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About the Journal

The UniCath Journal of Biomedicine and Bioethics is a scholarly journal established by the Senate of the Catholic University of Croatia on January 16, 2024. The journal has a dual mission: to promote high-quality research in the fields of biomedicine and bioethics, and to serve as a learning platform for young researchers at the beginning of their academic careers.

The journal welcomes a broad range of submissions, including original research articles, editorials, case reports, and other scholarly contributions. Our editorial process follows the highest standards of peer review and publication ethics with all submitted manuscripts undergoing a double-blind review by at least two expert reviewers. The journal is published twice a year, both in print (ISSN 3043-7164) and online (ISSN 3043-8373) editions. The full-text online edition is available at https://unij2b.unicath.hr/.

Each article is assigned a DOI (Digital Object Identifier) ensuring permanent access, reliable citation, and inclusion in international scientific databases. The journal is indexed in Hrčak—Portal of Scientific Journals of Croