dosiahnutie zdravotnej gramotnosti pacientov je Model poskytovania informácií a vzdelávania pacientov *(Patient education informational delivery model, PITS)*, ktorý ponúka logicky štruktúrovaný a organizovaný formát informácií týkajúci sa zdravia alebo choroby pri dodržiavaní štandardného modelu komunikácie. Model *PITS* je obvyklá mapa alebo postup edukácie od patofyziológie, indikácie, liečby a špecifík choroby s ohľadom na konkrétneho pacienta (Tab. 2).

Tab. 2: PITS model

P Pathophysiology	Patológia chorobného procesu. Fyzické zmeny, ktoré sa vyskytujú v tele súvisiace s lekárskou diagnózou. Patofyziológia chorobného procesu. Biochemické zmeny, ktoré sa vyskytujú v tele súvisiace s lekárskou diagnózou.
I Indications	Dôsledky chorobného procesu. Znaky, symptómy súvisiace s diagnózou, ktoré môžu reflektovať progres alebo znovu vzplanutie choroby.
T Treatment	Liečba chorobného procesu. Manažment liečby choroby.
S Specifics	Špecifiká choroby. Súvislosti s individuálnymi špecifikami choroby a manažmentu liečby.

Zdroj: Stewart 2020

Zapojenie pacienta, sa môže realizovať ešte pred samotnou edukáciou napr. tým, že mu bude poskytnutý formulár, kde sa pacient zoznámi, čo sa od neho očakáva a môže si premyslieť otázky, ktoré položí zdravotníkovi. *PITS* umožňuje poskytovateľom zdravotnej starostlivosti posúdiť stav pacienta pomocou Škály porozumenia osobného vnímania *(Understanding personal perception scale, UPP*), kde pacienti odpovedajú na dve základné otázky: 1. Ako je Vám jasné vaše súčasné chápanie týchto informácií, s ktorými ste sa zoznámili? 2. Nakoľko ste spokojný so svojím porozumením a schopnosťou konať alebo správať sa podľa týchto informácií? Vyhodnotenie *UPP* používa 5-bodovú Likertovu stupnicu (Stewart 2020). Pacienti potrebujú lepšie porozumieť chorobe, aby boli schopní viac participovať na starostlivosti o seba, ako byť len prijímateľom zdravotnej starostlivosti. Model *PITS* ponúka cestu komunikácie s prijímateľom zdravotnej starostlivosti od diagnostikovania, plánovania, liečby a fázy starostlivosti pre dosahovanie cieľov pacienta. *PITS* je univerzálny vzdelávací model použiteľný pre všetky ochorenia a odborníkov zastupujúcich všetky disciplíny, od lekárov, sestier, fyzioterapeutov, farmaceutov, asistentov výživy a iných, ktorí prispievajú k liečbe pacienta z aspektu svojej disciplíny. Proces edukácie môže podľa tohto modelu prebiehať od ochorenia k pacientovi, alebo aj od informácií od pacienta k ochoreniu (Jaimalai et al. 2024). Model *PITS* prispieva k presadzovaniu rovnosti a kvality vo vzdelávaní, je dôležitým aspektom pre trvalo udržateľný rozvoj, zohľadňuje prehlbujúce sa hospodárske a sociálne nerovnosti, rýchlu urbanizáciu, hrozby pre klímu a životné prostredie, záťaž infekčnými a neprenosnými

chorobami a s tým súvisiace problémy (Kvangarsnes et al. 2023). Medagogika vo vzdelávaní zdôrazňuje význam komunikácie pre rozvoj zdravotnej gramotnosti pre orientovanie sa v zdravotníckych službách a vzdelávaniu na individuálnej a komunitnej úrovni. Zdravotníci by si mali osvojiť efektívne komunikačné stratégie nácvikom komunikácie na simulovaných rozhovoroch a cvičiť empatické počúvanie, aby pochopili hodnoty a preferencie pacienta (Brega et al. 2019).

Medagogika zahŕňa široké spektrum inovatívnych metód, ktoré reflektujú moderné trendy v zdravotníckom vzdelávaní aj s využitím digitálnych technológií. Patria k nim motivačné rozhovory, edukačné plány a cesty pacienta, sebaedukácia a gamifikácia, reflexia a spätná väzba, telemedicína a využitie umelej inteligencie, rozprávanie príbehov, dlhodobý koučing a mentorstvo, virtuálna a rozšírená realita (simulácie), online vzdelávacie moduly, chatboty a ďalšie iné metódy (Stewart 2020).

Motivačnými rozhovormi (*motivational interviewing)* podporujeme pacienta v identifikácii vlastných cieľov, hodnôt a bariér pri zmene správania. Zdravotník je ako facilitátor, ktorý kladie otvorené otázky a podporuje pacienta pri nachádzaní vlastných riešení. Motivačné rozhovory pomáhajú pacientom, ktorí nemajú motiváciu alebo nie sú si istí potrebou zmeny správania (napr. obézni, fajčiari), čím sa zlepšuje aj adherencia k liečbe. Edukačné plány a cesty pacienta (*educational plans and patient pathways*) je metóda vypracovania individuálneho plánu, ktorý mapuje pacientovu cestu od diagnostiky až po dlhodobú starostlivosť. V pláne sú obsiahnuté konkrétne kroky, očakávania a kontrolné intervencie pre pacienta. Pacienti získajú jasný, štruktúrovaný plán, čo zvyšuje sebavedomie, schopnosť zvládnuť sebaopateru, selfmanažment, napr. diabetes mellitus (ciele pre kontrolu glykémie, úpravu stravy, fyzickú aktivitu a i.).

Digitálne metódy a ich rozvoj menia rozsah a spôsob, akým sa vymieňajú zdravotné informácie (Pagliari 2021), čo sa ukázalo aj počas pandémie COVID-19. Používanie digitálnych nástrojov a digitalizácia ovplyvnili spoločnosť, spôsob a tempo, akým komunikujeme. Rozsah dostupných informácií ovplyvňuje aj zdravotné a ošetrovateľské či opatrovateľské služby. Digitálne zdravotnícke služby vyžadujú, aby používatelia mali digitálnu zdravotnú gramotnosť alebo elektronickú zdravotnú gramotnosť (e-zdravotná gramotnosť) (Norman a Skinner 2006). E-zdravotná gramotnosť môže vytvárať v populácii, medzi určitými skupinami pacientov (seniori 65+, ľudia bez domova, ľudia s handicapom a i.), väčšie nerovnosti vo vzťahu k zručnostiam a prístupu k zdravotníckym službám (Olsson et al. 2019). Medagogika uznáva digitálnu zdravotnú gramotnosť, kde sa využíva metóda telemedicíny, kde sa poskytujú individuálne odporúčania cez aplikácie, telemedicínske konzultácie na diaľku a tiež sledovanie stavu pacienta v reálnom čase. Pacienti môžu byť priebežne monitorovaní a súčasne môžu dostávať rady prispôsobené jeho potrebám. Zdravotníci tak majú možnosť zasiahnuť v reálnom čase pri identifikácii rizík.

Význam má tiež sebaedukácia a gamifikácia (*self-education and gamification*) s použitím digitálnych nástrojov, aplikácií a hier. Gamifikácia využíva prvky hier, ako sú odmeny alebo výzvy na splnenie (krokomery, denníky stravy a i.). Zvyšuje sa tým angažovanosť a aktivita pacienta, napr. sledovanie hmotnosti a kalorického príjmu. Dôležitou metódou v nadobúdaní zdravotnej gramotnosti formou edukácie je reflexia a spätná väzba (*reflection and teach-back*). Pri tejto metóde pacient po absolvovaní edukácie o jeho zdravotných problémoch, opakuje informácie spätne „edukátorovi/učiteľovi – zdravotníkovi“ (*teach-back*). Následne v pravidelných intervaloch sa poskytuje spätná väzba pacientovi, kde sa zohľadňujú jeho vlastné reflexie (denníky, aplikácie). Umožňuje to pacientovi reflektovať svoje úspechy a zlepšiť oblasti, kde má nedostatky. Zdravotník je pre pacienta partner, ktorý ho podporuje a motivuje (Stewart 2020). Účinnými metódami, pre porozumenie zdravotným problémom, môžu byť aj prípadové štúdie *(case studies),* koučing a mentorstvo, virtuálna realita – simulácie, či online vzdelávacie moduly. Inovatívne edukačné metódy v komunite sú aplikovateľné ako zdravotnícke festivaly a podujatia, edukácia je prispôsobená kultúrnym potrebám a realizovaná prostredníctvom dobrovoľníkov a pacientskych skupín (Stewart 2020). Každá z edukačných metód si vyžaduje, aby zdravotníci mali odborné vedomosti a zručnosti a boli tvorcami štruktúrovanej edukácie pri využívaní princípov medagogiky a dosahovaní cieľov zdravotnej gramotnosti.

4. ZÁVER

Dôraz na vzdelávanie ku zdravotnej gramotnosti predstavuje koncept medagogiky. Medagogika považuje za prospešné využívanie inovatívnych edukačných metód vo vzdelávaní, ktoré na základe štruktúrovanej edukácie podľa *PITS* modelu, pomôžu dosahovať očakávané výsledky v správaní a rozvoji zdravotnej gramotnosti. Medagogika akcentuje individualizáciu, aktívnu účasť, podporu motivácie a dlhodobé ciele pre optimálne zdravie a kvalitu života jednotlivca, rodiny alebo komunity.

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Diferencie v didaktických kompetenciách medzi študentmi učiteľstva a učiteľmi v praxi

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Abstrakt Príspevok prináša vybrané výsledky nášho výskumu zameraného na zisťovanie úrovne a rozdielov v didaktických kompetenciách medzi študentmi učiteľstva a učiteľmi pôsobiacimi v praxi. Úroveň týchto komptencií sme posudzovali pomocou Dotazníka didaktických kompetencií, ktorý hodnotí päť kľúčových oblastí: plánovanie a príprava vyučovacej hodiny, realizácia vyučovacej hodiny, klíma a disciplína v triede, diagnostika a hodnotenie žiakov a sebareflexia. Výsledky výskumu ukázali, že učitelia v praxi dosahujú vyššiu úroveň vo všetkých sledovaných oblastiach didaktických kompetencií v porovnaní so študentmi učiteľstva. Ďalej sme analyzovali rozvoj didaktických kompetencií u študentov učiteľstva s odstupom jedného roka. Signifikantne významný rozdiel sa prejavil len v oblasti plánovania a prípravy vyučovacích hodín.

Kľúčové slová Didaktické kompetencie, študenti učiteľstva, pregraduálna príprava, učitelia v praxi

1. DIDAKTICKÉ KOMPETENCIE UČITEĽOV

Didaktické kompetencie sú dôležitou súčasťou profesijných kompetencií učiteľov, ktoré sú nevyhnutné pre efektívne plánovanie, organizáciu, riadenie a hodnotenie výchovno-vzdelávacieho procesu (Šuťáková, Ferencová, 2017).

Tulis (2022) tvrdí, že vzdelávanie (budúcich) učiteľov by malo byť orientované na poskytnutie pedagogických a psychologických poznatkov, ktoré budú nápomocné pri plánovaní, realizácii a hodnotení edukačného procesu. Plánovanie, realizovanie a hodnotenie vyučovacieho procesu možno zastrešiť pojmom didaktické kompetencie. Hupková, Petlák (2004) definujú didaktické kompetencie ako schopnosť učiteľa dôkladne poznať obsah vzdelávania, riadiť a usmerňovať výchovno-vzdelávací proces s využitím aktivizujúcich a kreatívnych metód. Naše vnímanie didaktických kompetencií učiteľa je v zhode so Šuťákovou (2017), Sokolovou (2021) a i., ktoré ich chápu ako vedomosti, schopnosti a zručnosti potrebné pre plánovanie, organizovanie, realizáciu a hodnotenie výchovno-vzdelávacieho procesu. Naše chápanie didaktickej kompetencie presahuje aj do vedomostí, schopností a zručností učiteľa vytvárať pozitívnu triednu klímu, budovať disciplínu, vytvárať si prirodzenú autoritu a sebareflektovať vlastnú pedagogickú činnosť. Učiteľ s rozvinutou didaktickou kompetenciou pre nás predstavuje učiteľa, ktorý pozná aktuálny stav rozvoja svojich žiakov, má znalosti obsahu, procesu a metodiky učenia, ktoré mu dovoľujú využiť vo výučbe vhodné metódy, postupy, stratégie a pomôcky, vďaka čomu dochádza k optimálnemu rozvoju vedomostí, schopností, zručností a osobnostných vlastností žiakov. Zároveň pozná a vo výučbe vhodne aplikuje rôzne metódy a formy hodnotenia žiakov a vie využívať i vhodné výchovné metódy, ktorými predchádza, príp. odstraňuje nevhodné prejavy správania sa žiakov.

V pregraduálnej príprave učiteľov sú didaktické kompetencie študentov učiteľstva rozvíjané v teoretickej, ale i praktickej rovine prostredníctvom viacerých predmetov – všeobecná didaktika, didaktika predmetov, výskumný projekt didaktiky predmetov, prostredníctvom pedagogickej praxe, ako i rôznymi formami výučby.

Vyučovací proces je veľmi variabilný, jeho konkrétny priebeh závisí od mnohých činiteľov. Pre učiteľa je zložité postupovať podľa nejakej vopred stanovenej štruktúry. Na druhej strane, je to proces premyslený, systematický, s logickou štruktúrou a vlastnou dynamikou, ktorý by mal byť učiteľom z didaktického hľadiska realizovaný tak, aby podnecoval učenie sa žiaka a rozvoj jeho spôsobilostí. Didaktické kompetencie učiteľa pokrývajú učiteľove vedomosti, schopnosti a zručnosti, ktoré mu umožňujú realizovať vyučovací proces tak, že bude rešpektovaný princíp kongruencie, čo znamená, že jednotlivé prvky a fázy vyučovacieho cyklu logicky na seba nadväzujú a sú navzájom kompatibilné. Každý cyklus začína plánovaním, pokračuje realizáciou a vyúsťuje do reflexie, ktorá je zároveň východiskom ďalšieho vyučovacieho cyklu (Ferencová, Kosturková, 2020).

2. VÝSKUM DIDAKTICKÝCH KOMPETENCIÍ ŠTUDENTOV UČITEĽSTVA A UČITEĽOV V PRAXI

Cieľom výskumu bolo zistiť úroveň a rozdiely v didaktických kompetenciách študentov učiteľstva a učiteľov v praxi.

Ďalším výskumným zámerom bolo zrealizovať longitudinálne sledovanie didaktických kompetencií študentov učiteľstva – učiteľov v pregraduálnej príprave.

2.1 Výskumný súbor

Výskumný súbor sme získali dostupným výberom a pozostával z podsúboru študentov učiteľstva (N=925) a podsúboru učiteľov v praxi pôsobiacich v regionálnom školstve v predprimárnom, primárnom, nižšom a vyššom sekundárnom vzdelávaní v SR (N=443). Priemerný vek študentov učiteľstva bol 20,44 rokov a priemerný vek učiteľov v praxi 44,29 rokov. Z celkového výskumného podsúboru učiteľov v pregraduálnej príprave bolo 125 mužov (13,5%) a z podsúboru učiteľov v praxi bolo 48 mužov (10,9%). V našom výskumnom súbore je teda značná dominancia žien, čo je istým špecifikom učiteľskej profesie – feminizácia učiteľskej profesie.

2.2 Výskumné metódy

Na identifikovanie didaktických kompetencií sme využili Dotazník didaktických kompetencií, ktorého autorkami sú Rapsová, Szíjjártóová, Süttő (2021) a ktorý bol overený Ballovou Mikuškovou (2022). Na základe ňou prezentovaných výsledkov vykazuje dotazník dobrú vnútornú konzistenciu a jednotlivé oblasti didaktických kompetencií spolu súvisia očakávaným smerom. Z uvedeného dôvodu ho považujeme za vhodný na výskumné použitie. Dotazník je použiteľný u učiteľov, prípadne študentov učiteľstva a nemá časové obmedzenie (zvyčajne trvá 10-15 minút). Administrovaný materiál obsahuje 57 položiek, ktoré sú rozdelené do 5 oblastí (plánovanie a príprava, realizácia, triedna klíma a disciplína, diagnostika a hodnotenie, sebareflexia), v ktorých sa premietajú didaktické kompetencie učiteľa. Respondenti hodnotia jednotlivé položky na 5-bodovej škále (1 – nikdy, 2 – občas, 3 – niekedy, 4 – často, 5 – vždy). Prostredníctvom škály hodnotia do akej miery, ako často konajú spôsobom opísaným v jednotlivých položkách. Pre každú dimenziu kompetencií v rámci jednotlivých oblastí je počítané priemerné skóre (vyššie skóre znamená lepšie rozvinuté didaktické kompetencie).
Pre spracovanie dát sme využili štatistický software IBM SPSS Statistics v.27, licenčne zakúpený a využívaný KPŠP PF UKF v Nitre.

2.3 Diferencie v didaktických kompetenciách u študentov učiteľstva a učiteľov v praxi

Jedným z cieľov nášho výskumu bolo komparovať jednotlivé oblasti didaktických kompetencií študentov učiteľstva a učiteľov v praxi (tabuľka 1). Študenti učiteľstva vzhľadom na nedostatok praxe, svoje didaktické kompetencie ešte nemusia mať dostatočne rozvinuté a v použitých dotazníkoch reflektovali skôr predstavu o tom, akými by chceli byť učiteľmi. Z analýz vyplýva, že učitelia pôsobiaci v praxi majú v porovnaní s budúcimi učiteľmi v štatisticky významnej miere viac rozvinuté didaktické kompetencie v oblastiach plánovanie a príprava vyučovacej hodiny, realizácia vyučovacej hodiny, triedna klíma a disciplína, diagnostika a hodnotenie a sebareflexia.

Tabuľka 1 *Porovnanie študentov učiteľstva a učiteľov v praxi v ich didaktických kompetenciách*

Didaktické kompetencie	t	df	p	d
Plánovanie a príprava	-5,640	1365	**<,001**	-0,326
Realizácia	-6,283	1363	**<,001**	-0,363
Triedna klíma a disciplína	-6,067	1364	**<,001**	-0,351
Diagnostika a hodnotenie	-8,200	1361	**<,001**	-0,474
Sebareflexia	-7,873	1360	**<,001**	-0,455

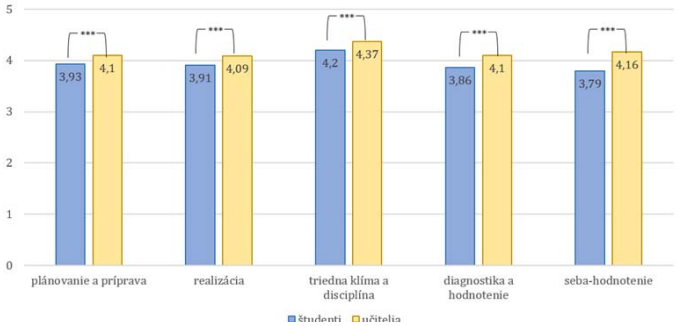
t – hodnota t-testu, df – stupne voľnosti, p – signifikancia, d – Cohenovo d

Najväčšie rozdiely medzi študentmi učiteľstva a učiteľmi v praxi sme zaznamenali v didaktických kompetenciách sebareflexia a diagnostika a hodnotenie. Učitelia z praxe dosiahli v dimenzii sebareflexia o 0,37 bodu vyššie skóre ako študenti, rovnako i v dimenzii diagnostika a hodnotenia vykazovali učitelia v praxi o 0,24 bodu vyššie skóre ako budúci učitelia.

Signifikantne významný rozdiel sme zaznamenali tiež v didaktickej kompetencii plánovanie a príprava a didaktickej kompetencii triedna klíma a disciplína, kde učitelia v praxi dosiahli v uvedených didaktických kompetenciách o 0,17 bodu vyššie priemerné skóre v porovnaní s budúcimi učiteľmi. V didaktickej kompetencii spojenej s realizáciou vyučovacej hodiny dosiahli učitelia v praxi o 0,18 bodu vyššie priemerné skóre ako študenti učiteľstva.

Prostredníctvom grafu 1 prezentujeme porovnania priemerných hodnôt jednotlivých dimenzií didaktických kompetencií študentov učiteľstva a učiteľov v praxi, ktoré sme merali prostredníctvom Dotazníka didaktických kompetencií.

Graf 1 *Porovnanie študentov učiteľstva a učiteľov v praxi v ich didaktických kompetenciách*



2.4 Prierezové porovnanie didaktických kompetencií študentov učiteľstva v čase

Naším prvotným zámerom bola komparácia didaktických kompetencií učiteľov v pregraduálnej príprave a učiteľov v praxi v čase. Tento cieľ sa nám však nepodarilo naplniť, nakoľko zhoda participantov v roku 2022 a v roku 2023 bola minimálna. Z uvedeného dôvodu sme sa zamerali na porovnanie úrovne didaktických kompetencií študentov bakalárskych učiteľských študijných programov (tabuľka 2). Meranie sme zrealizovali v zimnom semestri ich prvého roku štúdia (rok 2022) a v zimnom semestri v roku 2023, kedy navštevovali druhý ročník.

Z výsledkov vyplýva, že budúci učitelia mali v roku 2022 v porovnaní s nasledujúcim rokom 2023 v štatisticky významnej miere viac rozvinuté didaktické kompetencie spojené s plánovaním a prípravou vyučovacej hodiny.

Tabuľka 2 *Porovnanie didaktických kompetencií študentov učiteľstva v čase*

	rok	N	M	SD	t	df	p	d
DK								
PaP	2022	313	3,96	0,49	2,601	622	**0,010**	0,208
	2023	304	3,85	0,50				

R	2022	313	3,90	0,49	0,557	620	0,578	0,045
	2023	311	3,88	0,49				
TKaD	2022	313	4,22	0,47	1,875	621	0,061	0,150
	2023	309	4,15	0,51				
DaH	2022	313	3,87	0,47	0,978	618	0,329	0,079
	2023	310	3,83	0,50				
S	2022	313	3,80	0,82	0,931	617	0,352	0,075
	2023	307	3,74	0,82				

DK – didaktické kompetencie, PaP – plánovanie a príprava, R – realizácia, TKaD – triedna klíma a disciplína. DaH – diagnostika a hodnotenie. S – sebareflexia, N – počet, M – priemer, SD – štandardná odchýlka t – hodnota t-testu, df – stupne voľnosti, p – signifikancia, d – Cohenovo d

Pri overovaní rozdielov v úrovni rozvoja didaktických kompetencií budúcich učiteľov v roku 2022 a v roku 2023 sme signifikantne významný rozdiel zaznamenali len v didaktickej kompetencii plánovanie a príprava, kde študenti v roku 2023 dosiahli o 0,11 bodu nižšie priemerné skóre ako v roku 2022. Rovnako aj v iných dimenziách didaktických kompetencií bolo zistené nižšie priemerné skóre v roku 2023 v porovnaní s rokom 2022. V didaktickej kompetencii realizácia vyučovacej hodiny dosiali študenti v roku 2023 o 0,02 bodu nižšie skóre, v dimenzii triedna klíma a disciplína o 0,07 bodu nižšie skóre, v dimenzii diagnostika a hodnotenie o 0,04 bodu nižšie skóre a v sebareflexii o 0,06 bodu nižšie priemerné skóre v porovnaní s rokom 2022. Tieto rozdiely však neboli štatisticky významné.

3. DISKUSIA A ZÁVER

Vo výskume sme sa zamerali na zisťovanie úrovne didaktických kompetencií študentov učiteľstva a učiteľov v praxi. Z našich zistení vyplýva, že učitelia v praxi majú v porovnaní s učiteľmi v pregraduálnej príprave rozvinutejšie všetky didaktické kompetencie, hoci sú medzi nimi len minimálne rozdiely. Z kvalitatívneho hľadiska možno hovoriť o značnej rozvinutosti všetkých oblastí didaktických kompetencií učiteľov v praxi, zatiaľ čo u študentov učiteľstva sa miera rozvinutia ich didaktických kompetencií pohybuje od priemernej až po značnú rozvinutosť.

Najviac rozvinutou didaktickou kompetenciou v oboch skupinách respondentov je kompetencia spojená s vytváraním a udržiavaním pozitívnej klímy a disciplíny na vyučovaní. K rovnakým zisteniam dospela aj Ballová Mikušková (2022), ktorá sa vo svojom výskume zameriavala na meranie profesijných kompetencií učiteľov a študentov učiteľstva. Rovnako i Rapsová (2024) u 595 učiteľov pôsobiacich v materských, základných a stredných školách odhalila najviac rozvinutejšiu didaktickú kompetenciu v dimenzii triedna klíma a disciplína. Táto didaktická kompetencia sa ukázala ako značne rozvinutá aj u študentov učiteľských študijných programov, ktorých do svojho výskumu zahrnuli Guttová, Verešová (2022). Práve vytváranie a udržiavanie pozitívnej klímy na vyučovaní je jednou zo základných úloh učiteľa, nakoľko ovplyvňuje učebné výkony žiakov, ich motiváciu, tvorivosť a vzťahy v triede (Lomnický a kol., 2017).

Najväčšie rozdiely priemerného skóre u študentov a učiteľov v praxi sme zaznamenali v didaktickej kompetencii v oblasti sebareflexie. Študenti mali túto kompetenciu v porovnaní s inými oblasťami najmenej rozvinutú. Sebareflexívnu kompetenciu vnímame v zhode s Hupkovou, Petlákom (2004) a Hupkovou (2006) ako integrujúcu kompetenciu pri rozvoji všetkých ostatných kompetencií, spôsobilostí a zručností. S týmto názorom sa stotožňujú i Bruteničová a kol. (2021) a Orosová, Petríková, Starosta (2019), ktorých výskumné zistenia poukazujú na primerane rozvinutú sebareflexívnu kompetenciu učiteľov. Výsledky ich výskumu naznačujú, že slovenskí učitelia dokážu reálne vnímať, poznať a posudzovať seba samého, svoje schopnosti a možnosti, kontrolovať svoje správanie a usmerňovať seba samého, čo im pomáha efektívne riadiť vyučovací proces. S cieľom rozvinúť sebareflexiu, ale i sociálne kompetencie študentov učiteľstva odporúčame zakomponovať do pregraduálnej prípravy sociálno-psychologický výcvik ako povinný predmet s vyššou časovou dotáciou. Kurzov sociálno-psychologického výcviku, kurzov na rozvoj komunikačných a sebareflexívnych zručností by sa mali zúčastňovať aj učitelia v praxi. Sebareflexívnym zručnostiam by mali byť vedení študenti učiteľstva na každom predmete, ktorý v rámci svojho štúdia absolvujú. Učiteľ v praxi môže realizovať sebareflexiu a reflexiu vlastnej práce v kontexte práce svojich kolegov. Nápomocná môže byť aj aktívna komunikácia so žiakmi a s rodičovskou komunitou.

Z výskumu tiež vyplýva, že pri diagnostikovaní a hodnotení žiakov, študenti učiteľstva a učitelia v praxi do značnej miery zadávajú žiakom rôzne úlohy, ktoré preverujú ich kognitívne a non-kognitívne procesy, poskytujú žiakom možnosť hodnotenia seba samých, ba dokonca sa zhodujú v skutočnosti, že výsledky diagnostikovania usmerňujú ich edukačnú činnosť. Okrem toho sme zistili, že študenti a učitelia dokážu adekvátne a na odbornej úrovni intervenovať vzniknuté (problémové) situácie v triede, no menší problém sa javí v schopnostiach identifikovať žiaka so špeciálnymi edukačnými potrebami. Problémy v oblasti pedagogickej diagnostiky potvrdili i výsledky viacerých výskumov (Rovňanová, 2017; Bruteničová a kol., 2021). Takéto zistenia považujeme za nepriaznivé, nakoľko je pedagogická diagnostika každodennou samozrejmosťou v práci učiteľa. Na druhej strane však treba spomenúť, že existuje množstvo problémov, ktoré sťažujú jej praktické uplatnenie v práci učiteľa. Odstránenie týchto nedostatkov predpokladá rozvoj takých koncepcií pedagogickej diagnostiky, ktoré by zohľadňovali reálne fungovanie školy, ale i možnosti učiteľa, čím sa posilnia i jeho diagnostické kompetencie.

Náš výskum s parciálnym cieľom merania didaktických kompetencií študentov učiteľstva a učiteľov v praxi považujeme za jedinečný, nakoľko sa v našom prostredí didaktické kompetencie učiteľa neskúmajú po celej ich šírke, ale len parciálne. Ako príklad môžeme uviesť skúmanie didaktickej kompetencie učiteľov (Šuťáková, 2017) len vo vzťahu k stanoveniu výchovno-vzdelávacích cieľov a výberu vhodných didaktických metód. Didaktická kompetencia však spočíva tiež v schopnosti modifikovať učebný obsah zo statickej podoby učebných osnov, plánovať a riadiť výchovno-vzdelávací proces, správne a vhodne voliť metódy a formy vo vyučovaní, pohotovo reagovať na chyby a nedostatky vo vedomostiach, spôsobilosť pracovať s učebnicou a odbornou literatúrou, správne formulovať otázky, vzbudzovať záujem žiakov o učenie a i. Môžeme teda konštatovať, že najväčším problémom je nedostatok výskumov v oblasti celostného mapovania profesijných kompetencií slovenských učiteľov.

Pozitívnym zistením , ktoré vyplýva z nášho výskumu je skutočnosť, že študenti učiteľstva, ako i učitelia v praxi majú jednotlivé didaktické kompetencie priemerne až značne rozvinuté. Odlišné výsledky zaznamenali viaceré výskumy (Čelárová, 2010; Valihorová, Keppertová, Šukolová, 2016; Šuťáková, 2017; Rovňanová, 2017), ktoré naopak poukázali na nízku úroveň didaktických kompetencií učiteľov. Príslušné výskumy deklarujú, že slovenskí učitelia síce disponujú vysokou znalosťou obsahu učenia, no majú problémy s metodickou stránkou výučby. Upozorňujeme, že kvalitný učiteľ musí poznať a vyberať adekvátne metódy, postupy a stratégie, aby dokázal účinne rozvíjať schopnosti, vedomosti a osobnostné vlastnosti žiakov. Za účelom rozvinúť didaktické kompetencie budúcich učiteľov odporúčame v pregraduálnej príprave zvýšiť časovú dotáciu predmetu všeobecná didaktika a didaktika príslušného predmetu. Spomínané predmety odporúčame realizovať praktickou formou za aktívnej účasti

študentov, ktorí si prostredníctvom nácviku výučby daného predmetu, rozvinú zručnosti spojené s plánovaním, prípravou, realizáciou a hodnotením vyučovacieho procesu a učebných výsledkov žiakov. Na didaktických kurzoch by si mali študenti zároveň osvojiť prostredníctvom modelových situácií zo školského prostredia zručnosti spojené s budovaním pozitívnej triednej klímy a zručnosti v oblasti diagnostikovania a hodnotenia. Účastníci vzdelávania by mali byť neustále konfrontovaní so spätnoväzbovými informáciami, vďaka ktorým sa rozvinie zároveň ich sebareflexívna kompetencia.

Ďalším cieľom nášho výskumu bolo zistiť rozdiely v didaktických kompetenciách medzi budúcimi učiteľmi a učiteľmi pôsobiacimi v praxi. Výsledky poukazujú na zistenie, že učitelia v praxi majú v porovnaní so študentmi učiteľstva, vo významnej miere viac rozvinuté všetky didaktické kompetencie. Najväčšie rozdiely sa ukázali v didaktických kompetenciách sebareflexia a diagnostika a hodnotenie. Uvedené zistenia o rozvinutejších didaktických kompetenciách učiteľov v praxi nie sú prekvapením, nakoľko sa predpokladá, že učitelia prostredníctvom úspešne absolvovanej pregraduálnej prípravy nadobudli potrebné vedomosti, zručnosti a spôsobilosti a disponujú kompetenciami, ktoré sú kľúčové pre kvalitný výkon učiteľskej profesie. Tieto kompetencie si zároveň svojou vlastnou pedagogickou praxou rozvíjajú. Pri výkone svojej práce sú konfrontovaní so školskou praxou a získavajú pritom množstvo skúseností, ktoré im pomáhajú poznať bližšie pedagogický proces, skvalitniť výučbu správnou voľbou metód, organizačných foriem, využitím rôznych učebných postupov, pomôcok, ale taktiež i výchovne pôsobiť na žiakov a tak dotvárať ich všestranný harmonický rozvoj.

Ďalším výskumným zámerom bolo zrealizovať longitudinálne sledovanie didaktických kompetencií učiteľov v pregraduálnej príprave a v praxi. Tento cieľ nebolo možné naplniť kvôli minimálnej zhode parcipantov v roku 2022 a v roku 2023. Nakoniec sme pristúpili ku komparácii didaktických kompetencií študentov učiteľstva. Meranie ich didaktických kompetencií prebehlo s ročným časovým odstupom. V čase prvého merania navštevovali študenti prvý ročník vysokoškolského štúdia zameraného na učiteľské študijné programy. V roku 2023 sme namerali nižšie priemerné skóre vo všetkých oblastiach didaktických kompetencií v porovnaní s rokom 2022. Signifikantne významný rozdiel sa ukázal len v didaktickej kompetencii plánovanie a príprava vyučovacej hodiny. Tieto výsledky považujeme za zaujímavé, pretože by sme mohli predpokladať, že pribúdajúcimi rokmi štúdia dosiahnu študenti v jednotlivých didaktických kompetenciách lepšie výsledky, na základe čoho by sme mohli hovoriť o postupnom rozvoji týchto kompetencií. Uvedené zistenia si však môžeme vysvetliť tým, že vstupné meranie didaktických kompetencií študentov prebehlo v prvom roku ich štúdia, kedy ešte nemali absolvovaný predmet všeobecná didaktika, ani didaktika predmetov a zároveň nemali žiadnu skúsenosť s vyučovacou hodinou a so žiakmi, preto pri vypĺňaní dotazníka vyjadrovali v odpovediach skôr svoje predstavy seba ako učiteľa. V týchto odpovediach tak študenti pravdepodobne premietali svoje predstavy o ideálnom učiteľovi, zatiaľ čo v nasledujúcom roku svojho štúdia mali absolvovanú hospitačnú prax, prípadne i asistentskú prax, a na príslušné otázky odpovedali skôr z pohľadu prvotných skúseností so školskou praxou a z pohľadu vlastných nadobudnutých vedomostí a zručností.

Sumárnym pohľadom na nami prezentované výsledky konštatujeme, že didaktické kompetencie študentov učiteľstva a učiteľov v praxi sú priemerne, až značne rozvinuté. Na základe uvedeného možno tvrdiť, že pregraduálna príprava učiteľov pravdepodobne významne prispieva k rozvoju kompetencií nevyhnutých pre kvalitný výkon učiteľskej profesie. S cieľom ďalšieho skvalitnenia profesijných kompetencií budúcich učiteľov odporúčame v pregraduálnej príprave skvalitniť a zvýšiť rozsah pedagogickej praxe. Na toto odporúčanie centrujú pozornosť i krajiny OECD v súvislosti s výsledkami medzinárodných merní PISA. Práve prostredníctvom praxe získajú študenti učiteľských študijných programov praktické skúsenosti s výchovou a vzdelávaním detí a žiakov, nadobudnú skúsenosti v riešení problémov školskej praxe a rozvinú si tak svoje profesijné kompetencie. V súvislosti s pregraduálnou prípravou je potrebné upriamiť pozornosť na dôležitú úlohu vysokoškolských pedagógov, ktorí okrem sprostredkovania podstatných vedomostí, zároveň svojimi názormi a postojmi ovplyvňujú aj osobnosť študentov. Univerzity a vysoké školy by mali preto dbať na to, aby zamestnávali erudovaných a osobnostne kultivovaných pedagógov. Odbornosť pedagógov v našom školstve je samozrejmosťou, no niekedy sa vynára problém súvisiaci s ich chýbajúcou pedagogickou kvalifikáciou, čo môže v konečnom dôsledku spôsobiť to, že vysokoškolský pedagóg je síce odborníkom vo svojom odbore, ale chýbajú mu pedagogické a didaktické vedomosti a zručnosti, vďaka ktorým vie študentom príslušné vedomosti účinne sprostredkovať. Vychádzajúc z tohto problému odporúčame implementovať do legislatívy povinnosť pedagogickej kvalifikácie vysokoškolských učiteľov. Myslíme si, že vysokoškolskí pedagógovia by mali mať zároveň praktické skúsenosti z vyučovania na tom type školy (materská škola, základná škola, stredná škola), pre ktorú pripravujú svojich študentov – budúcich učiteľov. Významným zdrojom rozvoja kompetencií učiteľov v praxi je aj kontinuálne vzdelávanie, ktoré ponúka rôzne možnosti na skvalitnenie či prehĺbenie profesijných kompetencií v organizáciách určených platnou legislatívou. Aj v tomto prípade platí vyššie uvedené odporúčanie vzťahujúce sa k potrebe pedagogickej kvalifikácie lektorov akreditovaných kurzov ďalšieho vzdelávania pre učiteľov. Máme za to, že rozvinúť didaktické kompetencie budúcich učiteľov alebo učiteľov v praxi je možné len pod vedením vysokoškolského pedagóga, ktorý sám disponuje rozvinutými didaktickými kompetenciami. Za účelom rozvoja didaktických kompetencií odporúčame učiteľom z praxe kooperovať so svojimi kolegami, vymieňať si skúsenosti s výberom a používaním vhodných výchovno-vzdelávacích stratégií. Vzájomná kooperácia učiteľov prispieva k efektívnemu učeniu sa učiteľov, k profesijnému rozvoju a k pracovnej spokojnosti, čo sa odzrkadlí na kvalite výchovno-vzdelávacieho procesu. S cieľom kooperácie a výmeny skúseností odporúčame tiež, aby sa učitelia aktívne zapájili do členstva v profesijných združeniach, komorách alebo skupinách učiteľov. V súvislosti s uvedeným odporúčaním považujeme za potrebné, aby vedenie škôl vytvorilo pre učiteľov vhodné podmienky na ich spoluprácu a podporovalo ich profesijný rast. Spoluprácu učiteľov je potrebné zvyšovať nielen na úrovni jednej školy, ale aj na vyšších úrovniach (spolupráca škôl). Za týmto účelom je vhodné posilniť prepojenie medzi základnými, strednými a vysokými školami vo výučbe a výskume. Hlavný prínos vidíme predovšetkým v kontexte skvalitnenia pregraduálnej prípravy učiteľov v smere zhodnom so súčasnými požiadavkami, prepojením teórie s praxou. Ako prínosné pre rozvoj didaktických kompetencií sa javí posilnenie metodickej podpory na základných, stredných, vysokých školách a univerzitách v podobe tvorby a distribúcie didaktík, metodických príručiek, interaktívnych príručiek, doplnkových textov a pod. Zo skúseností z praxe a z viacerých výskumov vyplýva, že učiteľom, vysokoškolským pedagógom a lektorom sa nedostáva dostatočnej metodickej podpory facilitujúcej moderné metódy výučby. Učitelia by isto prijali, keby okrem publikácií metodického charakteru, mohli využívať aj moderné učebnice rôznych predmetov, ktoré by školská knižnica zaradila do svojej ponuky a pravidelne ich aktualizovala. Dôležitú úlohu v samotnom skvalitňovaní nehrajú len motivovaní učitelia s odbornými vedomosťami a požadovanými osobnostnými kvalitami, ale i školské inštitúcie, v ktorých učitelia pôsobia. Myslíme si, že každá škola by mala mať vypracovaný systém ďalšieho vzdelávania zohľadňujúci záujmy a potreby samotného učiteľa a vedenie školy by malo podporovať odborný rast učiteľov

vo všetkých sférach ich pedagogického pôsobenia, čo je zárukou napredovania učiteľov, žiakov a tým aj školy ako vzdelávacej inštitúcie. Je zrejmé, že na ceste za kvalitou školstva zohráva rozhodujúcu úlohu aj Ministerstvo školstva, výskumu, vývoja a mládeže SR, ktoré by malo uskutočniť systémové zmeny a motivovať učiteľov k sebavzdelávaniu a k účasti na svojom osobnostnom rozvoji. V zmysle rozvoja profesijných kompetencií učiteľov je dôležité a nevyhnutné, aby bolo získavanie a rozširovanie kompetencií a zručností prostredníctvom ďalšieho vzdelávania adekvátne finančne ohodnotené. Platobné podmienky učiteľov sú neadekvátne k zodpovednosti a množstvu kompetencií, ktoré musí učiteľ uplatňovať vo svojej práci. Rozhodujúcou sa stáva úloha vytvoriť pre každého učiteľa celoživotný prístup k možnostiam vzdelávať sa, rozvíjať svoje zručnosti a kompetencie počas celého života, v každom životnom štádiu a s ohľadom na individuálne potreby a okolnosti tak, aby každý učiteľ mohol realizovať svoj potenciál nielen v pracovnom, ale i osobnom živote. Toto odporúčanie je zároveň jedným zo základných princípov Stratégie celoživotného vzdelávania a poradenstva 2021 – 2030.

Nami formulované odporúčania sú smerované jednak k inštitúciám zastrešujúcim vzdelávanie študentov učiteľstva a učiteľov v praxi, jednak k učiteľom, vysokoškolským pedagógom a lektorom, jednak k samotným budúcim učiteľom alebo učiteľom v praxi. Všetky tieto cieľové kategórie sú navzájom prepojené a bez ich spolupráce, podpory a (seba)motivácie nie je možné, aby v školstve pôsobili učitelia s rozvinutými profesijnými kompetenciami, ktoré sú zárukou kvalitného výkonu učiteľskej profesie prejavujúceho sa požadovanými učebnými výsledkami, pozitívnou školskou klímou a spokojnosťou žiakov.

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Artephyletic Activities in the Classroom with Students with Developmental Learning Disabilities and Their Impact on the Social Climate

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Abstract Artefiletics is an effective method aimed at improving the condition of students with developmental learning disabilities, particularly in social and emotional domains. The goal of this study is to verify the effectiveness of artefiletic activities in the context of supporting a positive classroom climate. The authors describe a modified intervention program utilizing the principles of artefiletics within the educational process. A pilot implementation of the program took place in 2024 with secondary school students in the Trnava region. A group of 20 students participated in the intervention. To evaluate the intervention, the "Our Class" questionnaire, designed to measure classroom social climate, was used. Following the implementation of the artefiletic activity program, improvements were observed in the monitored areas, particularly significant among students with special educational needs.

Keywords Social climate. Developmental learning disorders. High schools. Pupils with learning disabilities. Artephyletics. Projecting artephyletic activities.

1. INTRODUCTION

Specific learning disabilities (SLD), also referred to by some authors as developmental learning disorders (DLD), affect approximately 16,000 Slovak children (2–5% of the child population). Therefore, considering the prevalence within the child population, it is clear that this is a significant issue.

These disorders impact a student's ability to interpret what they see and hear, or their ability to integrate information from various parts of the brain. Learning disabilities greatly influence a student's academic performance and also affect classroom climate, as they impact daily interactions and relationships with peers. Some students may experience multiple learning disabilities simultaneously, while others may have only one specific disorder in isolation. This variation requires an individualized approach, as each student is unique and naturally differs in their developmental pace.

In addition to standard special-education procedures and interventions for educating these students, artephiletics can also be utilized as an effective method aimed at improving their skills, particularly in social and emotional areas.

According to Sender, B. (2022), artephiletics uses drawing, painting, and modeling techniques to help students with behavioral disorders learn to solve their own emotional problems, improve their social skills, control their behavior, cope with stress, and increase self-awareness. Bielčíková, K. and Sender, B. (2024), in their theoretical study, have confirmed that artephyletic activities represent an innovative approach to social support and are widely applicable as a way of providing support not only to individuals with DLD, but also to groups or entire communities.

Students with DLD often exhibit greater emotional instability, lower self-confidence, and negative attitudes toward their surroundings. Sender B., Bielčíková K. and Žovinec E. (2024) claim that these students have to exert much more effort, which can alsohave an impact on their psychological well-being. One way to help these students and enhance their self-confidence is to integrate artephiletic activities into their education. Experiencing success and positive emotions through creative artistic expression can support them in multiple problematic areas (see also: Turzák, T., Poláčková, V., Mališeková Dojčanová, A., 2023).

Artistic expression is an invaluable means of communication, especially for those who have difficulty expressing their thoughts verbally (Sender, B, 2023). Several international research studies demonstrate the positive impact of artistic activities in educating this group of students. Most foreign studies view artephiletic activities as complementary to traditional special-education interventions.
Results aligning with our objectives can be found, for instance, in the work of Karimi D. A. and Yazdanpanahi, R. (2024). Their study aimed to examine the effect of an artephiletic program on hostility, shyness, and social skills among students (including those with learning disabilities) at the high school level. The experimental group showed a significant reduction in shyness and considerable improvement in social skills compared to the control group after just eight weeks of intervention. The authors emphasize that artephiletic activities are an effective tool for fostering a positive classroom climate and supporting the inclusion of students with developmental learning disorders.

Similar outcomes are reported by Saunders, E. J., and Saunders, J. A. (2000), who noted improvements in the social domain. Furthermore, Freilich, R., and Shechtman, Z. (2010), in their study, highlighted an important observation: no statistically significant educational differences were recorded between the experimental and

control groups, with both showing similar improvements. However, significant differences between the groups were identified in social and emotional areas.

Numerous similar studies could be cited. Such findings support the relevance of applying artephiletic principles in secondary education, particularly among students with developmental or other learning disorders. Intervention programs using artephiletic activities should particularly aim at fostering so-called soft skills, ideally contributing to improved social climate within the classroom.

1.1 Supportive intervention program using the principles of artephyletics in the teaching process

The aim of the study is to verify the effectiveness of a modified intervention program utilizing artephiletic principles in the educational process at secondary school. The intention is to improve the classroom climate among students with developmental learning disorders. In the following section, we describe the content of the modified intervention program we utilized.

The proposed artephiletic program, with specific areas and activities, was inspired by the work of Slavík, J., Eliášová, S., and Slavíková, V. (2015). The program was also created based on recommendations from international literature, particularly by authors Losinski, M., Hughey, J., and Maag, J. W. (2016), who outlined specific steps and principles for the most effective planning of such activities. During planning, we adhered to the individual steps of the artephiletic intervention activities process and design (modified according to Losinski, M., Hughey, J., Maag, J. W., 2016). For further details, see Turzák, T., Poláčková, V., Mališeková Dojčanová, A. (2023) and Kollárová, D., Mališeková Dojčanová, A, (2024).

We implemented the artephiletic activity intervention program to support classroom climate as a two-hour block once weekly in the first year of secondary school over three months (November 2024 – January 2025). It consisted of three main areas, each comprising several linked activities.

Area: Colors
1st Block - Activation: Students select a hat, cap, or baseball cap provided and put it on their heads. They move around the space and greet each other without speaking—waving, smiling, shaking hands, tipping hats, touching briefly, making eye contact, holding hands, and spinning around (approx. 3-5 min). They then sit in a circle on the floor, taking turns answering the teacher's questions about where they live, if they have their room, and if they share it. After responding, students place their hats in the circle's center. The discussion continues with the question of whether each student could draw their house.

2nd Block - Each student draws their house on a paper (approx. 10 min). The teacher may comment verbally during their work. The primary creative activity involves splitting students into two groups, each working at a table with a large sheet of wrapping paper. Each student pastes their drawn house anywhere on the paper. Students receive a paper cup of tempera paint and a brush, with colors distributed randomly. They use their colors to connect the houses, exploring the paper freely, as if visiting neighbors. Colors may meet, avoid each other, or move freely across the paper. Students work silently for 15 minutes. The activity concludes with relaxation thoughts and reflection—discussing dominant colors, preferences, challenges, and color combinations formed.

Area: Portrait as Metaphor
3rd Block - Portraits are considered within the context of visual art. Portraits select external and internal characteristics that the artist tries to express visually. Here, a general metaphor principle is applied, extending beyond visual art. Students represent their portraits verbally (with one or three words), musically (using instruments or sounds), or physically (through pantomime, facial expressions, and gestures). This targeted approach to portraits enhances mutual understanding and comparing impressions among classmates.

4th Block - Working with oil pastels and paper, students sit in a circle, observe their facial details in a mirror, then draw themselves as they perceive themselves. Subsequently, in small groups, they also draw a literary or movie hero with whom they identify.

Area: Portrait – Organizing Objects into Wholes
5th Block - Students explore self-image and others' perceptions through visual appearance. They transform communicative content into visual metaphor mosaics as portraits. Working individually, students use paper, colorful magazines, flyers, and glue to replace facial features with objects cut from printed materials, visually expressing metaphoric characteristics.

6th Block – Reflective Dialogue: Active mutual communication deepens understanding and fosters creative thinking. Students actively discuss new insights from their experiential processes. Confronting differing opinions helps students recognize their unique experiences, enriching mutual respect. Reflective self-questioning—what they created, how, and motivations behind their creations—promotes deeper self-awareness. Aligning and contrasting individual student experiences are crucial for guiding adults' personal competencies, managing group dynamics, empathetic responses, and feedback-based reflection.

Artephiletics is grounded in experiential learning, focusing on experiences and personal reflections. It is uniquely designed to bring education closer to students' personal experiences, making reflective processes essential.

2. METHODS AND METHODOLOGY OF PILOT TESTING OF THE INTERVENTION PROGRAM

The aim of the research was to conduct a pilot verification of the effectiveness of an intervention program applying the principles of artefiletics within the teaching process. The implemented program focused on supporting the social climate in a classroom of first-year secondary school students with specific learning disabilities (SLD).
In relation to the main research aim, the following research questions were formulated:

- How will secondary school students evaluate classroom satisfaction, conflicts, and peer cohesion before and after the implementation of our intervention?
- What differences in the assessment of the monitored areas will be recorded before and after the implementation of our intervention among students with specific learning disabilities?

Sample
The pilot verification of the intervention program involved 21 first-year secondary school students over a period of 3 months (from November 2024 to January 2025). The intervention was implemented in a classroom with 14 boys and 7 girls. The classroom also included students with learning disabilities, specifically: two boys diagnosed with ADHD (one of whom also had a co-occurring communication disorder and came from a bilingual background –

his father's native language was different from Slovak), one girl with a communication disorder.
The sampling had the character of purposive selection. For the purposes of the pilot research, we deliberately selected a class with a higher proportion of students with special educational needs. Additionally, no prior diagnostics of social relations had been carried out in this class, nor had any interventions focused on supporting the social and classroom climate been implemented before.

Data collection methods, data analysis, and research methodology
The results were obtained by administering the "Our Class" questionnaire (Naša trieda) by Lašek, J. & Mareš, J. (1991), which allows assessment of the classroom social climate based on five dimensions (i.e., five variables). The questionnaire contains 25 items (questions) in total and focuses on the following areas:

Classroom satisfaction – evaluates how students perceive their classroom, their satisfaction level, and overall sense of well-being. (Items: 1, 6, 11, 16, 21)

Classroom conflicts – explores interpersonal issues, frequency and intensity of tensions, disputes, conflicts, fights, and inappropriate behavior in social interactions. (Items: 2, 7, 12, 17, 22)
Classroom competitiveness – examines competitiveness among students, efforts to stand out, and the emotional impact of school failures. (Items: 3, 8, 13, 18, 23)
Academic demands – assesses how students perceive school demands and how difficult they find their studies. (Items: 4, 9, 14, 19, 24)
Student cohesion – investigates friendly and unfriendly relationships among students, as well as the overall level of class cohesion. (Items: 5, 10, 15, 20, 25) (For more details, see Lašek, J., Mareš, J., 1991)
For the purposes of this study, we analyzed and present in the text only the results related to classroom satisfaction, conflicts, and student cohesion. Considering the research aim (to pilot test the effectiveness of the program), the statistical analysis of the data was carried out at a descriptive level only at this stage.

3. RESULTS

Our aim was to examine how secondary school students would evaluate classroom satisfaction, peer conflict, and group cohesion before and after the implementation of our intervention. In the following section, we present the findings obtained through the classroom climate assessment, as described in the previous methodology. The effectiveness of the intervention is illustrated through a series of graphs.

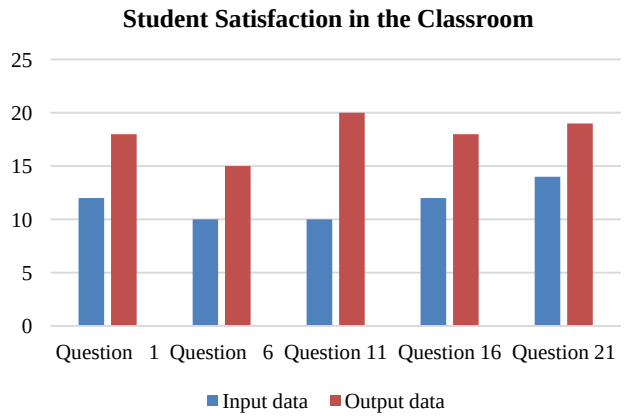
The first domain we monitored was "classroom satisfaction." This was assessed using the research tool through a set of items (questions 1, 6, 11, 16, and 21), which evaluate how students perceive their classroom environment, including their overall sense of satisfaction and well-being.

Initial results indicated the following: In response to item 1, which examined whether students enjoy schoolwork, 12 students responded positively. However, all three students with specific learning disabilities (SLD) stated they did not enjoy schoolwork. On item 6, which explored whether all students are happy in class, 11 students answered positively. Again, students with SLD unanimously stated that not all classmates are happy. On item 11, ten students reported they liked their class. For item 16, which asked whether some students dislike being in the classroom, nine students responded affirmatively. Finally, item 21 explored whether students perceive humor and fun in the classroom. Fourteen students answered positively, while seven reported they did not notice any humor or playfulness. After the intervention, the results showed marked improvements: Eighteen students reported enjoying schoolwork, suggesting an increase of six positive responses. Only six students still believed some of their classmates were not happy, while the majority perceived a more positive emotional climate. Twenty students reported liking their classroom, and only three felt some students did not enjoy being part of it. Notably, in item 21, 19 students stated they noticed humor and fun in class, compared to only 14 before. The graphical representation clearly demonstrates that, following the implementation of our artefiletic program, improvements were observed across all five items related to classroom satisfaction. Specifically:

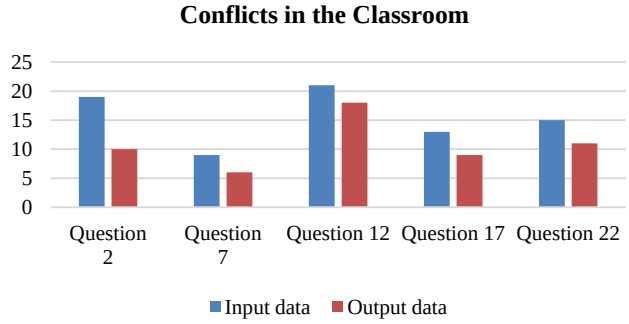
- Item 1 (enjoyment of schoolwork): an increase from 12 to 18 points (+6)
- Item 6 (happiness of classmates): an increase of 5 points
- Item 11 (liking the class): an improvement of 10 points
- Item 16 (some students dislike the classroom): improved from 12 to 18 points
- Item 21 (humor and fun in class): increased from 14 to 19 points (+5)

In summary, the post-intervention results indicate a consistent improvement in students' perceptions of classroom satisfaction across all observed indicators. Within just three months, the artefiletic program contributed to creating a more positive and enjoyable classroom climate. This was evidenced by a total improvement of 10 points out of a possible 21 in the overall satisfaction score.

Graph 1: Frequency of Classroom Satisfaction Ratings Before and After the Implemented Intervention Program

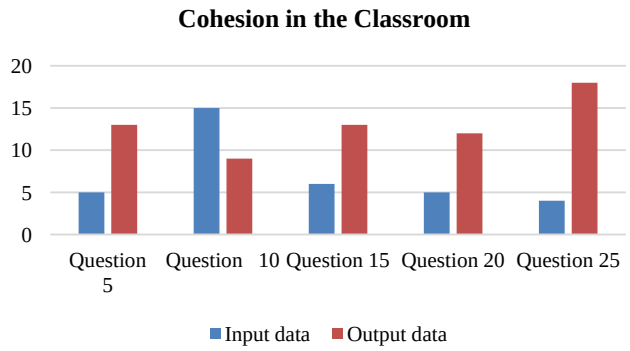


Graph 2: Frequency of Classroom Conflict Ratings Before and After the Implemented Intervention Program



Nineteen students reported that occasional conflicts occur among classmates. Nine students perceived selfish behavior among their peers. All 21 students indicated that some classmates intentionally provoke or annoy others. In response to whether there are students in the class to whom others must adapt, 13 students answered affirmatively. Furthermore, 15 students confirmed the frequent occurrence of arguments.

Graph 3: Frequency of Student Cohesion Ratings Before and After the Implemented Intervention Program



Out of a total of 21 students, only five perceived the class as a group of friends (these five students form a close-knit group that also socializes outside of school). Sixteen students did not perceive the class as a community of friends. Five students reported having close, trusted friendships within the classroom. Similarly, five students evaluated the overall sense of mutual tolerance among classmates positively. Only four students perceived strong mutual friendships among their peers in the classroom.

4. DISCUSSION AND CONCLUSION

In line with the research objectives, we conducted a separate analysis of frequency tables (in selected areas) for both the pre-test and post-test phases, with a specific focus on students with specific learning disabilities (SLD). Students with SLD (referred to here as Student 1, Student 2, and Student 3) demonstrated negative responses in the pre-test phase on items related to classroom satisfaction. For example, when asked whether they enjoyed schoolwork, all three answered negatively. After implementing our artefiletic intervention program, all three students provided positive responses to the same items in the post-test phase. Similar trends were observed in other areas, suggesting more positive evaluations by students with SLD compared to their typically developing peers following the intervention.

It is evident that artefiletics contributes meaningfully to improving the social climate within the classroom. This method proves to be effective both as a primary intervention and as a complementary approach—for both typically developing students and those with health or learning disadvantages. Our findings indicate that artefiletic activities particularly enhance students' subjective perception of satisfaction in the classroom among those with learning difficulties. In comparison with their peers, these students reported a significantly greater reduction in classroom conflict following the implementation of the program. Beyond this, we also recorded meaningful improvements in the area of perceived student cohesion for learners with special educational needs.

The findings of our pilot study are consistent with several international research studies in this field. Most available studies report significant improvements in students' social and emotional domains following participation in artefiletic activities, while the impact on academic outcomes tends to be less pronounced.

Lavric and Soponaru (2023) conducted a study analyzing the effects of a structured group-based artefiletic program on empathy, prosocial behavior, and anxiety levels in students with special educational needs, including those with SLD. They found a statistically significant increase in both empathy and prosocial behavior in the experimental group that participated in the program. Artefiletic activities implemented in the school environment can significantly reduce experienced anxiety—particularly in students with SLD—and foster empathy and prosocial behavior. These outcomes directly contribute to a more positive social climate in the classroom.

Similarly, Lim (2014) investigated the effectiveness of a group-based art therapy program aimed at enhancing self-esteem and social skills among adolescents with specific learning disabilities. His findings showed marked improvement in both self-esteem and social competencies after participation in the program. The author emphasized that group-based art therapy and artefiletic interventions serve as effective tools for promoting social inclusion and psychological well-being among adolescents with SLD in school settings.

Several additional studies report comparable results, some of which were discussed in the introductory section of this study.
Study Limitations and Future Directions:
In conclusion, several limitations of the present study should be acknowledged. Despite the relatively long duration of the intervention (one of the strengths of this research), the study would benefit from a larger research sample. Our findings suggest that artefiletic activities should ideally be implemented continuously throughout the entire school year. In this sense, they can also be understood as a preventive tool against deteriorating classroom climate and the development of undesirable social and behavioral problems.

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Rozšírenie a význam borovíc na Slovensku

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Názov grantu: Genetická diverzita a patogenita vybraných húb kolonizujúcich *Pinus* sp.
Odborové zameranie: EH - Ekológia-spoločenstvá

Abstrakt Borovice (*Pinus* sp.) predstavujú jednu z najvýznamnejších skupín ihličnatých drevín severnej pologule, ktorá zohráva dôležitú úlohu nielen z ekologického, ale aj hospodárskeho, krajinotvorného a kultúrneho hľadiska. Vyznačujú sa širokou ekologickou prispôsobivosťou, druhovou rozmanitosťou a rozsiahlym geografickým rozšírením – od morského pobrežia až po vysokohorské oblasti. Na Slovensku sa borovice uplatnili ako autochtónne druhy v prirodzených ekosystémoch, ale aj ako introdukované dreviny v rekultivačných, ochranných či produkčných porastoch. Okrem ich praktického významu si viaceré exempláre borovíc získali aj štatút chránených stromov vďaka svojim mimoriadnym ekologickým, historickým či estetickým hodnotám. Táto práca sa zameriava na prehľad taxonomického zaradenia, ekologickej a druhovej diverzity rodu *Pinus* s dôrazom na rozšírenie, význam a ochranu borovíc na území Slovenskej republiky. Zvláštna pozornosť je venovaná chráneným jedincom, ktoré reprezentujú kultúrne dedičstvo a biologickú hodnotu nášho územia.

Kľúčové slová *Pinus* sp., pôvodné a nepôvodné druhy, Slovensko, význam

1. BOROVICA (*PINUS* SP.)

Borovica (*Pinus*) je rod neopadavých ihličnatých drevín, častejšie stromov, zaradený do oddelenia: borovicorasty (Pinophyta), triedy: ihličnany (Pinopsida) a čeľade: borovicovité (Pinaceae). Odhaduje sa, že zahŕňa okolo 110 druhov (Farjon, 2021; Gernandt et al., 2005). Borovice sú rozšírené nielen na severnej, ale i južnej pologuli, a to vo výškach od úrovne mora až po hornú hranicu lesa. Ekologická valencia a distribúcia rodu borovica je druhovo individuálna, od kozmopolitnej borovice lesnej (*Pinus sylvestris* L.), s prirodzeným výskytom od Škótska po Sibír, až po endemit Kanárskych ostrovov borovicu kanársku (*Pinus canariensis* C.Sm).

1.1 Rozšírenie a druhové zastúpenie borovíc na Slovensku

Porasty borovíc majú na Slovensku významné postavenie, nakoľko sú po smreku druhým najpočetnejším rodom ihličnatých drevín s aktuálnym zastúpením 6,4 % , čo predstavuje takmer 130 tis. ha lesnej plochy (Zelená správa, 2024). Na území Slovenska sú autochtónnymi druhmi borovica lesná – sosna (*P. sylvestris*), postupne vytláčaná na extrémne stanovištia, borovica horská – kosodrevina (*P. mugo* Turra), tvoriaca samostatný vegetačný stupeň a borovica limba (*P. cembra* L.), zachovaná vo vyšších nadmorských výškach, avšak na rozdiel od Álp netvoriaca vlastný vegetačný stupeň, len prímes v smrečinách a porastoch kosodreviny (Kormuťák et al., 2013). V rámci lesných spoločenstiev, ale aj sídelnej vegetácie bola významne introdukovaná borovica čierna (*P. nigra* Arnold), využívaná predovšetkým ako produkčná a melioračná drevina (Tokár a Krekulová, 2005). V Kremnici bolo jej semeno pochádzajúce z Dolného Rakúska vysiate už v roku 1769 (Nožička, 1969). Z ihličnatých drevín je borovica čierna najčastejšou cudzokrajnou drevinou pestovanou na Slovensku (Pagan, 1996). Z iných nepôvodných druhov borovíc sa v našich lesoch vysádzala tiež borovica hladká – vejmutovka (*P. strobus* L.), avšak jej zastúpenie medzi introdukovanými drevinami v lesoch Slovenskej republiky sa odhaduje len na 0,1 %, zatiaľ čo u borovice čiernej 14,7 % (Kapusta, 2023). Ostatné alochtónne druhy *Pinus* sp. sú súčasťou najmä vegetácie parkov, záhrad, arborét a pod. Nepredstavujú hospodársky významné dreviny, plnia účel estetický, sociálny, edukačný, vedecký a i.

Introdukcia nepôvodných druhov v na začiatku 18. storočia do Európy vznikla ako odraz nedostatku dreva. Na Slovensku sa popri *P. nigra* najviac uplatňovala *P. strobus* (Holubčík, 1968). Menšie reprodukčné plochy boli vytvárané aj z iných druhov borovíc ako napr. borovica stočená (*P. contorta* Dougl. ex Loud.), borovica ťažká – borovica žltá (*P. ponderosa* Dougl. ex Laws.), borovica Banksova (*P. banksiana* Lamb), borovica tuhá (*P. rigida* Mill., *P. serotina* Michx.). Následne však došlo k ich postupnému zmiešavaniu s domácimi druhmi, až k ich zániku ako produkčných plôch (Benčať, 1982).

Ďalšie nepôvodné druhy rodu *Pinus* na našom území, ktorými sú napr. borovica ostitá (*P. aristata* Engelm.), borovica Armandova (*P. armandii* Franch.), borovica Bungeho (*P. bungeana* Zucc. ex Endl.), borovica Coulterova (*P. coulteri* D. Don), borovica hustokvetá – japonská červená borovica (*P. densiflora* S. & Z.), borovica ohybná (*P. flexilis* James), borovica pancierová (*P. heldreichii* Christ.), borovica Jeffreyova (*P. jeffreyi* Grev. & Balf.), borovica kórejská (*P. koraiensis* S. & Z.), borovica pohorská (*P. monticola* Dougl. ex D. Don), borovica málokvetá – japonská biela borovica (*P.*

parviflora S. & Z.), borovica balkánska (*P. peuce* Griseb), borovica červená (*P. resinosa* Ait.), borovica sibírska (*P. sibirica* Du Tour), borovica čínska (*P. sinensis* D. Don), *P. tabuliformis* Carr., *P. thunbergii* Parl., borovica barinná (*P. uncinata* Mill. ex Mirb.) a borovica himalájska (*P. wallichiana* A.B. Jacks.) sú zväčša vysádzané ako malé populácie v arborétach, botanických a okrasných záhradách, alebo ako solitéry v parkoch a záhradách (Benčať, 1982; Červenka et al., 1986; Hoťka a Barta, 2012). So zvýšenými možnosťami cestovania, otvorenými hranicami v EU, môžeme predpokladať, že na individuálnej úrovni môže antropogénnou činnosťou dochádzať k introdukcii nových, pestovateľsky zaujímavých druhov rodu *Pinus* na územie Slovenska.

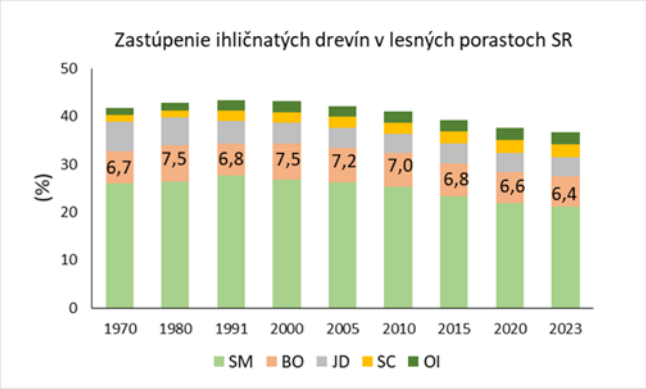
1.2 Význam pestovania borovíc na Slovensku

Význam *P. nigra* nespočíva v produkcii drevnej hmoty, ale predovšetkým v tom, že sa využíva ako priekopnícka a melioračná drevina na degradovaných pôdach, na zalesňovanie krasových oblastí, kde rýchlo rastie, tvorí bohatú korunu, má každoročný bohatý opad ihličia, a tak prispieva k vytváraniu nových pôdnych vrstiev. Dobre znáša abiotický stres ako sucho, vietor emisie a exhaláty. Je najčastejšie vysádzanou drevinou na najnepriaznivejších pôdach (Pagan, 1996).

P. mugo je mimoriadne prispôsobivá a na podmienky nenáročná drevina, ktorá má schopnosť rásť v extrémnych podmienkach, kde tvorí rozsiahle porasty v subalpínskom stupni. Tam sa uplatňuje predovšetkým jej protierózna, pôdoochranná a hospodárska funkcia (Pagan, 1996).

Hospodársky, ekonomicky prínosný a drevospracovateľský význam má predovšetkým druh *P. sylvestris*. Je charakteristická nielen vysokým produkčným potenciálom, ale aj významnou genetickou variabilitou svojich populácií a širokou ekologickou plasticitou (Brichta et al., 2023).

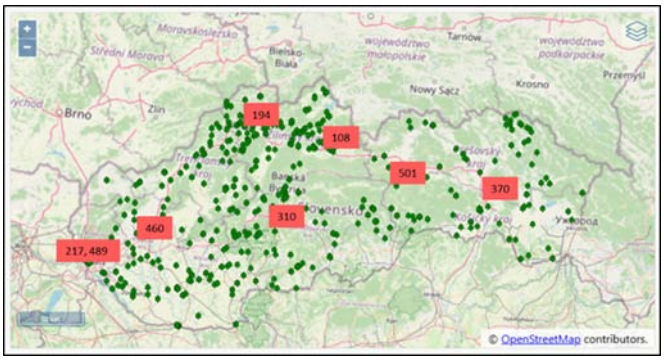
Na základe dnešných poznatkov o vplyve klimatickej zmeny na lesy v SR sa z ihličnanov okrem smrekovca javia borovice ako relatívne prispôsobivé voči predpokladaným teplotným zmenám, a preto by sa mali zaraďovať do tzv. zmiešaných porastov, pri ktorých je možné predpokladať väčšiu ekologickú plasticitu (Zelená správa, 2024). Hoci je borovica lesná považovaná za odolnú drevinu vo vzťahu k nedostatku zrážok, borovicové porasty naprieč Európou boli v posledných rokoch enormne poškodené opakujúcimi sa suchami, kedy sú najmä zrážky hlavným faktorom, ovplyvňujúcim rastové procesy borovíc. Môžeme povedať, že borovica je v súčasnosti jedným z najohrozenejších druhov stromov v Európe (Brichta et al., 2023). Potvrdzuje to aj Správa o lesnom hospodárstve v Slovenskej republike za rok 2023 (Zelená správa, 2024), podľa ktorej sa zastúpenie ihličnatých drevín (aj borovíc) v lesných porastoch SR dlhodobo znižuje (Obr. 1). Odumieranie borovice spôsobené komplexným pôsobením sucha, podkôrneho hmyzu a húb nemožno podceňovať.



Obr. 1 Vývoj zastúpenia vybraných ihličnatých drevín v lesných porastoch Slovenskej republiky (SR). Prameň: Národné lesnícke centrum, Súhrnné informácie o stave lesov SR 1971-2024; SM – smrek obyčajný, BO – borovica lesná, JD – jedľa biela, SC – smrekovec opadavý (Zelená správa, 2024).

Vzhľadom na klimatickú zmenu odzrkadľujúcu sa predovšetkým suchými ročníkmi je potrebné preto zvážiť nový prístup v oblasti obhospodarovania borovicových porastov v lokalitách Slovenska (Leontovyč et al., 2020).

Okrem hospodárskeho a ekologického významu majú mnohé stromy historický a kultúrny význam. Mnohé rastú neďaleko historických obydlí hradov a kaštieľov, v parkoch a pri pamätníkoch, sú spájané s ľudovou tradíciou (napr. stromy pod ktorými kázali kazatelia, stretávali sa obyvatelia dediny), alebo majú symbolickú hodnotu (strom mieru, strom priateľstva, strom slobody). Mnohé stromy majú genetický a vedecký význam alebo majú estetický a krajinotvorný význam. K takýmto jedincom patrí aj skupina stromov, medzi ktoré zaraďujeme aj borovice, so statusom chránený strom (Obr. 2). Podľa § 49 ods. 1 zákona tam patria kultúrne, vedecky, ekologicky, krajinotvorne alebo esteticky mimoriadne významné stromy alebo ich skupiny vrátane stromoradí. Tento status im udeľuje okresný úrad v sídle kraja. Ak to vyžaduje záujem ochrany chráneného stromu, možno vyhlásiť jeho ochranné pásmo. Ak nebolo osobitne vyhlásené, je ním potom územie okolo chráneného stromu v plošnom priemete jeho koruny, ktorý je zväčšený o jeden a pol metra, najmenej však v okruhu 10 m od kmeňa stromu. V ochrannom pásme chráneného stromu platia zákazy, ktoré sú ustanovené v § 49 ods. 7 zákona (ŠOPSR, cit. 2025-06-24). Každý zásah do týchto stromov (orez, výrub, poškodenie koreňov) je zakázaný alebo prísne regulovaný – a podlieha súhlasu Štátnej ochrany prírody.



Obr. 2 Chránené borovice na území Slovenska: 310 - Borovica Ľudmily Podjavorinskej, 217 - Borovica na ulici Boženy Němcovej, 108 - Borovica v Matiašovciach, 501 - Borovica v Spišskom Štvrtku, 460 - Borovica v Zámockej záhrade v Hlohovci, 370 -

Borovica v Zámutove, 489 - Borovice čierne na ulici Francúzskych partizánov, 194 - Borovice v Terchovej.
Upravené podľa: https://data.sopsr.sk/chranene-objekty/

1.3 Prehľad a stručná charakteristika niektorých chránených borovíc na Slovensku

Borovica Ľudmily Podjavorinskej
Druh: borovica lesná, *P. sylvestris*
Evidenčné číslo: 310
Kraj: Banskobystrický, Okres: Zvolen, Kataster Rybáre
Charakteristika: Za chránený strom bola vyhlásená v roku 1996. Borovica lesná s výškou 23 m, obvodom kmeňa 350 cm, priemerom koruny 20 m a vekom okolo 150 rokov. Je chránená z kultúrno-výchovných, historických a estetických dôvodov. Viaže sa na spisovateľku Ľudmilu Podjavorinskú. Nachádza sa v Sliači v areáli kúpeľov medzi objektom liečebného domu Slovensko a správou kúpeľov (Obr. 3).

Borovica na ulici Boženy Němcovej
Druh: borovica hladká, *P. strobus*
Evidenčné číslo: 217
Kraj: Bratislavský, Okres: Bratislava I, Kataster: Staré Mesto
Charakteristika: Za chránený strom bola vyhlásená v roku 1996 z dôvodu kultúrneho, vedeckého, krajinotvorného, historického, estetického a ekologického významu. Exemplár je významný vysokou biologickou hodnotou a zriedkavým výskytom. Borovica hladká je vysoká 20 m, s obvodom kmeňa 157 cm, priemerom koruny 12 m a vekom 70 rokov. Stojí na ulici Boženy Němcovej 8 v záhrade.

Borovica v Matiašovciach
Druh: borovica limbová, *P. cembra*
Evidenčné číslo: 108
Kraj: Žilinský, Okres: Liptovský Mikuláš, Kataster: Liptovské Matiašovce
Charakteristika: Za chránený bola vyhlásená v roku 1975 a 1996. Borovica limbová s obvodom kmeňa 229 cm, výškou 20 m, priemerom koruny 8 m a vekom 90 rokov. Je chránená z biologického, estetického, kultúrneho a vedeckého dôvodu. Stojí v obci Liptovské Matiašovce v sade J. Krčmárika. Všetci zástupcovia tohto druhu sú na území SR chránení. Strom je výrazne dlhoveký, môže dosiahnuť vek nad 500 rokov.

Borovica v Spišskom Štvrtku
Druh: borovica lesná, *P. sylvestris*
Evidenčné číslo: 501
Kraj: Prešovský, Okres: Levoča, Kataster Rybáre
Charakteristika: Za chránený strom bola vyhlásená v roku 2008. Borovica lesná s výškou 14 m, obvodom kmeňa 365 cm, priemerom koruny 14 m a vekom viac ako 200 rokov. Ochrana významného stromu z ekologických, estetických a krajinotvorných dôvodov. Nachádza sa v obci Spišský Štvrtok.

Borovica v Zámockej záhrade v Hlohovci
Druh: borovica lesná, *P. sylvestris*
Evidenčné číslo: 460
Kraj: Trnavský, Okres: Hlohovec, Kataster: Hlohovec
Charakteristika: Za chránený bola vyhlásená v roku 2000. Vzhľadom na svoj vek, ekologickú, krajinotvornú a estetickú funkciu je mimoriadne významným stromom v okrese. Borovica lesná s obvodom kmeňa 301cm, výškou 28 m, priemerom koruny 10 m a vekom 120 rokov. Rastie v Hlohovci v parku (Obr. 3).

Borovica v Zámutove
Druh: borovica Jeffreyova, *Pinus jeffreyi*
Evidenčné číslo: 370
Kraj: Prešovský, Okres: Vranov nad Topľou, Kataster: Zámutov
Charakteristika: Za chránený strom bola vyhlásená v roku 1990 a 1997. Borovica Jeffreyova s výškou 25 m, obvodom kmeňa 249 cm, priemerom koruny 8 m a vekom viac ako 200 rokov. Je chránená z vedecko-výskumných, náučných, ekologických, kultúrno-historických a estetických dôvodov. Nachádza sa v blízkosti obce Zámutov v lesnom poraste.

Borovice čierne na ulici Francúzskych partizánov
Druh: borovica čierna, *P. nigra*
Evidenčné číslo: 489
Kraj: Bratislavský, Okres: Bratislava I, Kataster: Staré Mesto
Charakteristika: Za chránený strom boli vyhlásené v roku 2001 z dôvodu ich biologického, krajinotvorného a estetického významu. Sú to tri exempláre borovice čiernej. Všetky stromy majú vek 120 rokov. Prvá borovica má obvod kmeňa 258 cm a priemer koruny 12 m, druhá 169 cm a 8 m a tretia 238 cm a 10 m. Stromy stoja v súkromnej záhrade.

Borovice v Terchovej
Druh: borovica hladká, *P. strobus*
Evidenčné číslo: 194
Kraj: Žilinský, Okres: Žilina, Kataster: Terchová
Charakteristika: Za chránené boli vyhlásené v roku 1982 a 1996. Dva exempláre borovice hladkej. Prvá má obvod kmeňa 222 cm, výšku
22 m a priemer koruny 10 m. Druhá má obvod kmeňa 212 cm, výšku 21 m a priemer koruny 10 m. Oba stromy majú odhadovaný vek
150 rokov a pochádzajú zo Severnej Ameriky. Je to ojedinelý výskyt na území okresu. Rastú na cintoríne.

Ochrana borovíc je zastrešená aj v rámci chránených území (CHÚ):

Sielnický borovicový háj
Kategória: Chránený areál
Evidenčné číslo: 219
Rozloha: 5,58 ha
Stupeň ochrany: 4.
Kraj: Žilinský, Okres: Liptovský Mikuláš, Kataster: Liptovská Sielnica
Charakteristika: Areál bol vyhlásený za chránený v roku 1978 ako pamiatka na udalosti spojené s históriou slovenského národa a samotnej obce Liptovská Sielnica.

Borovicový lesík
Kategória: Chránený areál
Evidenčné číslo: 903
Rozloha: 0,8012 ha
Stupeň ochrany: 4.
Kraj: bratislavský, Okres: Bratislava I, Kataster: Staré Mesto
Charakteristika: Chránený areál bol vyhlásený roku 1982, a to z dôvodu zabezpečenia ochrany dubovo-hrabového lesa.

Obr. 3 Chránené borovice na Slovensku: A: Borovica v Zámockej záhrade v Hlohovci, B: Borovica Ľudmily Podjavorinskej:
Zdroje: Borovica lesná: https://gobohemia.cz/sk/body-zaujmu/275-borovica-lesna-chs
Monumental trees: https://www.monumentaltrees.com/en/svk/banskabystrica/zvolen/3428_sliackupele/6615/#google_vignette

2. ZÁVER

Rod borovica (*Pinus* sp.) zohráva na Slovensku významnú ekologickú, hospodársku i kultúrnu úlohu. Ako druhovo pestrá skupina ihličnatých drevín s vysokou ekologickou plasticitou sa borovice dokážu prispôsobiť rozličným stanovištným podmienkam, od suchých a degradovaných pôd až po horské subalpínske oblasti. Kým autochtónne druhy ako borovica lesná, limba či kosodrevina majú nezastupiteľné miesto v prirodzených lesných ekosystémoch, introdukované druhy ako borovica čierna či vejmutovka zohrali dôležitú úlohu pri rekultivácii a zalesňovaní menej priaznivých lokalít, čím rozšírili produkčný aj stabilizačný potenciál lesných porastov. Chránené stromy a územia dokumentujú snahu o zachovanie genetickej, ekologickej a historickej rozmanitosti tejto skupiny drevín.

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Preparement of nurses for providing treatment in care of patients with tracheostomy

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Abstract Tracheostomy is a relatively common procedure in today's medicine, although it always carries a great deal of risk. Nurses play an important role in the follow-up care of the tracheostomy patient. However, at present, we are still facing the fact that they are not sufficiently prepared to treat such patients. The aim of this study was to investigate the preparedness of nurses in OAIM and ICU in providing nursing care to tracheostomy patients. A semi-structured questionnaire of our own design was used to collect data and distribute online. The research sample consisted of 112 respondents (nurses), working in the OAIM or ICU department, who had encountered nursing care of a patient with tracheostomy by analysis and statistical processing. We found that nurses possess knowledge in the studied area in the range of 50-80%, where 50% is considered as the very low limit of satisfactory results.

Key words: Tracheostomy. Readiness of nurses. Nursing care. Department of anaesthesiology and intensive care medicine. Intensive care unit.

1. SPECIFIC CARE OF THE PATIENT WITH TRACHEOSTOMY

We consider patients with tracheostomy as bio-psycho-social beings, therefore the specific care of such a patient includes every aspect of him/her. Multidisciplinary teams are needed to improve patient care; members should be aware of all related aspects of care and potential complications associated with tracheostomy placement (Alsunaid et al., 2021). The author (Mahfoz, 2022) in his study states that in many regions of the world, tracheostomy care is a major health concern. Many patients die as a result of lack of nurses' awareness about tracheostomy care. The nurse needs to be able to recognize when a patient has a build-up of secretions in the airway, which may compromise its patency, and how they need to respond in such a case (Mussa et al., 2021). Humidification as one of the specifics of patient care prevents the airway from drying out, preventing the formation of thick secretions that dry on dry airway walls, cannulae, increasing the risk of choking (Birk et al., 2017).

The nurse and any other healthcare professional should also know how to communicate with the tracheostomy patient. Since a tracheostomy patient does not produce any voice or spoken word, we have to use alternatives to communicate with the patient. Just because the patient does not speak does not mean that they have no needs or requirements. We should always be patient with such a patient, reserve enough time for him/her to express what he/she needs or wants. He may try to show us, he may use non-verbal expressions, the nurse may try to read lips or use other methods of communication (Rose et al., 2021).

As stated by the authors (Avsar et al., 2024) the level of preparedness of nurses in providing nursing care is important in terms of patient safety and quality of care. Also, the authors (Huston et al., 2017) argue that if nurses are not prepared, it can lead to negative consequences for patient safety such as increased incidence of nursing errors and delayed patient recovery. It is critical to assess nurses' preparedness in providing nursing care and compare the findings with current nursing knowledge and competencies (Kim, Shin, 2022).

The patient with a tracheostomy feels fear, helplessness, and needs answers to questions, even though several studies show that tracheostomy patients can eat and drink through the mouth and not through a nasogastric or other probe. There are, of course, many factors to consider regarding a patient's candidacy for evaluation, such as patient care goals, level of alertness, medical stability, current diagnosis, past medical history, comorbidities, disease trajectory, vital signs, and overall clinical picture. Frequent questions are mainly regarding the pattern of food intake. We agree with all the areas mentioned. When providing specific care to tracheostomy patients on the wards, we mainly encounter communication barriers. Furthermore, the patient's fear and apprehension about following meals, which in some cases has developed into refusal of food and the need for parenteral nutrition to replenish the patient's nutrients, minerals and vitamins.

1.1 Oral hygiene

In patients with tracheostomy, regular oral hygiene is necessary to prevent leakage of secretions from the oral cavity over the obturator cuff of the cannula. Leakage of secretions can cause microaspiration and impair healing of the stomal area. Oral hygiene also prevents disease changes on teeth and gums, avoids infections that could spread to the stoma entrance area, drying and bad breath (Gmur et al., 2013). In their book (Bartunek et al., 2016), they state that oral care in UPV patients in anaesthesia-resuscitation units represents an elementary role in the prevention of pathological changes in the oral cavity and in the prevention of the development of infectious ventilator-associated pneumonia. Also, the authors (Ewan et al., 2015) argue that nursing care should include oral care to prevent the occurrence of aspiration ventilator pneumonia, which even today represents the most common nosocomial infection in patients admitted to intensive care units. The extent to which the risk of complications of artificial lung ventilation (ALV) will increase also depends on the attending staff. Knowledge of the correct oral care practices for patients on UPV by the attending staff is essential for the successful prevention of ventilator-associated pneumonia and the development of possible negative consequences on the course of hospitalization as well as the patient's overall health.

The authors (Sánchez et al., 2020) also state in their study that patients are at potential risk of developing pneumonia, with poor oral hygiene and due to bacterial colonization of the airways. In order to implement effective prevention, the link between oral health and pneumonia needs to be verified. The oral hygiene procedure is carried out in such a way that if the patient is conscious, he/she is familiarised with the procedure. The patient is placed in the correct sitting or Fowler's position. If the patient does not have a problem with upper limb mobility, we motivate and involve him in the procedure, thus promoting his independence. In an unconscious or UPV-connected patient, we change the position minimally. If necessary, we suction the patient's oral cavity before hygiene, thus getting rid of accumulated secretions from the mouth (Műller, Kováľová, 2015). The equipment we need for oral hygiene in a non-self-sufficient patient includes: oral blades covered with a mule that is firmly fixed, a pean with swabs, brushes with flavours, solution, an emersion tray, a cup with water, cellulose cotton wool, a towel or disposable pad, a flashlight, a suction cup, suction coils, protective equipment such as gloves, drapes, goggles, and a face shield (Vytejčková et al., 2013).

The same author describes the course of oral hygiene, which should be quick and gentle so as not to induce a gag reflex in the patient. Using a soft toothbrush, the nurse first gently cleans the tooth surfaces. Using moistened swabs or flavoured brushes, the patient's tongue is wiped from the root to the tip. The palate, upper and lower gums are then cleaned both externally and internally and finally the buccal mucosa is cleaned. We can use special brushes with holes which we attach to the suction cup and gently remove the plaque with it. Oral hygiene is performed in ventilated unconscious patients every 3-4 hours or as needed (Vytejčková, 2013). We know from our own experience that inadequate oral hygiene in a tracheostomy patient can endanger their health or their life.

1.2 Open and closed tracheostomy cannula suctioning

Nurses caring for tracheostomy patients must use their clinical judgement as well as evidence-based safe suctioning practice. Preparation, correct equipment and suction pressures, safe suctioning procedure and post-procedure assessment (Ireton, 2007). As such, suctioning is essential to maintain airway patency, to remove mucus and to prevent blockage of the tracheostomy cannula. Suctioning takes place at different time intervals and depends on several indications. Indications for suctioning include: audible or visual signs of secretions in the tube, signs of respiratory distress, suspected partially or completely blocked patency in the airway, desaturation, vomiting, changes in ventilation pressures in a ventilated patient, and in conscious patients there may be a verbal request for suctioning from the cannula (Májek, Török, 2022).

The authors also state that the goal of suctioning is to maximize removal of secretions from the airways while minimizing desaturation and tissue damage. Suctioning should only be performed if it is audible and visible that secretions are present in the airway or if obstruction is suspected (Boroughs and Dougherty, 2015; Mitchell et al., 2013). However, other reasons for suctioning are also included by the author (Mitchell et al., 2013) as reduced breath sounds or reduced oxygenation. The author (Watters, 2017, p. 813) argues that rather than relying on a set schedule, the need for suctioning should be tailored to the individual patient. Suctioning may be needed more frequently during infections or respiratory illnesses. When performing suctioning, authors (Boroughs, Dougherty, 2015; McClean, 2011) agree that rapid suctioning is safer and more effective. Therefore, they recommend twisting the suction coil between the thumb and index finger during insertion and removal to ensure maximal removal of secretions from all areas of the tracheal tube and also recommend a 5-second interval to prevent atelectasis and desaturations. This theory was confirmed by author McClean, who conducted a pilot study where he found that such suctioning actually removed a greater amount of secretions than when suctioning only when the suction coil was advanced or withdrawn. There are two separate techniques for suctioning, namely open and closed suction systems. Open system suctioning is performed with disposable sterile suction catheters with aseptic conditions being observed by inserting the catheter without active suctioning using a sterile instrument into the tracheostomy cannula to its end, then pulling it out 1 cm and starting suctioning while pulling out the suction catheter (Ministry of Health, 2021). In one of the authors' studies (Hlinková et al., 2013), they state that sufficient hand hygiene and the use of protective clothing should be performed before open suctioning of the patient.

Closed-system suctioning is accomplished by deploying the suction system in a protective package containing the suction catheter, introducing it to the end, pulling it up, and initiating suctioning while simultaneously withdrawing the catheter. After suctioning, the catheter is flushed with saline or sterile water, disconnected from the suction device, capped and replaced every 24-72 hours according to the manufacturer's recommendations (Ministry of Health of the Slovak Republic, 2021). There are many studies comparing these two suction systems. Especially in ventilated patients at risk of ventilator-associated pneumonia. One of them is a study by the authors (Elmansoury, Said, 2014) who in their study investigated whether there is a difference in the incidence of ventilator associated pneumonia with the use of an open suction system or a closed suction system. The conclusion of the study was that there was no difference in the incidence of ventilator-associated pneumonia between the two groups. The authors' studies (Seyed Hossein Ardehali et al., 2020, Denissa Faradita Aryania, Judith Tannerb, 2018) also found that there was no difference in the incidence of ventilator-associated pneumonia when using open or closed type of suction.

We know from our own experience that suctioning is an important aspect of oral hygiene and airway cleaning. Our suctioning habits of the patient are mainly based on visual or auscultatory cues, not on a time interval, so as not to irritate the patient unnecessarily with the suction coil. Closed suctioning is used more often in our department, as open suctioning has a higher risk of introducing infection into the

airway by sterilising the suction coil. We use a system that is replaced after 72 hours or as needed.

2. SURVEY

Working with patients who have a tracheostomy can be quite challenging. As nurses are largely involved in their care, they should be sufficiently theoretically prepared and practically skilled. It is for this reason that an empirical investigation was undertaken to find out how prepared hospital nurses are to provide nursing care to patients with tracheostomies.

2.1 Methodology, Set, Objectives

For data collection, we chose a semi-structured questionnaire of our own design, which was intended for nurses working in the OAIM or ICU . In our questionnaire, we used most of the closed-ended questions with a total of 22 questions for faster and clearer completion. For some questions we used Likert scale (agreement scale). The total number of respondents was 112. Our aim was to find out the knowledge of nurses about oral hygiene in tracheostomy patient with respect to education. Nurses with first degree education constituted the largest number of 40 (36%), followed by nurses with secondary education 36 (32%), then nurses with second degree education 32 (29%). Diploma nurses had the lowest representation in the research with a number of 4 representing 3% of the total number.

2.2 Results

Respondents were divided into two groups based on their response to a question about educational attainment. Nurses who had as their highest educational attainment a HND or diploma in nursing were placed in the first group. Nurses with a first, second or third degree were placed in the second group.

We compared the items related to the knowledge of oral hygiene in tracheostomy patient. One knowledge item was a 3-choice item, with only one of them being correct. For the second item, respondents were asked to answer using a 5-point scale. Since the numerosity of both groups is greater than 30, we used parametric Student's t-test and F-test for validation.

Table 1 Respondents' knowledge by highest educational attainment

Student's t-test	lower (high school)	higher (university)
Mean	0,95	1,24
Variance	0,41	0,44
F-test (p-value)	0,416	
Number	40	72
Test statistic	-2,22	
p-value	0,028	

Table 2 Transformation of items

Claim	Answers	Transformation
The oral hygiene procedure should be:	Quick	1 point
	other answers	0 point
Neglected oral hygiene poses a risk of developing aspiration ventilator-associated pneumonia.	5 - strongly agree 4 - rather agree	1 point
	other answers	0 point

From the results, we can see that the mean value is higher in the group of university-educated nurses. The first group consisted of 40 nurses with secondary and higher vocational education. These respondents answered 0.95 questions correctly on average. In the second group, there were 72 college-educated nurses. They answered correctly on average 1.24 questions. The variances are comparable: 0.41 in the first group, 0.44 in the second. Since the p-value of the F-test is 0.416, we used the t-test with equality of variances to compare the means.

The p-value of the t-test is 0.028. This value is below the significance level of 0.05. Therefore, we can conclude that nurses' knowledge about oral hygiene in tracheostomy patient varies according to educational attainment. Nurses with higher education demonstrated better knowledge than nurses with lower education.

2.3 Discussion

From the knowledge gained so far, we know that performing oral hygiene is one of the most important procedures in tracheostomy patients, whether analgosedated on artificial lung ventilation or conscious without oxygen therapy. As reported by (Vytejčková et al., 2015), it is important to maintain a healthy oral cavity in critically ill patients. The microbial flora is concentrated in dental plaque, which is also found on the tooth surface and forms a biofilm on which other microorganisms are very well trapped. Excessive accumulation of plaque and bacteria can cause colonization of the oropharynx, contributing to the development of chronic obstructive pulmonary disease, endocarditis, bacteremia, ventilator-associated pneumonia, and others. We used two statements in the questionnaire to obtain information about the preparedness of nurses in performing oral hygiene. First, we asked the respondents whether they knew what the oral hygiene procedure should be. Respondents were asked to state that it should be performed quickly so that prolonged performance would not provoke an irritating cough or gag reflex in the patient.

The option that it should be done quickly was indicated by 45 (40.18%) of the respondents, who thought that the performance has no time constraint was as high as 42 (37.5%) and the option that the performance should be done slowly was 25 (22.32%). Although it is evident that most of the correct answers were not even half but only 40.18% of the total 100% respondents, which we consider unsatisfactory. However, very similarly, nurses thought that performing oral hygiene is without time constraint. The next statement in the questionnaire we wanted to know whether nurses agree or disagree that neglected oral hygiene leads to a higher risk of developing ventilator assisted pneumonia (VAP). In this case, the nurses were asked to indicate their agreeing responses. The number of nurses who marked the strongly agree option was 54 (48.21%), the agree option was marked by 28 (25%), making a total of 73.21%. This figure shows us that more than half of the nurses know that there is such a risk in neglected oral hygiene. There were also nurses who disagreed with the statement. A total of 24 (21.43%) nurses marked disagree and 6 (5.36%) nurses marked don't know option. Our findings can be compared with the results of the authors' research (Alja'afreh et al., 2018), who also investigated the nurses' readiness in providing oral hygiene in tracheostomy patients.

However, their finding was that although nurses are knowledgeable enough to perform, many find it an unpleasant task. Our finding was also positive as more respondents answered each item correctly. Further investigation can be done to find out how nurses perceive this performance, whether they will show a positive attitude or it will be the same as in the research of the aforementioned authors. Also in the study of authors (Singh et al., 2022) focused on oral

hygiene in relation to the occurrence of VAP in which they found that nurses should know the correct evidence based oral hygiene practice. Based on the results of the study, they concluded that tooth brushing along with oral care provides an additional benefit in preventing VAP in patients on mechanical ventilation.

2.4 Conclusion

It is important that nurses directly involved in the postoperative care of tracheostomy patients can provide appropriate tracheostomy care, are aware of the potential complications associated with tracheostomy and are able to manage these complications, particularly in an immediate life-threatening situation. Unfortunately, the unavailability of standard tracheostomy management guidelines and inadequate staff training can make this essential practice much more difficult and frightening (Khanum et al., 2022). They demonstrated adequate levels of knowledge among healthcare professionals ranging from only 48% to 50% and revealed that there are still gaps in various aspects of tracheostomy care and management. Nurses with inadequate knowledge put the patient's health, their progress in treatment even their life at risk (Lewith, Athanassoglou, 2019).

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Detekcia zearalenónu v suchých krmivách pre psov

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Název grantu: Sledovanie účinku kŕmnych doplnkových látok prírodného pôvodu a alternatívnych kŕmnych komponentov na produkciu a zdravie monogastrických zvierat
Oborové zaměření: GH - Výživa hospodářských zvířat

Abstrakt Chov spoločenských zvierat by mal zahŕňať aj starostlivosť o ich zdravie. Jedným zo základných prvkov pre zachovanie dobrého zdravotného statusu zvierat je používanie kvalitných krmív. V súčasnej dobe sa globálnym problémom, v súvislosti s bezpečnosťou podávaných krmív, stáva výskyt mykotoxínov. Zearalenón je jedným z celosvetovo najrozšírenejších mykotoxínov. Táto práca bola zameraná na stanovenie zearalenónu v 14 vzorkách priemyselne vyrábaných krmivách pre dospelých psov. Zearalenón bol detegovaný v 4 vzorkách prémiových krmív v rozsahu koncentrácií od 21,799 µg/kg do 163,463 µg/kg. Je potrebné skonštatovať, že výsledné koncentrácie zearalenónu vo vzorkách krmív pre psov nepresahujú aktuálne platné smerodajné hladiny zearalenónu v krmivách pre spoločenské zvieratá uvedené v Odporúčaní Komisie (EÚ) 2016/1319.

Klíčová slova Krmivo, pes, zearalenón

1. ÚVOD

V súčasnosti bývajú spoločenské zvieratá (psy alebo iné spoločenské zvieratá) ich majiteľmi často definované ako členovia rodiny (Yang a kol., 2023). Je pozoruhodné, že v sérii štúdií bolo preukázané, že prítomnosť domácich zvierat počas života človeka prispieva k zníženiu srdcovej frekvencie, krvného tlaku, depresie a problémov s duševným zdravím, čo sa pripisuje pozitívnym interakciám medzi majiteľmi a spoločenskými zvieratami (Witaszak a kol., 2020). Vzhľadom na silný emocionálny vzťah medzi domácimi zvieratami a majiteľmi, majitelia venujú viac pozornosti zdraviu domácich zvierat (White a kol., 2016). Na zabezpečenie dobrého zdravotného stavu zvierat, sa okrem iných faktorov považuje za dôležité podávanie kvalitného a bezpečného krmiva pre domáce zvieratá (Grandi a kol., 2019).

Pre správne priemyselné spracovanie krmiva pre psov bývajú nevyhnutnou zložkou obilniny. Vo výžive psov sa používa niekoľko rôznych obilnín, ako je ryža, kukurica, pšenica, jačmeň a ovos, pretože sú dobrým a lacným zdrojom energie. Vo väčšine suchých krmív je podiel sacharidov zvyčajne 30 – 60 % (Kempe a kol., 2004). Vysoký podiel obilnín v priemyselne vyrábaných krmivách pre psov predstavuje potenciálne riziko výskytu mikroskopických vláknitých húb a ich sekundárnych metabolitov. Najvýznamnejšími patogénmi obilnín sú okrem iných mikroskopických húb, zástupcovia rodu *Fusarium*. Väčšina druhov fuzárií sú potenciálne toxinogénne, teda sú schopné syntézy mykotoxínov.

Zearalenón je jedným z najčastejšie sa vyskytujúcich sekundárnych metabolitov mikromycét rodu *Fusarium*. Produkuje ho niekoľko druhov mikroskopických vláknitých húb vrátane *F. graminearum, F. culmorum, F. cerealis* a *F. equiseti*. Tento nesteroidný estrogénový mykotoxín sa vyskytuje predovšetkým v kukurici, pšenici, ovse a v jačmeni. Jeho syntéza súvisí s nízkymi teplotami a vysokou vlhkosťou prostredia (Yazar a kol., 2008). Zearalenón je termostabilná zlúčenina, ktorá sa nerozkladá počas spracovania kŕmnych surovín a krmiva, a to ani pri vysokých teplotách (Thapa a kol., 2021). Sučky sú obzvlášť citlivé na estrogény a zvýšené koncentrácie endogénnych a/alebo exogénnych hormónov môžu tiež zvýšiť riziko iných systémových porúch (Gajecka a kol., 2015). Po vstupe do tela môže zearalenón spôsobiť akútnu vulvovaginitídu, poruchy estrálneho cyklu a zhoršenú plodnosť (Svoboda a kol., 2001). Účinky zearalenónu u väčšiny zvierat sú podobné účinkom, ktoré vznikajú po vystavení organizmu vysokým koncentráciám estrogénu, prejavujú sa neplodnosťou, abnormálnou laktáciou, mŕtvo narodenými plodmi, potratmi, mastitídou, vaginitídou a vaginálnym alebo rektálnym prolapsom (Bissoqui a kol., 2016).

Podľa EFSA (Európsky úrad pre bezpečnosť potravín) sa psy považujú za zvieratá citlivé na účinky zearalenónu. Na základe lézií myometria a endometria, zväčšenia alebo atrofie maternicových žliaz, hematologických a biochemických parametrov krvi, bola u

dospelých sučiek odhadnutá najnižšia pozorovaná hladina nežiaducich účinkov (LOAEL) na 25 µg/kg telesnej hmotnosti za deň (EFSA, 2017). Keďže prítomnosti zearalenónu v krmivách sa nedá úplne vyhnúť, v EÚ boli vypracované usmernenia pre smerodajné hladiny mykotoxínov v kŕmnych zmesiach pre rôzne zvieratá vrátane psov (Tabuľka 1) (Odporúčanie Komisie, 2016).

Tabuľka 1 Smerodajné hodnoty zearalenónu v kŕmnych zmesiach pre zvieratá

Mykotoxín	**Výrobky určené na kŕmenie zvierat**	**Smerodajná hodnota v µg/kg (ppb) krmiva v prepočte na 12 % obsah vlhkosti**
Zearalenón	Kŕmne zmesi pre: • odstavčatá a prasničky, šteňatá, mačiatka, psy a mačky na reprodukciu • dospelé psy a mačky, iné ako na reprodukciu • prasnice a ošípané na výkrm • teľatá, dojnice, ovce (vrátane jahniat), kozy (vrátanie kozliat)	100 200 250 500

Zdroj: Vlastná tabuľka, prepracované podľa Odporúčania Komisie (EÚ) 2016/1319 z 29. júla 2016, ktorým sa mení odporúčanie 2006/576/ES, pokiaľ ide o deoxynivalenol, zearalenón a ochratoxín A v krmive pre spoločenské zvieratá

Cieľom tejto práce bola detekcia a kvantitatívne stanovenie zearalenónu v 14 vzorkách suchého krmiva pre dospelé psy prostredníctvom imunoenzymatickej analýzy ELISA.

2. MATERIÁL A METODIKA

2.1 Vzorky

Celkovo bolo vyšetrených 14 vzoriek suchého krmiva pre psov vo forme granúl. Vzorky boli získané od rôznych komerčných a špecializovaných predajcov a boli určené na kŕmenie dospelých psov. Vzorky boli rozdelené do troch kategórií: generické, populárne a prémiové. Skupina generických krmív zahŕňala vzorky krmív, ktoré neboli označené názvom výrobcu a boli predávané lokálne alebo regionálne. Druhá kategória, tzv. populárne krmivá, zahŕňala vzorky krmív predávaných v sieťach obchodov s potravinami. Tretia kategória zahŕňala prémiové krmivá od špecializovaných predajcov.

2.2 Príprava vzoriek

Príprava vzoriek prebiehala podľa protokolu komerčnej súpravy Veratox for zearalenone (Neogen corporation, USA). Postup prípravy vzorky bol nasledovný: k 5 g zomletej vzorky sa pridal 70 % metanol v množstve 25 ml. Vzorky sa trepali 3 minúty na orbitálnej trepačke (Orbital Shaker – Biosan) a filtrovali sa cez filtračný papier Whatman 1. Filtráty sa zriedili destilovanou vodou v pomere 1:5. Na kvantitatívne stanovenie zearalenónu pomocou imunoanalýzy ELISA sa použilo 50 µl zriedených vzoriek.

2.3 ELISA analýza

Princíp analýzy ELISA v prípade vzoriek skúmaných na prítomnosť zearalenónu je založený na reakcii antigénu a protilátky. Štandardné roztoky, ktoré boli použité pri analýze obsahovali zearalenón v nasledujúcich koncentráciách: 0 ppb; 25 ppb; 75 ppb; 150 ppb a 500 ppb. Výsledné koncentrácie zearalenónu (ppb; µg/kg) boli odčítané pri absorbancii 650 nm a boli vyhodnotené pomocou ELISA čítačky (Dynex Technologies, Inc., Virginia, USA).

3. VÝSLEDKY

V tabuľke číslo 2 sú uvedené výsledky kvantitatívneho stanovenia zearalenónu vo vzorkách suchých krmív pre dospelých psov. Z uvedených výsledkov vyplýva, že v nami vyšetrených 2 vzorkách generických, 2 vzorkách populárnych krmív a 6 vzorkách prémiových krmív zearalenón nebol detegovaný, resp. koncentrácie boli pod detekčným limitom použitého testu (5 µg/kg). V 4 vzorkách prémiových krmív pre psov sa vyskytoval zearalenón v nasledovných koncentráciách: 21,799µg/kg; 69,187 µg/kg; 96,745 µg/kg a 163,463 µg/kg. Je ale dôležité poznamenať, že stanovené koncentrácie zearalenónu nepresahujú smerodajné hodnoty, ktoré sú uvedené v Odporúčaní Komisie 2016/1319 (Tabuľka 1).

Tabuľka 2 Stanovenie koncentrácií zearalenónu (µg/kg) vo vzorkách priemyselne vyrábaných krmív pre dospelých psov mimo reprodukcie

Typ krmiva pre psov	**Vzorky (n=14)**	**Koncentrácie zearalenónu**
generické	2	< 5 µg/kg
populárne	2	< 5 µg/kg
prémiové	6 4	< 5 µg/kg > 5 µg/kg

4. DISKUSIA

Zearalenón je mykoestrogén, ktorý je toxický pre samice aj samce (Stopa a kol., 2014). Podľa štúdie Boermansa a Leunga (2007), dávka ~1 mg/kg zearalenónu v krmive môže u spoločenských zvierat spôsobiť neplodnosť, negatívne ovplyvniť ovuláciu, implantáciu, graviditu a následne životaschopnosť mláďat. Okrem toho sa popisuje, že denný príjem nízkych dávok zearalenónu, by mohol postupne poškodiť zdravie psa a vyvolať zmeny v metabolických procesoch (Gajecka a kol., 2015; Witaszak a kol., 2020).

V nami vyšetrených vzorkách bol zearalenón detegovaný v 4 vzorkách prémiových krmív pre psov v rozsahu koncentrácií od 21.799 µg/kg do 163,463 µg/kg. Bissoqui a kol. (2016) skúmali 100 vzoriek suchého krmiva pre psov získaných z Brazílie a uviedli, že koncentrácia zearalenónu sa pohybovala od 5,45 µg/kg do 442,2 µg/kg a priemerná hodnota bola 49,2 µg/kg. Zearalenón bol prítomný aj vo všetkých prémiových krmivách (100 %) a v 88,2 % krmív zo supermarketov v Španielsku (Macías-Montes a kol., 2020). Podobná štúdia uvádza, že vo viac ako polovici (62,5 %, 25 z 32) komerčných krmív pre psov bol prítomný zearalenón s priemernou hodnotou 54,5 µg/kg. V rámci tejto štúdie bol zearalenón stanovený v maximálnej hodnote 389,2 µg/kg (Shao a kol., 2018). V 26 suchých krmivách pre psov zozbieraných z poľského trhu sa koncentrácie zearalenónu pohybovali od 0,3 do 30,3 µg/kg (Witaszak a kol., 2020). Okrem toho v ďalšom prieskume, ktorý vykonali Geicu a kol., (2020) sa ukázalo, že priemerná, minimálna a maximálna hodnota zearalenónu v 34 suchých krmív

pochádzajúcich z predajní v Rumunsku bola 90,89µg/kg; 0,0 µg/kg resp. 230,24 µg/kg (Geicu a kol., 2022).

Witaszak a kol., 2022 pripomínajú, že prítomnosť zearalenónu v krmivách pre psov v nízkych hladinách nevylučuje riziko zdravotných komplikácií a denné užívanie nízkych dávok zearalenónu by mohlo postupne narušiť zdravie psov (Witaszak a kol., 2020). Toto tvrdenie podporuje aj štúdia Gajecka a kol. 2004, ktorí zaznamenali zmeny v reprodukčnom systéme psov už po 7 dňoch pri denných dávkach 200µg/kg telesnej hmotnosti aúčinky na koncentrácie pohlavných hormónov v krvi po vystavení menším dávkam počas dlhšieho časového obdobiaµg/kg telesnej hmotnosti počas 42 dní). Vzhľadom na prítomnosť zearalenónu v našich vzorkách a vo vzorkách zo zahraničného výskumu by bolo potrebné pravidelné monitorovanie mykotoxínov v suchom krmive pre psov.

5. ZÁVER

Zachovanie a podpora dobrého zdravotného stavu spoločenských zvierat úzko súvisí aj s podávaním kvalitného a bezpečného krmiva. Skrytou hrozbou a potenciálnym rizikom narušenia zdravia býva prítomnosť sekundárnych metabolitov mikroskopických húb - mykotoxínov v krmivách. Mykotoxíny sú dlhodobo celosvetovým problémom a ich prítomnosti v krmivách sa nedá úplne zabrániť. Preto je potrebné vykonávanie monitoringu v súvislosti s ich výskytom nielen v procese tvorby krmív, ale aj počas skladovania.

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Vplyv rôznych koncentrácií humínových látok na mikrobiálnu populáciu črevného obsahu u brojlerových kurčiat

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Oborové zaměření: GH - Výživa hospodářských zvířat

Abstrakt Cieľom tejto štúdie bolo zhodnotenie vplyvu humínových látok na črevnú mikrobiotu na základe stanovenia počtu baktérií mliečneho kvasenia a enterobaktérií v obsahu slepých čriev brojlerových kurčiat. Deväťdesiat 1-dňových brojlerových kurčiat (hybrid Ross 308) bolo rozdelených do troch skupín. Humínové látky boli pridávané do kŕmnych zmesí pokusných skupín v množstve 6 alebo 9 g/kg v priebehu celého pokusného obdobia. Podávanie humínových látok vo vyššom množstve viedlo k signifikantnému zníženiu počtu enterobaktérií a pomeru počtu enetrobaktérií k počtu baktérií mliečneho kvasenia v obsahu slepých čriev v porovnaní s kontrolnou skupinou ($P < 0,05$). Na základe výsledkov tejto štúdie je možné konštatovať, že humínové látky sú schopné modulovať črevnú mikrobiotu v prospech hostiteľa.

Klíčová slova Hydina, prírodné kŕmne aditíva, črevná mikrobiota

1. ÚVOD

V posledných rokoch sa vo výskume v oblasti výživy hydiny zvýšil záujem o látky prírodného pôvodu, ktoré by boli vhodnou a bezpečnou alternatívou za antibiotické stimulátory rastu, keďže ukončením ich používania (v EÚ od roku 2006) sa zvýšil výskyt črevných problémov, ktoré negatívne ovplyvňujú úžitkovosť zvierat a ekonomiku chovu (Abd El-Hack a kol., 2022). Jednou z takýchto možných alternatív sú aj humínové látky vznikajúce degradáciou rastlinných a živočíšnych zvyškov. Sú to organické zlúčeniny, ktoré sa bežne vyskytujú v pôde, rašeline, lignite, hnedom uhlí, odpadových vodách, prírodných vodách a ich sedimentoch. Ich hlavnými zložkami sú humínové, fulvové a ulmové kyseliny (Stevenson 1994).

Existuje celý rad vedeckých publikácií, v ktorých sa popisuje možný pozitívny vplyv podávania humínových látok na produkčné parametre u hydiny (Abdel-Mageed 2012, Taklimi a kol. 2012, Mirnawati a Marlida 2013, Marcinčáková a kol. 2015, Arif a kol. 2016, ELnaggar a El-Kelawy 2018, Hammod a kol. 2021). Okrem zvýšenia intenzity rastu zvierat, zlepšenia konverzie krmiva, zvýšenia jatočnej výťažnosti bolo zaznamenané aj zníženie mortality. Na objasnenie pozorovaného pozitívneho vplyvu podávania humínových látok bolo navrhnutých niekoľko mechanizmov účinku, zahrňujúc inhibíciu rastu patogénnych baktérii a stabilizáciu črevnej mikroflóry (Agboola a kol. 2021, Omidiwura a kol. 2022). Z výsledkov rôznych štúdií však vyplýva, že účinok humínových látok môže byť variabilný v závislosti od ich zloženia a podávaného množstva, ako aj od spôsobu ich aplikácie (do krmiva alebo do vody) alebo druhu použitých zvierat.

Keďže ovplyvnenie črevného zdravia je jednou z možností ovplyvnenia celkového zdravotného stavu a následne zlepšenia produkcie zvierat, cieľom tejto štúdie bolo zhodnotenie prípadných zmien v počtoch baktérií mliečneho kvasenia a enterobaktérií v obsahu slepých čriev brojlerových kurčiat po prídavku humínových látok (HUMAC MycotoxiSorb) v rôznej koncentrácii do krmiva.

2. MATERIÁL A METODIKA

Do 6-týždňového pokusu bolo zaradených 90 kusov nesexovaných jednodňových brojlerových kurčiat úžitkového hybridu Ross 308, ktoré boli náhodne rozdelené do troch skupín (kontrolnej a dvoch pokusných; n = 30). Vo všetkých skupinách boli kurčatá individuálne odvážené a označené identifikačným krúžkom.

Ustajnené boli na hlbokej podstielke pri dodržaní štandardných podmienok prostredia (s kontrolovanou teplotou a vlhkosťou).

Kurčatá boli v priebehu pokusu kŕmené komerčne vyrábanými kompletnými kŕmnymi zmesami (Tomáš spol. s r. o., Dolná Ždaňa, Slovenská republika) na báze pšenice, sójového extrahované šrotu, kukurice a repkového extrahovaného šrotu podľa rastových fáz: štartérová 1. – 2. týždeň, rastová 3. – 5. týždeň, finálna 6. týždeň. V pokusných skupinách boli k uvedeným kŕmnym zmesiam pridané humínové látky (HUMAC MycotoxiSorb; Humac s.r.o, Košice, Slovensko; veľkosť častíc do 200 µm, pH 5,8; vlhkosť max. 21 %, humínové kyseliny min. 65 % a fulvové kyseliny 5 % v sušine): v skupine H1 v množstve 6 g/kg a v skupine H2 v množstve 9 g/kg. Príjem krmiva a napájanie bolo počas celého pokusu zabezpečené *ad libitum*. Chemická analýza kŕmnych zmesí bola vykonaná analytickými metódami podľa Nariadenia komisie (ES) č. 152/2009. Analyzovaný obsah živín v kŕmnych zmesiach je uvedený v Tabuľkách 1a-c.

Tabuľka 1a. Analyzovaný obsah živín v kŕmnych zmesiach - Štartérová

	K	H1	H2
sušina (g/kg KZ)	885,2	884,9	887,7
NL (g/kg S)	229,6	229,0	226,1
HT (g/kg S)	20,3	19,3	19,0
HV (g/kg S)	44,7	42,0	40,1
popol (g/kg S)	53,9	55,5	67,5
ME (MJ/kg S)	12,4	12,3	12,2

Tabuľka 1b. Analyzovaný obsah živín v kŕmnych zmesiach - Rastová

	K	H1	H2
sušina (g/kg KZ)	886,3	886,5	888,4
NL (g/kg S)	217,8	217,5	214,2
HT (g/kg S)	21,6	23,7	22,4
HV (g/kg S)	56,5	46,7	51,6
popol (g/kg S)	62,7	63,6	70,5
ME (MJ/kg S)	12,6	12,6	12,6

Tabuľka 1c. Analyzovaný obsah živín v kŕmnych zmesiach - Finálna

	K	H1	H2
sušina (g/kg KZ)	885,8	883,6	882,9
NL (g/kg S)	197,3	190,1	182,8
HT (g/kg S)	25,4	24,8	23,6
HV (g/kg S)	50,7	49,1	51,5
popol (g/kg S)	59,0	66,3	70,4
ME (MJ/kg S)	13,1	13,0	13,0

K – kontrolná skupina; H1 – pokusná skupina s prídavkom humínových látok v množstve 6 g/kg; H2 – pokusná skupina s prídavkom humínových látok v množstve 9 g/kg; KZ – kŕmna zmes; S – sušina; NL – dusíkaté látky; HT – hrubý tuk; HV – hrubá vláknina; ME - Metabolizovateľná energia.

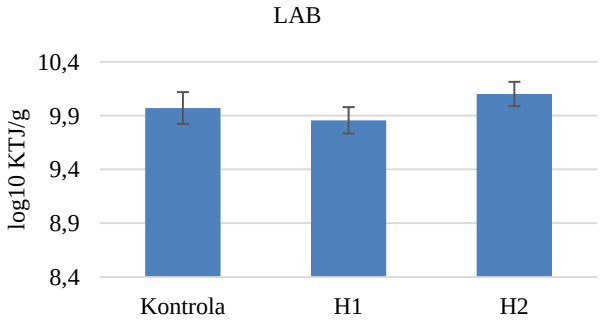
Na konci pokusu (na 42. deň) bolo z každej skupiny náhodne vybraných šesť kurčiat, od ktorých po omráčení, usmrtení a jatočnom opracovaní boli odobrané slepé črevá. Počty baktérií mliečneho kvasenia (LAB) a enterobaktérií (ENT) v obsahu slepých čriev boli stanovené platňovou metódou. Pre stanovenie počtu LAB bol použitý MRS agar (Biolife, Taliansko) a pre stanovenie počtu ENT bol použitý MacConkey agar (HiMedia, India). Z jednotlivých slepých čriev bol odobratý 1 g obsahu, ktorý bol nariedený 9 ml fyziologického roztoku (Mikrochem, Slovensko) a dôkladne homogenizovaný použitím stomachera (IUL, Instruments, Spain). Následne boli zhomogenizované vzorky riedené decimálnym riedením fyziologickým roztokom a očkované na príslušné agary v množstve 100 µl. Pripravené platne boli vložené do termostatu a kultivované pri 37 °C: MRS agar bol kultivovaný po dobu 48 hodín v anaeróbnom prostredí a MacConkey agar bol kultivovaný po dobu 24 hodín v aeróbnom prostredí. Počty baktérií sú vyjadrené ako logaritmus kolónie tvoriacich jednotiek na gram obsahu (log10KTJ/g).

Získané výsledky boli vyhodnotené štatisticky použitím jednocestnej ANOVY (Tukey`s multiple comparison test). Výsledky sú prezentované ako priemer ± štandardná chyba priemeru (SEM).

3. VÝSLEDKY A DISKUSIA

Baktérie mliečneho kvasenia ako aj enterobaktérie sú skupinami baktérií, ktoré sú prirodzenou súčasťou črevného mikrobiómu. Kým baktérie mliečneho kvasenia predstavujú prospešnú mikrobiotu, medzi enterobaktérie patria aj patogénne druhy, ktoré spôsobujú infekcie gastrointestinálneho traktu. Mikrobiologickým vyšetrením obsahu slepých čriev sme zistili, že prídavok humínových látok do kŕmnych zmesí brojlerových kurčiat nemal významný vplyv na počty baktérií mliečneho kvasenia ($P > 0,05$; Graf 1.). No podávanie humínových látok vo vyššom množstve (9 g/kg; skupina H2) viedlo k signifikantnému zníženiu počtu enterobaktérií v porovnaní s kontrolnou skupinou ($P = 0,024$; Graf. 2). Zníženie počtu enterobaktérií v obsahu slepých čriev v porovnaní s kontrolnou skupinou bolo zaznamenané aj v pokusnej skupine s prídavkom humínových látok v nižšom množstve (6 g/kg, skupina H1), no rozdiel nebol štatisticky významný ($P > 0,05$). Zároveň bol zistený štatisticky významný lineárny trend zníženia počtu enterobaktérií ($P = 0,009$). So zvyšujúcou sa koncentráciou humínových látok v krmive sa lineárne znížil počet enterobaktérií v obsahu slepých čriev brojlerových kurčiat.

Graf 1. Vplyv suplementácie kŕmnych zmesí humínovými látkami na počet baktérií mliečneho kvasenia (LAB) v obsahu slepých čriev brojlerových kurčiat

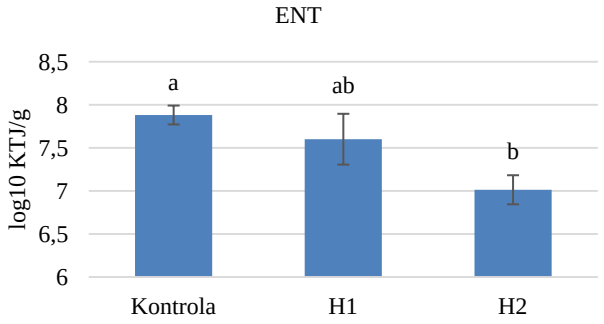


H1 – pokusná skupina s prídavkom humínových látok v množstve 6 g/kg; H2 – pokusná skupina s prídavkom humínových látok v množstve 9 g/kg.

Napriek nesignifikantným zmenám v obsahu baktérií mliečneho kvasenia, bol v pokusnej skupine H2 v dôsledku signifikantného zníženia počtu enterobaktérií zaznamenaný aj signifikantne nižší pomer enteribaktérií k baktériám mliečneho kvasenia v porovnaní s kontrolnou skupinou ($P = 0,048$; Graf 3.), čo poukazuje na nárast prospešnej črevnej mikrobioty v tejto pokusnej skupine. Podobný

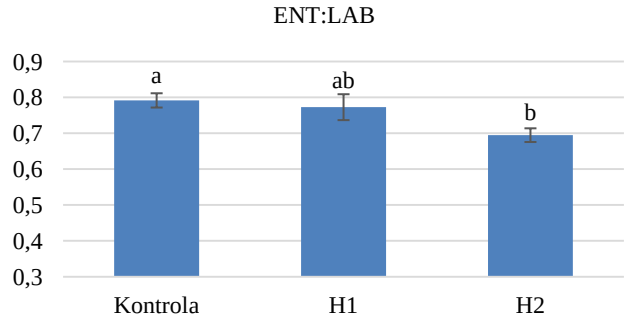
trend bol pozorovaný aj v pokusnej skupine H1, ale rozdiel oproti kontrolnej skupine nebol štatisticky preukazný.

Graf 2. Vplyv suplementácie kŕmnych zmesí humínovými látkami na počet enterobaktérií (ENT) v obsahu slepých čriev brojlerových kurčiat



H1 – pokusná skupina s prídavkom humínových látok v množstve 6 g/kg; H2 – pokusná skupina s prídavkom humínových látok v množstve 9 g/kg.
[ab] Rozdielné označenie stĺpcov vyjadruje štatisticku významnosť (P < 0,05).

Graf 3. Vplyv suplementácie kŕmnych zmesí humínovými látkami na pomer počtu enterobaktérií (ENT) k počtu baktérií mliečneho kvasenia (LAB) v obsahu slepých čriev brojlerových kurčiat



H1 – pokusná skupina s prídavkom humínových látok v množstve 6 g/kg; H2 – pokusná skupina s prídavkom humínových látok v množstve 9 g/kg.
[ab] Rozdielné označenie stĺpcov vyjadruje štatisticku významnosť (P < 0,05).

Signifikantné zníženie počtu enterobektérii a signifikantné zníženie pomeru enteribaktérií k baktériám mliečneho kvasenia v obsahu slepých čriev bolo zaznamenané aj u brojlerových kurčiat, ktoré prijímali kŕmne zmesi s obsahom humínových látok v 0,8 % koncentrácii (Mudroňová a kol. 2020). Podobne, významné zníženie počtu koliformných baktérií a E. coli v črevnom obsahu vplyvom skrmovania humínových látok bolo zistené aj u japonských prepelíc (Abdel-Mageed 2012), u Sasso kurčiat (ELnaggar a El-Kelawy 2018) a u králikov (Abdl Razek Mohmed Mohmed a kol. 2020). El-Kelawy a kol. (2024), ktorí sa venovali štúdiu humínových kyselín, okrem významného zníženia počtu E. coli v črevnom obsahu brojlerových kurčiat prijímajúcich diéty s obsahom humínových kyselín (v množstve 1 a 2 g/kg) zaznamenali aj signifikantné zvýšenie počtu laktobacilov.

4. ZÁVER

Tento experiment potvrdil, že podávanie humínových látok (HUMAC MycotoxiSorb) dokáže potlačiť rast enterobaktérií, signifikantne pri podávaní vo vyššom množstve (9g/kg). Na základe výsledkov tejto štúdie je možné konštatovať, že humínové látky sú schopné modulovať črevnú mikrobiotu v prospech hostiteľa prostredníctvom zníženia počtu škodlivých baktérií a tak prispieť k zabezpečeniu dobrého zdravotného stavu a prípadne k následnému zlepšeniu produkcie zvierat.

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Výskyt a etiológia mastitíd dojníc a ich vplyv na reprodukčné ukazovatele

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Abstrakt Cieľom práce bolo vyhodnotiť výskyt a etiológiu mastitíd a ich vplyv na reprodukčné ukazovatele dojníc. V sledovaní bolo 112 ks dojníc, 10 dní po otelení s anamnézou zvýšeného počtu somatických buniek s pozitívnym NK-testom. U dojníc sa vykonalo vyšetrenie mliečnej žľazy s následným NK-testom a mikrobiologickým vyšetrením vzoriek mlieka s pozitívnym výsledkom u 50 dojníc (43%) pri subklinickej forme u 25 dojníc a klinickej rovnako u 25 dojníc. V pozitívnych vzorkách boli najviac prítomné baktérie *S. aureus*, koaguláza-negatívne stafylokoky (*S. xylosus* a *S. chromogenes*), *Aerococcus viridans* a *E. coli*. V porovnaní s optimálnymi hodnotami reprodukčných ukazovateľov, výsledky preukázali neuspokojivé reprodukčné hodnoty u dojníc s klinickou mastitídou.

Klíčová slova klinická mastitída, subklinická mastitída, medziobdobie, inseminačný interval, inseminačný index, servis perióda

1. ÚVOD

Ekonomická hodnota dojníc je určená predovšetkým dojivosťou, ako aj počtom laktácií počas ich produkčného obdobia. Produkčné ochorenia, predovšetkým mastitídy, patria medzi dôležité faktory ovplyvňujúce množstvo a kvalitu vyprodukovaného mlieka (Vršková et al., 2015). Na vzniku infekčných mastitíd sa podieľajú viaceré druhy mikroorganizmov. Až v 90% väčšinou ide o bakteriálne infekcie, v menšom počte prípadov o infekcie inými organizmami, ako sú vírusy, huby, kvasinky, parazity a iné. Počet druhov bakteriálnych pôvodcov mastitíd dojníc, uvádzaný v literatúre je veľký a zrejme doteraz neuzatvorený. Podľa Sharifa et al. (2009) medzi hlavné kontagiózne bakteriálne patogénny spôsobujúce mastitídy patria *S. aureus, Streptococcus agalactiae* a *Streptococcus uberis.*

Z enviromentálnych patogénov sa najčastejšie vyskytujú *Streptococcus disagalactiae, E. coli* a *Klebsiela.* Medzi ďalšie enviromentálne patogény bežne sa nachádzajúcimi na koži mliečnej žľazy patria koagulázo-negatívne stafylokoky (KNS) predovšetkým *Staphylococcus chromogenes, Staphylococcus simulans, Staphylococcus xylosus, Staphylococcus haemolyticus, Staphylococcus warneri* a *Staphylococcus epidermidis* (Pyörälä a Taponen, 2009). Mastitída spôsobená týmito patogénmi má často mierny priebeh, avšak pri ich dlhodobom pôsobení dochádza k značným ekonomickým stratám v dôsledku zníženej dojivosti alebo prekročenia stanoveného limitu počtu somatických buniek (PSB) a celkového počtu mikroorganizmov (CPM). Je veľmi dôležité, že všetky patogény vemena sa dostávajú do mlieka a sú ním vylučované, nie však vždy a v rovnakých množstvách. To záleží od mnohých okolností, napr. od intenzity ochorenia, jeho formy a dĺžky trvania, odolnosti makroorganizmu a pod.

Reprodukčné parametre u dojníc sú kľúčovým faktorom pre producentov mlieka a zhoršená reprodukcia je jednou z príčin zníženia efektivity výroby v mliekarenskom priemysle. Kľúčový ukazovateľ plodnosti stáda dojníc je teľnosť. Celkovú reprodukčnú výkonnosť chovu môžeme sledovať z rôznych aspektov a za poruchu reprodukcie môžeme považovať, ak nie sú dosiahnuté parametre, ktoré si chovateľ s ohľadom na plemeno, úžitkovosť a výživu stanovil. Pre jednoduché a rýchle posúdenie výsledkov riadenia plodnosti stáda sa využívajú reprodukčné ukazovatele. Medzi najdôležitejšie ukazovatele plodnosti kráv patria: vek pri prvom otelení, servis perióda, dĺžka gravidity, medziobdobie.

Cieľom práce bolo vyhodnotiť výskyt a etiológiu mastitíd a ich vplyv na reprodukčné ukazovatele dojníc.

2. MATERIÁL A METODIKA

Vyšetrovaný chov sa špecializuje na produkciu mlieka a nachádza sa v Trenčianskom kraji. Na farme sa chová 472 ks hovädzieho dobytka (prevažne Holštajnského typu), pričom 191 ks tvoria dojnice. Do štúdie sme zaradili dojnice, ktoré boli 10 dní po otelení, s anamnézou intramamárnej infekcie v predchádzajúcej laktácii. Išlo predovšetkým o dojnice, ktoré posledné tri mesiace pred zasušením vykazovali pozitívny NK-test a zvýšenú hodnotu PSB. Po prvotnej anamnéze boli dojnice klinicky vyšetrené. Mlieko z každej štvrte vemena bolo podrobené senzorickému vyšetreniu. NK-test (nepriamy diagnostický test, Krause, Dánsko) sa vykonával na všetkých štvrtiach dojených kráv. Následne bol vykonaný aseptický odber 12 ml mlieka zo všetkých štvrtí na laboratórne analýzy bakteriálnych patogénov. Vzorky boli ochladené na 4 °C a ihneď transportované do laboratória a analyzované nasledujúci deň.

Bakteriologické vyšetrenie bolo prevedené podľa metodiky Malinowski a Kłossowska (2006) s identifikáciou *Staphylococcus* spp., *Streptococcus* spp. *a Enterobacteriaceae* spp. pomocou STAPHY-testu, STREPTO-testu resp. ENTERO-testu a identifikované pomocou softwaru TNW Pro 7.0 (Erba-Lachema, CZ)(Zigo et al., 2018).
Nasledujúce parametre ako inseminačný interval, inseminačný index, medziobdobie, servis perióda a dĺžka laktácie boli získané z databáz daného chovu.

3. VÝSLEDKY A DISKUSIA

V tabuľke č. 1 sú uvedené výsledky hodnotenia vzoriek mlieka NK-testom a mikrobiologického vyšetrenia. Z celkového počtu 448 štvrťových vzoriek mlieka posudzovaných NK-testom bolo 67 pozitívnych. Z 112 zmiešaných vzoriek mlieka dojníc bolo 50 pozitívnych mikrobiologických nálezov, 25 pozitívnych nálezov pri subklinickej forme mastitídy a 25 pri klinickej forme (Graf 1) Pri subklinickej forme mastitídy boli identifikované patogény: *Aerococcus viridans*, *Staphylococcus xylosus*, *Staphylococcus aureus*, *Staphylococcus chromogenes* a *Staphylococcus warneri*. Pri klinickej forme *Staphylococcus aureus*, *Staphylococcus chromogenes*, *Aerocosus viridans*, *Staphylococcus xylosus* a *Escherichia coli.*

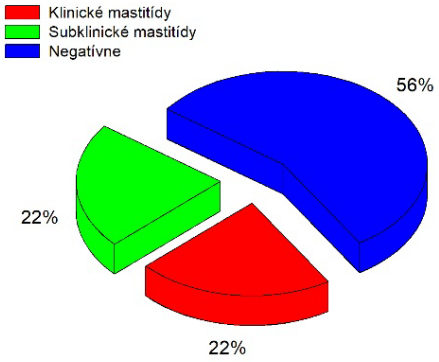
Viacerí autori vo svojich štúdiách zaznamenali, že *Staphylococcus* spp. patria medzi najčastejších pôvodcov intramamárnych infekcií u prežúvavcov (*Staphylococcus aureus* pri klinických formách a KNS pri subklinických). Z KNS je najčastejší pôvodca *Staphylococcus epidermidis*. Nie menej dôležitými bakteriálnymi patogénmi sú *Corynebacterium* spp., *Enterococcus* spp. a *Micrococcus* spp. (Bergonier et al., 2003; Berthelot et al., 2006). Fínsky autori uvádzajú, že až 50% izolovaných patogénnych baktérií tvoria KNS (Pitkälä et al. 2004). Druhými najčastejšie izolovanými patogénmi sú podľa Tenhagena et al. (2009) *Streptococcus* spp. (12,6%). Tento záver koreluje s výsledkami identifikácie izolátov (n = 1631) získaných z mliečnych fariem vo Francúzsku (Botrel et al. 2010), pričom 75 zástupcom s najvyššou prevalenciou bol *Streptococcus dysgalactiae*. Podľa De Vlieghera et al. (2012) je najčastejším pôvodcom bovinných environmentálnych mastitíd *Streptococcus uberis*.

Výsledky hodnotenia chovu dojníc na základe reprodukčných parametrov a výsledkov mikrobiologického vyšetrenia vzoriek sú uvedené v Tabuľke 2. Zo sledovaných reprodukčných ukazovateľov malo nevyhovujúce hodnoty 26 dojníc (23%) pri dĺžke inseminačného intervalu, 46 dojníc (41%) pri hodnote inseminačného indexu, 13 dojníc (12%) pri dĺžke servis periódy, 12 dojníc (11%) pri dĺžke medziobdobia a 26 dojníc (23%) pri dobe laktácie. Pri dojniciach s nevyhovujúcou hodnotou reprodukčného parametra bol zaznamenaný výskyt SKM (subklinická mastitída) a KM (klinická mastitída) v rôznom počte. Z 26 dojníc s nevyhovujúcou dĺžkou inseminačného intervalu bola zaznamenaná u 2 dojníc SKM (8%) a 4 KM (15%). Pri nevyhovujúcich hodnotách inseminačného indexu sme zaznamenali výskyt 7 SKM (15%) a 6 KM (13%), pri servis perióde 4 SKM (31%) a 3 KM (23%), pri medziobdobí 1 SKM (8%) a 1 KM (8%). Dĺžka laktácie bola ovplyvnená pri dojniciach s 4 SKM (15%) a 7 KM (27%).
Plodnosť je dôležitým faktorom pre rentabilitu chovu plemien so zameraním mliekovú, ale aj kombinovanú úžitkovosť. Analýza ukazovateľov reprodukcie je pomerne zložitá, pretože ich fenotypová premenlivosť je vzhľadom na veľké množstvo faktorov ovplyvňujúcich plodnosť veľmi veľká. Hodnotenie dĺžky medziobdobia je výberovým kritériom pre plodnosť. Dĺžku medziobdobia podmieňuje: inseminačný interval, servis perióda a dĺžka teľnosti. Medziobdobie úzko súvisí s priemerným laktačným dňom v stáde, ktorý má veľký vplyv na produkciu mlieka a tiež určuje rýchlosť obnovy stáda, tzn., koľko teliat sa narodí ročne. So zvyšujúcim sa medziobdobím stúpa počet dojníc vyradených zo stáda z dôvodu reprodukčných problémov. Hradecká et al. (2004) zistili pri hodnotení faktorov na ukazovatele reprodukcie u kráv má štatistický preukazný vplyv rok a mesiac otelenia, stádo, vek pri prvom otelení a plemeno. Bujko a Rybanská (2004) uvádzajú, že pri hodnotení produkčných a reprodukčných ukazovateľov v populácií kráv slovenského strakatého plemena má významný vplyv stádo, rok a mesiac otelenia. Kumar et al. (2017) a Dolecheck et al. (2019) poukázali na to, že mastitída počas obdobia rozmnožovania má negatívny vplyv na reprodukčnú schopnosť. Kravy s mastitídou majú oneskorenú ruje, zníženú graviditu a zvýšené riziko potratu. Systémová imunitná odpoveď a endokrinné zmeny spojené s mastitídou môžu tiež narušiť vývoj folikulov, funkciu oocytov a schopnosť ovulácie, čím ďalej zhoršujú plodnosť(Boujenane et al., 2015). Mastitída spôsobuje u kráv predĺženie intervalu ruje a zníženie luteálnej fázy, čo narúša udržanie gravidity a ovplyvňuje embryonálny vývoj (Edelhoff et al. 2020).

Tabuľka č. 1, Prehľad výsledkov NK-testu a mikrobiologického vyšetrenia

Odber	n	Výsledok NK-testu		Mikrobiologické vyšetrenie	
		Negatívny	Pozitívny	Negatívne	Pozitívne
1	56	190 (85%)	34 (15%)	21 (38%)	35 (62%)
2	26	95 (91%)	9 (9%)	15 (58%)	11 (42%)
3	30	96 (80%)	24 (20%)	26 (87%)	4 (13%)
SPOLU	**112**	**381 (85%)**	**67 (15%)**	**62 (55%)**	**50 (45%)**

Poznámka: n – počet vzoriek



Graf č.1 Percentuálne zastúpenie klinickej a subklinickej mastitídy v chove

Tab. č. 2, Hodnotenie chovu dojníc na základe reprodukčných parametrov a mikrobiologického vyšetrenia vzoriek mlieka

Parameter	Hodnota reprodukčného parametra		Dojnice s nevyhovujúcou hodnotou reprodukčného parametra		
	V [ks/%]	N [ks/%]	SKM [ks/%]	KM [ks/%]	Neg. [ks/%]
Inseminačný interval (55-80 dní)	86 ks (77%)	26 ks (23%)	2 ks (8%)	4 ks (15%)	20 ks (77%)
Inseminačný index (1,2-2)	66 ks (59%)	46 ks (41%)	7 ks (15%)	6 ks (13%)	33 ks (72%)
Servis perióda (60 -110 dní)	99 ks (88%)	13 ks (12%)	4 ks (31%)	3 ks (23%)	6 ks (46%)

Medziobdobie (365-400 dní)	46ks (41%)	12 ks (11%)	1 ks (8%)	1 ks (8%)	10 ks (84%)
Doba laktácie (240-305 dní)	86 ks (77%)	26 ks (23%)	4 ks (15%)	7 ks (27%)	15 ks (58%)

Poznámka: V – vyhovujúca, N – nevyhovujúca, SKM – subklinická mastitída, KM – klinická mastitída

4. ZÁVER

V zmiešaných vzorkách mlieka boli zistené pri oboch formách mastitídy baktérie *Staphylococcus aureus*, koaguláza-negatívne stafylokoky (*Staphylococcus xylosus* a *Staphylococcus chromogenes*), *Aerococcus viridans* a *Escherichia coli*. V porovnaní s optimálnymi hodnotami reprodukčných ukazovateľov, výsledky preukázali neuspokojivé reprodukčné hodnoty predovšetkým u dojníc s klinickou formou mastitídy.

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Vplyv nutričných faktorov na obsah močoviny v mlieku dojníc

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Abstrakt Cieľom práce bolo hodnotiť vplyv výživy na obsah močoviny v mlieku dojníc. Analyzovaný obsah živín v kŕmnej dávke zodpovedal potrebe dojníc pre produkciu mlieka na úrovni 39,4 ± 1,4 kg/d, pričom kolísanie zložiek mlieka a obsahu močoviny v mlieku poukazuje na rôzny obsah živín a genetický potenciál zvierat. U dojníc v 1. fáze laktácie bola potvrdená pozitívna regresná závislosť (R^2 = 0,982; P < 0,001) medzi koncentráciou močoviny v mlieku a obsahom dusíkatých látok v kŕmnej dávke a negatívna regresná závislosť (R^2 = 0,229; P < 0,05) medzi koncentráciou močoviny v mlieku a obsahom nevláknitých sacharidov a obsahom škrobu v kŕmnej dávke dojníc (R^2 = 0,339; P < 0,05).

Klíčová slova Výživa, hrubý proteín, energia, močovina v mlieku

1. ÚVOD

Bachorovo degradovateľné bielkoviny z kŕmnej dávky (KD) po vstupe do bachora sú degradované na amoniak, ktorý predstavuje hlavný zdroj dusíka (N) na syntézu mikrobiálnej bielkoviny v bachore (Karsli a Russel, 2001). Syntéza mikrobiálnej bielkoviny v bachore závisí aj od sacharidov ako zdroja energie pre baktérie (Rodríguez a kol., 2007).

Škrob ako hlavná energetická zložka v obilninách predstavuje primárny zdroj glukogénnej energie pre vysoko produkčné dojnice, slúžiaci ako fermentovateľný substrát pre bachorové mikroorganizmy a syntézu mikrobiálnej bielkoviny. Pri jeho nedostatku v KD obsah amoniaku v bachore stúpa, v pečeni dochádza k jeho transformácií na močovinu s následným vylučovaním von z tela močom, slinami a vzhľadom nato, že ide o malú molekulu rýchlo prestupuje bunkovými membránami a pri sekrécií mlieka prechádza do mliečnej žľazy úmerne s koncentráciou močoviny v krvi (Koenig a kol. 2003; Roy a kol., 2011).

Hodnotenie močoviny v mlieku (Milk urea - MU) predstavuje vhodný nástroj hodnotenia efektívnosti využitia bielkovín z kŕmnej dávky u dojníc. Obsah MU je ovplyvnený viacerými faktormi. Medzi nutričné faktory, ktoré majú zásadný vplyv na koncentráciu MU patria dusíkaté látky (NL), bachorovo degradovateľné (BDB) a bachorovo nedegradovateľné bielkoviny (BNB), pomer energia:bielkoviny a obsah škrobu a nevláknitých sacharidov (NVS) v kŕmnej dávke (Godden a kol., 2001).

Okrem nutričných faktorov, ktoré v najväčšej miere ovplyvňujú obsah MU je tento obsah podľa Arunvipas a kol. (2003) na 13,3 % ovplyvnený nenutričnými faktormi (plemeno, poradie laktácie, štádium laktácie, sezóna) a podľa Hojman a kol. (2004) na 37 % produkčnými faktormi (produkcia a zložky mlieka). Cieľom práce bolo hodnotiť vplyv výživy na obsah MU dojníc.

2. MATERIÁL A METODIKA

2.1 Rozdelenie stáda dojníc

Práca bola realizovaná na slovenskej farme v období od Januára 2018 do Decembra 2018 u dojníc Holsteinského plemena (n=180) v 1. fáze laktácie (laktačné dni 75 ± 26) s hmotnosťou 650 kg.

2.2 Zloženie a analýza TMR

Kŕmne dávky boli formované z kukuričnej, ďatelinovej a trávnej siláže doplnené o jadrovú zložku, ktorej základom bola kukurica, pšenica, jačmeň, ovos, sójový a repkový extrahovaný šrot. Analýza obsahu živín v žľabových vzorkách zmesných kŕmnych dávok (TMR) bola vykonaná v mesačných intervaloch so stanovením obsahu dusíkatých látok (NL), neutrálne detergentnej vlákniny (NDV) a škrobu konvenčnými metódami (Nariadenie komisie ES č. 152/2009). Dusíkaté látky boli analyzované Kjeldahlovou metódou N x 6,25 pomocou prístroja Kjeltec analyzátor 2300 (Foss Tecator AB, Hoganas, Švédsko). NDV bola stanovená pomocou prístroja Dosi-Fibre Analyzer (JP Selecta, Španielsko) a škrob bol stanovený polarimetrickou metódou. Nevláknité sacharidy (NVS) boli vypočítané rovnicami podľa analyzovaného obsahu živín v krmivách (NRC, 2021).

2.3 Produkčné parametre a utilizácia živín

Dojnice boli dojené dva krát denne a analýzou individuálne odobratých vzoriek mlieka raz mesačne bol hodnotený obsah zložiek mlieka a MU v Centrálnom analytickom laboratóriu mlieka (s akreditáciou podľa normy ISO/IEC 17025:2005) v spolupráci s Plemenárskou službou Slovenskej republiky využitím Plemenárskeho informačného systému. Obsah bielkovín, tuku, laktózy a koncentrácia MU boli analyzované metódou infračervenej spektroskopie s Fourierovou transformáciou na prístroji MilkoScan FT+ (Foss Electric, Hillerød, Dánsk) a Bentley FTS (Bentley Instruments Inc., Chaska, USA). Hodnotenie efektívnosti transformácie N (ETN) bola vypočítané s uplatnením regresnej rovnice (Huhtanen a kol., 2015) podľa analyzovaného obsahu močoviny v mlieku a produkcie mlieka. Emisia amoniaku bola odhadnutá pomocou modelu regresnej rovnice Burgosa a kol. (2010) podľa analyzovaného obsahu močovinového dusíka (MUN).

2.4 Štatistická analýza

Výsledky boli spracované pomocou štatistického programu SPSS Statistical software version 24.0 (IBM Corp., Armonk, NY, USA) a vyjadrené ako priemer ($\bar{x}$), smerodajná odchýlka (SD), minimálna a maximálna hodnota. V práci bola použitá jednoduchá lineárna závislosť na hodnotenie vzťahov medzi obsahom živín v TMR a MU u dojníc v 1. fáze laktácie.

3. VÝSLEDKY

3.1 Nutričné zloženie TMR

Analyzovaný obsah živín TMR u dojníc v 1. fáze laktácie je sumarizovaný v tabuľke č. 1. Analýzou nutričného zloženia TMR bol zistený obsah NL na úrovni 16 % v suš., čo predstavuje vhodné množstvo NL pre dojnice v 1.fáze laktácie (NRC, 2021), pričom analyzovaný obsah škrobu na úrovni 25 % v suš. predstavoval nízku koncentráciu pre zabezpečenie vysokej produkcie mlieka v 1. fáze laktácie.

Tabuľka č. 1, Analyzovaný obsah živín TMR dojníc v 1. fáze laktácie (% v suš.)

Nutričné zloženie	$\bar{x}$	SD	Min	Max
NL % v suš.	16,0	0,2	15,4	16,2
NDV % v suš.	34,2	1,1	31,3	35,3
Škrob % v suš.	25,0	0,8	24,0	26,1
NVS % v suš.	38,2	1,0	37,0	40,7
NVS:NL	2,4	0,1	2,3	2,6

NL - dusíkaté látky; NDV - neutrálne detergentná vláknina; NVS - nevláknité sacharidy; TMR - zmesná kŕmna dávka;

3.2 Hodnotenie produkcie, zložiek mlieka a obsahu močoviny v mlieku dojníc v 1. fáze laktácie

Produkcia, zastúpenie zložiek mlieka a obsah MU u dojníc v 1. fáze laktácie sú v priemerných hodnotách sumarizované v tabuľke č. 2. Priemerná produkcia mlieka bola 39,4 ± 1,4 kg/d (rozsah 36,6 – 40,8), čo zodpovedá produkcii dojníc v 1. fáze laktácie. Dojnice v 1. fáze laktácie dosahovali priemerný laktačný deň 75 ± 26, čomu zodpovedá aj analyzovaný obsah živín v TMR. Kolísanie zložiek mlieka a obsah MU poukazuje na rôzny obsah živín a genetický potenciál zvierat.

Tabuľka č. 2, Produkcia, zložky mlieka a obsah močoviny v mlieku dojníc v 1. fáze laktácie

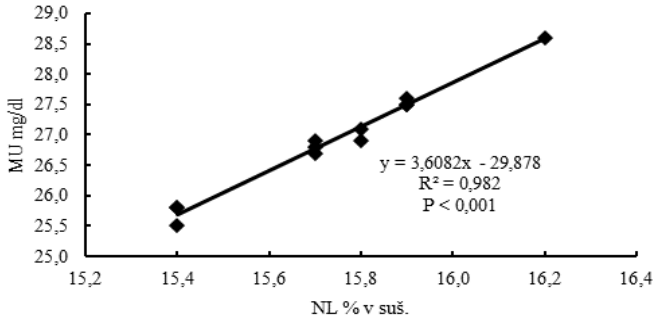
	$\bar{x}$	SD	Min	Max
Pôdoj kg/d	39,4	1,4	36,6	40,8
MU mg/dl	26,9	0,9	25,5	28,6
Tuk %	3,4	0,2	2,9	3,8
Bielkoviny %	3,0	0,1	2,9	3,3
Laktóza %	4,9	0,0	4,8	4,9
ETN %	31,5	1,8	31,1	31,6
Emisia NH_3 g/d	88,12	30,0	84,86	92,15

MU - močovina v mlieku; d - deň; ETN – efektívnosť transformácie dusíka

3.3 Hodnotenie vzťahov medzi koncentráciou MU a obsahom živín v TMR

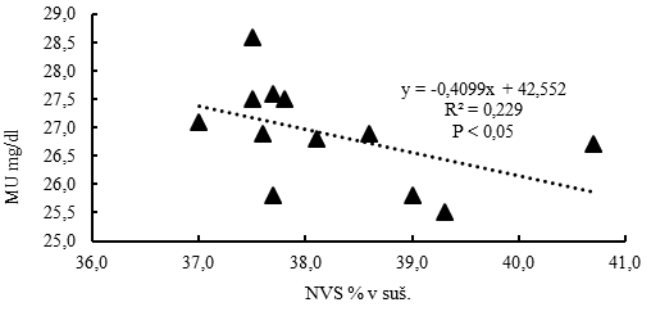
Hodnotením vzťahu medzi koncentráciou MU a obsahom NL (graf č.1) v TMR sme pomocou lineárnej regresnej závislosti potvrdili štatisticky významný (P < 0,001) pozitívny vzťah (R^2 = 0,9825), kedy so stúpajúcim obsahom NL v TMR stúpala aj koncentrácia močoviny v mlieku.

Graf č. 1, Regresná závislosť medzi MU (mg/dl) a obsahom NL v TMR (% v suš)



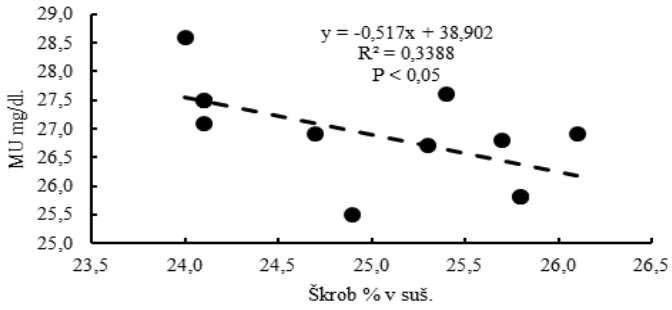
Hodnotením vzťahu medzi koncentráciou MU a obsahom NVS v TMR (graf č. 2) sme pomocou lineárnej regresnej závislosti potvrdili štatisticky významný (P < 0,05) negatívny vzťah, kedy so stúpajúcim obsahom NVS (R^2 = 0,229) v TMR klesala koncentrácia močoviny v mlieku.

Graf č. 2, Regresná závislosť medzi MU (mg/dl) a obsahom NVS v TMR (% v suš.)



Hodnotením vzťahu medzi koncentráciou MU a obsahom škrobu v TMR (graf č. 3) sme pomocou lineárnej regresnej závislosti potvrdili štatisticky významný (P < 0,05) negatívny vzťah, kedy so stúpajúcim obsahom škrobu (R^2 = 0,339) v TMR klesala koncentrácia močoviny v mlieku.

Graf č. 3, Regresná závislosť medzi MU (mg/dl) a obsahom škrobu v TMR (% v suš)



4. DISKUSIA

Správna výživa a úprava nutričných disbalancií v kŕmnych dávkach vysoko produkčných dojníc napomáha efektívnemu využitiu bielkovín z kŕmnej dávky, čo má za následok zníženie strát N do vonkajšieho prostredia.

Medzi nutričné faktory, ktoré v najväčšej miere ovplyvňujú koncentráciu MU patrí obsah NL a energie v TMR. Hodnotením vzťahu medzi obsahom MU a NL sme potvrdili pozitívnu závislosť (R^2= 0,982 ; P < 0,001), kedy so stúpajúcim obsahom NL v TMR stúpal aj obsah MU u dojníc. Koncentrácia MU stúpa pri zvýšenom príjme NL a nedostatočnom príjme sacharidov v TMR alebo nevhodnej skladbe aminokyselín (De Peters a Ferguson, 1992; Jonker a kol., 1998). Naše závery sa zhodujú s výsledkami Godden a kol. (2001) a Nousiainen a kol. (2004), ktorí tento vzťah vysvetľujú ako najdôležitejší nutričný faktor ovplyvňujúci obsah MU. Zvýšené hodnoty močoviny v mlieku môžu byť príznakom neefektívneho využitia bielkovín, čo má za následok jednak ekonomické straty (vysoké náklady na bielkovinové krmivá), environmentálne dôsledky najmä v podobe zvýšeného vylučovania N do životného prostredia (moč, výkaly), čo môže prispievať k eutrofizácii vôd a znečisťovaniu ovzdušia (emisie amoniaku) ale aj dopad na zdravie zvierat (imunita a reprodukcia) (Weiner a kol. 2014).

Naopak, vzťah medzi koncentráciou MU a obsahom NVS a škrobu v TMR bol potvrdený negatívnou regresnou závislosťou (R^2= 0,229; R^2= 0,339), kedy so stúpajúcim obsahom NVS a škrobu v TMR koncentrácia MU klesala (P < 0,05; P < 0,05). V experimentálnych podmienkach Hojman a kol. (2004) potvrdili vzťah medzi MU a obsahom energie v TMR tiež ako negatívny (P < 0,01). Tento vzťah poukazuje na nerovnováhu medzi pomerom energie:bielkovín v KD, kedy pri nedostatočnom príjme bielkovín a prekrmovaní energiou dochádza k nízkej produkcii amoniaku v bachore pre rast mikrobiálnej bielkoviny. Úprava nerovnováhy medzi obsahom bielkovín a energie v kŕmnej dávke môže podporiť zvýšenú efektívnosť využitia N a zníženie jeho strát s následným negatívnym vplyvom na životné prostredie (VandeHaar a St-Pierre, 2004).

Vysoký príjem dusíka spôsobuje kumuláciu amoniaku v bachore s vyššou produkciou močoviny v pečeni (Reynolds a Kristensen, 2008), čo zvyšuje obsah močoviny v krvi a mlieku a priamo súvisí so zvýšeným vylučovaním močovinového dusíka v moči a znižuje využitie dusíka na mliečnu bielkovinu (Recktenwald a kol., 2014). Tento proces je priamo ovplyvnený obsahom NL a pomerom škrobu k NL v kŕmnej dávke. Emisia amoniaku závisí od vylučovania dusíka močom. Vylučovaný dusík v moči je vyšší vo forme močovinového dusíka v moči, ktorý sa pri kontakte s ureázou rýchlo mení na amoniak a plynný amoniak (Burgos a kol., 2007), ktorý je potenciálnym zdrojom kontaminácie životného prostredia a vôd.

5. ZÁVER

Výživa dojníc zohráva kľúčovú úlohu v regulácii hladiny močoviny v mlieku, ktorá predstavuje významný bio indikátor dusíkovej rovnováhy v organizme zvieraťa. Správne vyváženie pomeru medzi bielkovinami a fermentovateľnou energiou v TMR je základným predpokladom efektívneho využitia dusíka v bachore. Analýza obsahu močoviny v mlieku je cenným nástrojom v rukách chovateľa, výživára či veterinára, ktorý umožňuje rýchlo a neinvazívne vyhodnotiť stav dusíkovej bilancie zvierat a optimalizovať výživu dojníc tak, aby bola zabezpečená vysoká produktivita, dobré zdravie zvierat a zároveň minimalizované environmentálne dopady chovu. S rastúcim dôrazom na udržateľnosť a efektivitu živočíšnej výroby je kontrola močoviny v mlieku jedným z dôležitých nástrojov pre moderné a zodpovedné riadenie mliečnych fariem.

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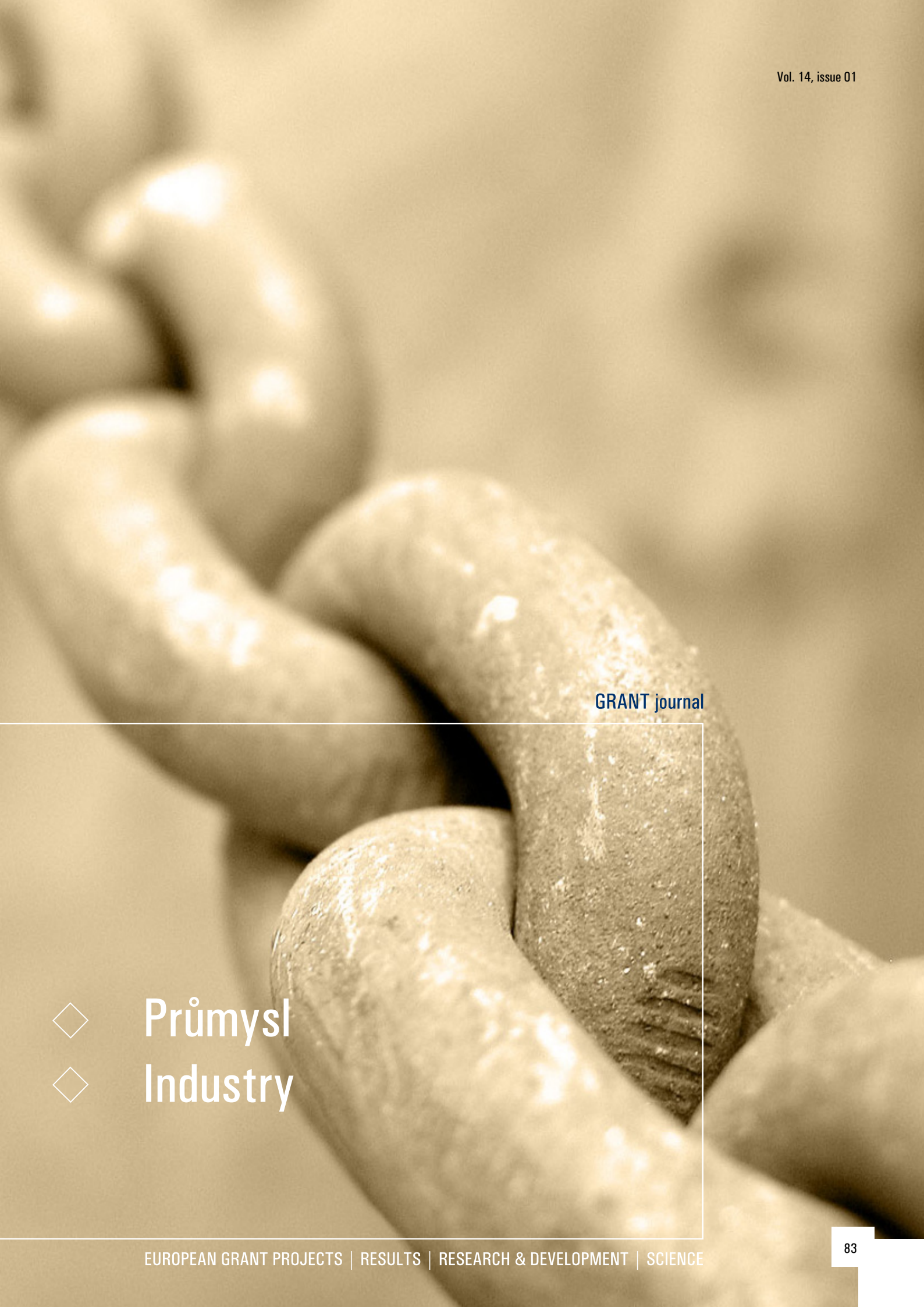

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Decreasing the Oil Temperature in the Hydraulic Circuits by Using the Removable Finned Cooler

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Abstract The paper is focused on the research of decreasing the oil temperature in the hydraulic circuit by the finned cooler. The experimental setup is used to investigate the oil temperature and the surface temperature of the hydraulic pipe at the inlet and outlet of the cooler. The data are compared with respect to the hydraulic circuit without the cooler used. In addition, the influence of the oil pump on and off on the temperatures is evaluated. The finned surface of the cooler ensured a decrease in oil temperature at the cooler outlet of 3.65 °C and 4.24 °C with the pump on (at 5 minutes) and with the pump off (at 10 minutes). With the pump off and not circulating oil in the circuit, the significance of the cooler was most pronounced. The distribution of temperature fields obtained by numerical simulation confirmed the advantageous importance of the demountable fin cooler for the experimental hydraulic circuit. Finned cooler providing enhanced heat dissipation and thus the hydraulic oil is protected from degradation. The design of the fin cooler enables simple installation without shutting down the hydraulic circuit.

Keywords Cooler, hydraulic pipe, heat, oil, temperature

1. INTRODUCTION

Hydraulic pipes are components of hydraulic circuits used e.g. in the fields of engineering, agriculture, waste management, forestry and transport technology, construction industry [1]. In order to handle heavy loads or to compress material, a closed hydraulic circuit is used in which hydraulic oil flows through a pressure pump [2]. The oil coolers in the assembly keep the hydraulic oil within the required temperature range, as the pressure and viscosity of the oil depend on the operating temperature [3, 4]. The oil cooling is an important part of hydraulic systems to ensure their correct operation and failure-free operation. Keeping the oil within operating temperature range has a positive impact on the life of the hydraulic oil and hydraulic circuit components, reducing maintenance and repair expenses, reducing downtimes [5]. Oil coolers are also used in high-performance internal combustion engines, where the oil absorbs the heat generated by the piston movement in the cylinder and dissipates it through the manifold and cooler to the ambient environment. Here the engine oil performs the function of heat dissipation, friction reduction, abrasion reduction, detergency, sealing of critical parts necessary for correct operation of the engine [6].
The two basic methods of cooling oil coolers are cooling by air and water, which allow the thermal energy to be dissipated into a secondary medium, usually air or liquid [7, 8]. In the air-cooling process, the inflow of cold air cools the hot walls of the cooler core. The advantage of this method is the simplicity of maintenance ensuring low operating costs, but the main disadvantage is that the cooling performance is significantly affected by the change in ambient temperature. Water-cooled systems use a hot and cold medium separated by a wall to dissipate heat. Here, higher cooling efficiency is assured because air temperature changes have negligible effect on cooling performance. A water-cooled cooler consists of a series of finned tubes through which the hot medium flows [9, 10]. The coolant absorbs heat from the oil and transfers it from the cooler to the ambient environment.

External finned coolers are most commonly used to heat transfer from the hot medium to the ambient air. Several researchers have investigated the intensification of heat transfer to the ambient environment through finned surfaces. By increasing the external heat exchange surface area, more intensive heat transfer from the heated surface to the ambient air can be achieved [11, 12]. For the mentioned method of heat dissipation by conduction, convection and radiation, it is also important to investigate the geometrical parameters and materials of finned coolers [13, 14]. The effect of fin thickness, spacing and height on the thermos-hydraulic properties of the enlarged heat exchange surfaces has been discussed in the literatures [15, 16].

In the case of machines and equipment, the hydraulic oil is overheating despite the oil cooler mounted in the hydraulic circuit. Overheating occurs especially in the summer months and in closed systems, as well as with high loads on machines and equipment, which is why the application of a supplementary demountable cooler is reasonable. Currently commonly used additional coolers

for hydraulic pipes work on the principle of an insertion between the two ends of the pipes, which brings several negatives. It is necessary to shut down the machine or equipment for the installation of such coolers and also to deal with some leaks. The demountable finned cooler designed and investigated in this paper solves these negatives, whereby the number of heat exchange segments can be added or removed as necessary depending on the dimensional capabilities of the machines and equipment. Also, the size adaptability of the cooler in terms of adjusting the internal diameter of the clamp provides the possibility of use for different diameters of hydraulic pipes. In the presented paper, a disassembled cooler is designed and investigated in terms of the oil temperatures at the inlet and outlet of the cooler, and the surface temperatures of the hydraulic hose. The hydraulic circuit with and without the cooler installed is compared. Simulations of the temperature fields are presented to compare the heat conduction in the materials when six segments and one segment of the cooler are used.

2. MATERIAL AND METHODS

The hydraulic circuit was designed and constructed for the realization of experimental measurements (Fig. 1). The heated oil circulated through the hydraulic pipe (1) and was cooled by a demountable finned cooler (2), which consisted of six segments of heat exchange surfaces. The oil temperature at the inlet and outlet of the cooler was measured by NTC temperature sensors ZA 9040-FS (3, 4) connected to the Almemo 2590 value logger. The measuring range of the resistance temperature sensors was -50 °C to 125 °C with measurement accuracy ±0.01 °C. The cooled oil flowed into the oil tank (5) and recirculated by means of a driven hydraulic pump (7) through the oil filter (6) and cooler (2). The fluid in the hydraulic circuit is continuously heated to the operating temperature during the operation of the machine or equipment, which is variable depending on the load. The optimum operating temperature of hydraulic oil used in construction machinery ranges from 40°C to 70 °C. The most suitable operating temperature is 50 °C. When hydraulic oil is heated above 90 °C, the negative hygroscopic properties of the oil increase significantly, causing degradation [17].

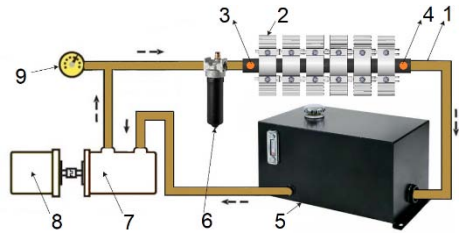

Figure 1 Experimental hydraulic circuit with installed demountable cooler. 1 – hydraulic pipe, 2 – demountable cooler, 3 – oil temperature sensor and pipe surface temperature sensor at the inlet to the cooler, 4 – oil temperature sensor and pipe surface temperature sensor at the cooler outlet, 5 – oil tank, 6 – oil filter, 7 – hydraulic pump, 8 – hydraulic pump drive, 9 – pressure gauge, arrows represent the direction of oil flow.

The pipe surface temperature at the inlet and outlet of the cooler T_{sin}, T_{sout} was measured by NiCr-Ni FTA 8068 contact temperature sensors, which have fixing clamps with springs in order to fix the sensor to the pipe. The oil temperature at the inlet and outlet of the cooler T_{oin}, T_{oout}. The oil temperature at the inlet and outlet of the cooler was measured by NTC ZA9040 resistive temperature sensors mounted directly in the pipe (Fig. 1). The sensors were connected to the Almemo 2590 value logger. The contact surfaces of the pipe and the cooler were coated with a copper-based thermally conductive paste with a thermal conductivity of 3.1 W/(m.K). The hydraulic pipe material was EPDM (ethylene propylene diene monomer) with a thermal conductivity of 0.29 W/(m.K) and the cooler was aluminium with a thermal conductivity of 237 W/(m.K). The 60 W hydraulic pump achieved a suction capacity of 3 l/min at an operating temperature of 40 °C to 70 °C. The Wika 7075643 pressure gauge was used to measure the operating pressure in the system. Type HL32 oil with a density of 875 kg/m^3 was circulated in the hydraulic pipe.

The demountable finned cooler is composed of an upper finned flange (2) and a lower flange (4) which encloses the outer wall of the hydraulic pipe (1). For the research, six segments were used for heat removal from the pipe (Fig. 2). The flanges are joined with the allen screws (3) to form a clamping joint. The individual segments are joined by means of pins with counter-nuts (5) into which brass connecting pins (6) are inserted. The number of cooler segments can be varied depending on the length of the hydraulic pipe. The hot hydraulic oil (A) flows through the hydraulic hose (1) and out of the partially cooled hydraulic hose (B) towards the oil tank and pump.

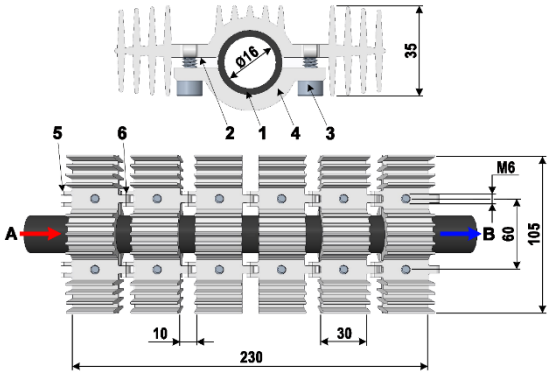

Figure 2 The basic dimensions and design of a demountable cooler. 1 – hydraulic pipe, 2 – upper finned flange, 3 – allen screw, 4 – lower flange, 5 – hinge, 6 – connecting pin, A – oil inlet, B – oil outlet.

In the machines and equipment mentioned above, the negative is the limited mounting space around the individual components. The hydraulic pipes are generally not only straight, but are mostly curved and turned at different angles. In the case of metal tubes, it is a direct attachment to the machine skeleton. This led to the design of a continuously adjustable cooler composed of the required number of cooling segments, given the location and difficulty of installation (Fig. 2). The rotation of the group of segments provided by means of pins with housings and coupling pins. This design also allows the pipe to change its length during the operation due to temperature changes.

3. RESULTS

The course of temperatures measured on the pipe surface at the inlet and outlet of the cooler when the hydraulic pump is switched on is shown in Fig. 3. The measurement points were identical with and without the cooler installed on the pipe. Subsequently, it was possible to compare and evaluate the effect of the additional cooler on the cooling efficiency. The cooling time was 5 minutes and the cooler reduced the outlet temperature by 1.7 °C compared to the state without cooler. In the starting cooling time from 0 to 1 minute, the highest efficiency of the installed cooler can be observed (difference of 5.3 °C to 8.3 °C at the outlet compared to the uninstalled cooler).

The oil temperature measured directly in the hydraulic line was recorded with the pump on for 5 minutes and subsequently from 5 to 10 minutes with the pump off (Fig. 4). The pump shutdown is also evident from the temperature courses at the inlet and outlet of the T_{oin}, T_{oout} cooler, where temperatures dropped in steps over a period of 5 minutes. Also, from the courses in Fig. 4, a positive effect of the installed cooler can be observed, by which the heat dissipation from the hydraulic line was increased, as evidenced by the lower oil temperatures at the outlet of the cooler T_{oout}. The installed cooler ensured a reduction in T_{oout} of 3.65 °C and 4.24 °C in a time of 5 minutes and 10 minutes with the pump on and pump off, respectively. When the pump is switched off and the oil is not circulating, the temperature differences between the installed cooler and the cooler without it are higher due to oil stagnation in the cooler area, which results in a more intensive heat dissipation through the cooler to the ambient environment. This condition commonly occurs in practice when the hydraulic control valve does not allow oil under pressure from the hydraulic pump and the required cylinder movement is counteracted by drag from the working environment (e.g. digger arms, hydraulic arms). The significance of the additional cooler is also evident from the T_{oin} values, as the circulation of the cooled oil in the hydraulic circuit causes a gradual decrease in the inlet temperature of the cooler. The cooler ensured a T_{oin} reduction of 3.42 °C and 3.27 °C in 5 minutes with the pump on and 10 minutes with the pump off. This has a positive effect on the long-term and more load-intensive operation of machines and equipment operating with hydraulic circuits.

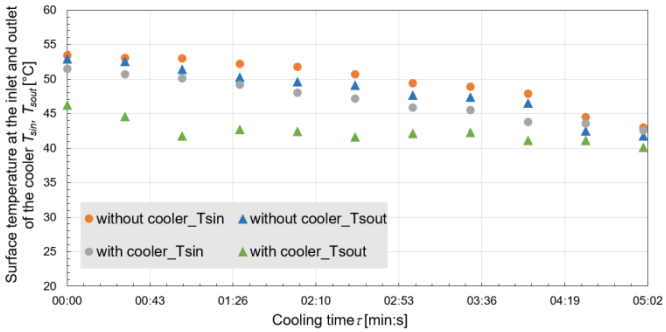

Figure 3 The pipe surface temperatures at the inlet and outlet of the cooler with the pump switched on.

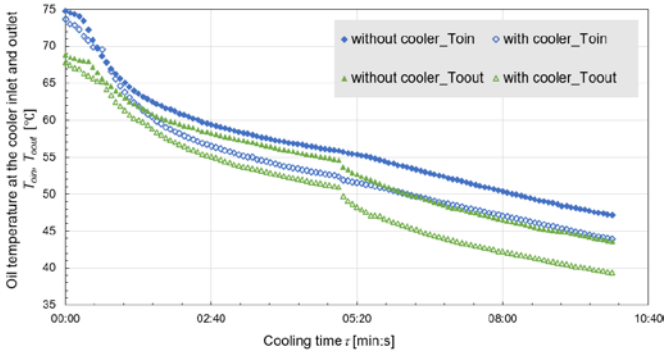

Figure 4 The course of oil temperatures at the inlet and outlet of the cooler.

Fig. 5, 6 shows the courses of the oil temperature differences ΔT at the inlet and outlet of the cooler, firstly when the pump is switched on for 5 minutes and then when the pump is switched off between 5 and 10 minutes. When the pump was switched on, it caused a gradual decrease in temperature differences (Fig. 5) and when it was switched off, the temperature differences increased and gradually stabilized (Fig. 6). Higher temperature differences between the inlet and outlet in this application indicate higher heat dissipation by the cooler. The significance of the installed cooler with the pump switched on became more pronounced from time 2:15, when a number of oil circulations in the hydraulic circuit had already occurred, thus gradually decreasing the temperature of the oil also at the inlet to the cooler. The difference between the ΔT values was 0.23 °C at the time of 5 minutes with the pump on.

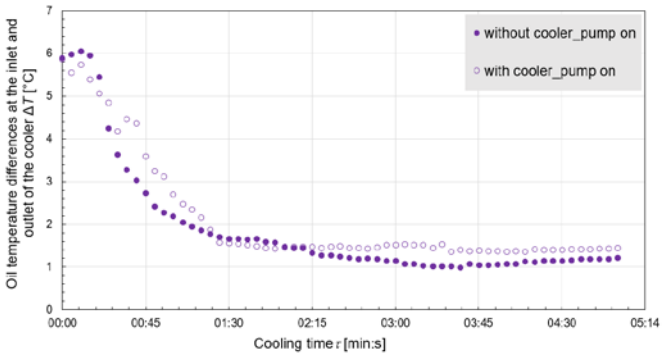

Figure 5 The course of the oil temperature differences at the inlet and outlet of the cooler with the pump switched on.

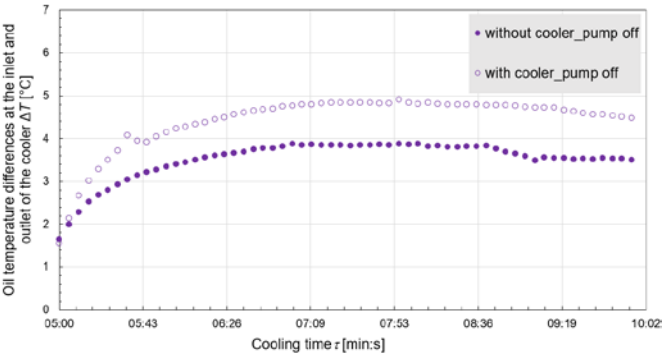

Figure 6 The course of the oil temperature differences at the inlet and outlet of the cooler with the pump switched off.

By switching off the pump, the temperature differences increased significantly and it was the importance of the installed cooler that became most pronounced here. At 10 minutes, the difference between the ΔT values was 0.98 °C and the installed cooler caused higher temperature differences, which means more intensive heat dissipation. From 06:30 onwards, the differences between ΔT values were of approximately the same range from 0.90 °C to 1.24 °C. In the case of the machine and equipment connected to the hydraulic circuit, the heat from the oil is dissipated more effectively through the cooler to the ambient environment.

The temperature distribution on the surface of the top and bottom flanges of the demountable cooler was solved numerically with Creo Simulate 7.0.1.0 (Fig. 7, 8). For the numerical simulations, the condition without the pump used was assumed for the maximum load of commonly used hydraulic circuits in practice, when the highest temperature of 70 °C is reached (overheating condition). Steady State Thermal Analysis was used for the computation. The Single-Pass Adaptive convergence criteria were setup using the Analysis Definition data form. The cooler was of Aluminium alloy (Al-Cu 2014) with a thermal conductivity of 192.163 W/(m.K) and a specific heat capacity of 9.63753e+08 J/(kg.K). The surface of the cooler was heat loaded to Q = 5,000 W with a surface temperature of 70 °C and a bulk temperature of 25 °C. The heat transfer coefficient on the horizontal surfaces and vertical surfaces was set to 25 and 50 W/(m^2.K), respectively.

From the distribution of the temperature fields of the six segments of the cooler, a gradual decrease of the temperatures in the z-axis direction can be observed, because in this direction the oil flow in

the hydraulic pipe (Fig. 7). The temperature gradient between the first and sixth segments was 10 °C at the centre fins of the top flanges. The condition is simulated after the oil supply is shut off by the hydraulic manifold, when the additional cooler enables the temperature of the hydraulic oil in the pipe to be decreased. There was also a gradual heat transfer in the x-axis direction by conduction in the material up to the lateral fins of the individual segments. The lateral fins ranged in temperature from 50.90 °C to 42.71 °C. As the temperature of the oil in the hydraulic manifold gradually decreased due to cooling, the surface temperature on the lower flanges of the individual segments also gradually decreased from a maximum temperature of 70.00 °C to 42.71 °C.

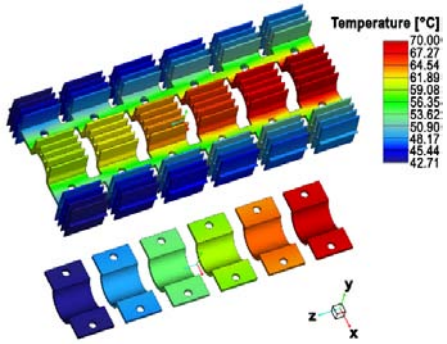

Figure 7 Distribution of temperature fields on the surface of the top flanges (finned) and bottom flanges of a demountable cooler with the pump switched off.

In the case of using only one segment as a cooler on the pipe, the temperature distribution is different especially on the lateral fins of the segment and the bottom flange of the segment (Fig. 8a). The application of the single segment would not be sufficient for efficient heat dissipation along the length of the hydraulic pipe.

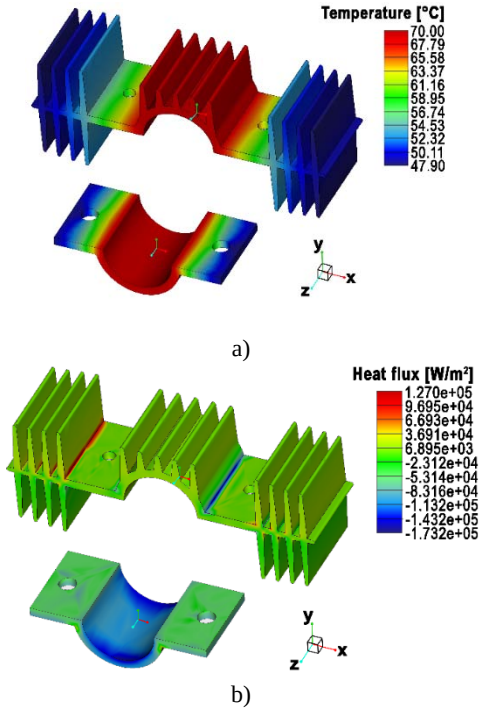

Figure 8 Numerical simulations of one segment of a demountable cooler with the pump off. a) the distribution of temperature fields on the surface of the top and bottom flange, b) the distribution of heat flux on the surface of the top and bottom flange.

The distribution of heat fluxes on the surface of top and bottom segments is shown in Fig. 8b. The heat flux on the surface of the top flange and fins of the cooler reached values up to 36,910 W/m^2. At singularity points between the horizontal surface of the cooler and the vertical surface of the fins, this means that the maximum and minimum values are not taken into consideration.

4. CONCLUSION

The designed demountable cooler allows to reduce the temperature of the hydraulic oil circulating in the hydraulic systems of a wide range of machines and equipment. If the oil is excessively heated, the rubber seals can be damaged, which also reduces the operating pressure and increases the heat of the oil. Simultaneously, if the oil is loaded with high temperature for a long time, oxidation products are formed which negatively affect the pump. Up to 85% of hydraulic system failures are related to the adverse condition of the oil. In some cases, conventional oil coolers are not sufficient, so this problem can be solved by dissipating heat from the hydraulic hoses via a demountable cooler.

Experimental measurements showed that our designed cooler achieved a reduction of 3.65 °C and 4.24 °C in the oil temperature at the cooler outlet for 5 minutes and 10 minutes with the pump on and pump off, respectively. With the pump off and not circulating oil in the circuit, the significance of the cooler was most pronounced. This condition occurs in practice in the operation of machines and equipment when the movement of the hydraulic cylinder is counteracted by the operating environment. By circulating the oil in the hydraulic circuit for several times, the temperature of the oil at the inlet to the cooler gradually decreased. The finned cooler achieved a reduction of 3.42 °C and 3.27 °C in the oil temperature at the inlet of the cooler for 5 minutes and 10 minutes with the pump on and pump off, respectively. This has positive effects on the long-term and more stress-intensive operation of machines and equipment operating with hydraulic circuits. From simulations of temperature fields and heat fluxes, it is observed that the increase in cooler surface area by the fins contributes to improved heat dissipation and thus the hydraulic oil is protected from degradation.

The application of the demountable cooler is especially significant in the summer months or in locations with higher ambient temperatures all the year round. The extended surface of the cooler ensures that the heat is dissipated from the hydraulic oil before it enters the hydraulic pump while the machines and equipment are being operated. The advantage of our designed cooler is its constructional flexibility, as it allows mounting on different diameters of pipes and hoses, not only straight but also bent at a specific angle. The installation of the cooler does not require the machine or equipment to be shut down, nor is its structural integrity compromised, which could result in hydraulic oil leakage or aeration of the hydraulic circuit.

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Effective emission reduction system for hydrogen combustion engines

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Abstract As global efforts to reduce greenhouse gas emissions intensify, there is growing interest in alternative propulsion systems that support sustainable transport. Among these, hydrogen-fueled internal combustion engines have emerged as a promising option due to their potential to significantly lower carbon-based emissions. Despite emitting primarily water vapor, hydrogen combustion at elevated temperatures leads to the production of nitrogen oxides, which remain a critical environmental concern. This paper introduces a novel concept for an emission reduction system tailored to the specific challenges of hydrogen-fueled internal combustion engine operation addressing factors such as elevated water vapor concentrations, the necessity for effective NO_x control, and the demand for corrosion-resistant system components. The proposed exhaust system represents a technological advancement aimed at minimizing pollutant output while improving the environmental and functional performance of hydrogen combustion engines.

Keywords hydrogen, combustion engine, emission

1. INTRODUCTION

With the growing emphasis on reducing greenhouse gas emissions and transitioning towards sustainable mobility, increasing attention is being devoted to alternative propulsion technologies. One promising pathway is the utilisation of hydrogen as a fuel in internal combustion engines, which offers the potential for decarbonising the transport sector while retaining the established operational principles of conventional powertrains.

Although the primary component of hydrogen combustion exhaust is water vapour, nitrogen oxides (NO_x) are also formed due to the high combustion temperatures, posing potential risks to air quality and human health [1]. The literature indicates that NO_x formation in hydrogen-fuelled engines is significantly influenced by the combustion strategy, combustion chamber geometry, and ignition control parameters [2,3]. In order to mitigate these emissions, technologies such as exhaust gas recirculation (EGR), selective catalytic reduction (SCR), and advanced catalytic systems based on zeolites and metal oxides are commonly employed [3–5].

Another specific feature of the exhaust system in hydrogen internal combustion engines is the elevated water vapour content, which may condense and lead to corrosion of exhaust components. According to [4], the application of corrosion-resistant materials and thermally stable alloys is essential to withstand the combined effects of high humidity, elevated temperatures, and pressure fluctuations. Consequently, the design of the exhaust manifold must account for both mechanical and chemical stresses on the system [6].

Some studies have also explored the potential for waste heat recovery from exhaust gases through energy recovery systems, which may enhance the overall efficiency of the vehicle [5,7]. However, such approaches require tailored solutions due to the distinct physical properties of hydrogen exhaust, particularly its high temperature and humidity [8].

Overall, it is evident that the exhaust system for a hydrogen internal combustion engine necessitates a fundamentally different design approach compared to fossil-fuel-based systems. The design must ensure efficient expulsion of exhaust gases, minimise NO_x formation, and simultaneously address the challenges of condensation and material corrosion [9].

2. EXHAUST SYSTEM FOR A HYDROGEN INTERNAL COMBUSTION ENGINE

The development of an exhaust system for a hydrogen internal combustion engine requires the implementation of specific technical solutions that take into account the physico-chemical properties of the exhaust gases, emission control requirements, and operational conditions [10]. The key design aspects of the exhaust system, as summarised in Table 1, can be categorised into several areas: material selection, NO_x mitigation, water vapour handling, and thermal flow management.

Parameter	Conventional engine	Hydrogen engine
Regulated emissions	CO_2, CO, HC, NO_x, particulate matter	H_2O, NO_x
Corrosion risk	Low to moderate	High
Catalyst requirement	Three-way catalyst or SCR	NO_x catalyst
Condensate accumulation	Minimal	Substantial
Material requirements	Standard-grade steels	Stainless steel, ceramics, aluminium alloys
Exhaust energy potential	Low to moderate	Moderate to high

Table 1 Comparison of the exhaust system of a hydrogen engine and a conventional internal combustion engine

Due to the high proportion of water vapour in the exhaust, condensation and the resulting corrosion pose a significant threat to the service life of the exhaust system. For this reason, stainless steels and ceramic coatings resistant to acidic condensate are preferred. In certain applications, titanium alloys or composite materials are also considered, offering a combination of low weight and high resistance to chemical degradation.

Although hydrogen contains no carbon, its combustion at elevated temperatures leads to the formation of thermally induced NO_x. Technologies such as NO_x adsorbers and zeolite-based catalysts may be applied to reduce these emissions, particularly in engines operating under transient load conditions [4].

The large volume of water vapour creates a risk of condensation within the exhaust piping, especially during cold starts and low engine loads. This issue can be addressed by specific muffler designs. Thermal flow management is also critical for ensuring the durability of exhaust components and the safe operation of the vehicle. Based on these considerations, a dedicated exhaust system design for hydrogen internal combustion engines was developed.

3. EXHAUST SYSTEM FOR HYDROGEN COMBUSTION APPLICATIONS

The exhaust system designed for hydrogen combustion applications, illustrated in Figure 1, forms an integral part of the hydrogen combustion engine concept. Its primary objectives are to optimise exhaust gas expulsion, minimise NO_x formation, and ensure resistance to the high humidity present in hydrogen exhaust gases. Note: the figure depicts the system without the catalyst insert.

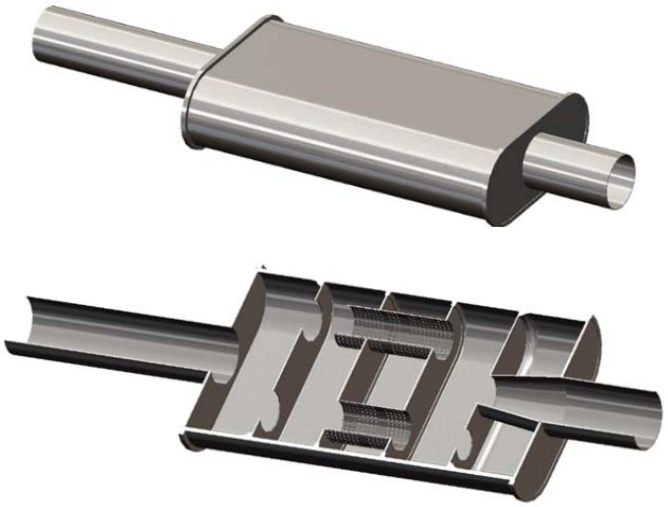

Figure 1 Exhaust system designed for hydrogen combustion applications

This exhaust system comprises an inlet pipe connected to a dual-chamber resonator featuring a symmetrical baffle to ensure uniform gas flow. The exhaust gases subsequently pass through a compression perforated tube and an expansion perforated tube situated within the absorption section. This section aids in reducing acoustic noise and in capturing condensate droplets. The exhaust gases are then directed to a catalyst specifically engineered for nitrogen oxide reduction, optimised for high water vapour content (Figure 2).

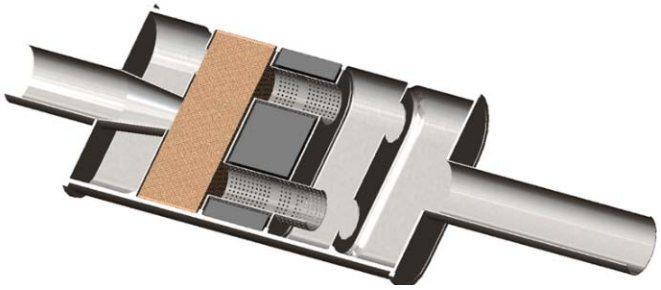

Figure 2 Comprehensive architecture of the designed exhaust systém

The outlet pipe is connected to the catalyst through an asymmetrical baffle, which separates the expansion chamber from the catalyst and serves to regulate backpressure wave propagation. At the transition area, a reverse cone is installed. Its narrowest diameter matches that of the perforated pipes, thereby ensuring balanced exhaust flow and preventing condensation (Figure 3).

Figure 3 Concept of the reverse cone and perforated tubes

The system concept delivers the following functional advantages:

- Reduction of NO_x emissions through a specialised catalytic system,
- Minimisation of water vapour condensation via controlled thermal flow and corrosion-resistant materials,
- Noise attenuation through the integrated resonator and absorber sections,
- Improved combustion efficiency by favourable redistribution of backpressure waves that support stable and homogeneous hydrogen combustion.

The proposed exhaust system for hydrogen combustion engines represents an innovative solution that specifically addresses the characteristics of hydrogen exhaust gases - particularly their high water vapour content, absence of carbonaceous compounds, and tendency to produce nitrogen oxides (NO_x) at elevated temperatures. The system's design prioritises a multi-functional approach: ensuring efficient exhaust flow, reducing harmful emissions, suppressing acoustic noise, and mitigating condensation and corrosion of system components.

This system is particularly applicable to light- and medium-duty automotive transport, where it offers an attractive compromise between the retention of conventional engine architecture and the requirements of carbon-neutral propulsion. With the anticipated expansion of hydrogen combustion engine technologies during the transitional phase of transport sector decarbonisation, this exhaust solution provides a practical and technologically feasible alternative for reducing environmental impact.

4. CONCLUSIONS

This study presents an exhaust system optimised for the specific requirements of hydrogen internal combustion engines. The system concept integrates multiple functional components, including a resonator chamber, an absorption section, a specialised NO_x catalyst, and an expansion chamber with a reverse cone. These elements collectively contribute to the reduction of nitrogen oxide formation through controlled temperature management and an efficient catalytic process. Simultaneously, the system mitigates water vapour condensation by means of thermal flow regulation and the use of corrosion-resistant materials.

Additional benefits include improved acoustic properties and support for stable and efficient hydrogen combustion. The findings suggest that a well-designed exhaust system can significantly contribute to the safe, reliable, and environmentally friendly operation of hydrogen-fuelled combustion engines.

Future research will be focused on the numerical optimisation of individual components and experimental validation under real-world operating conditions.

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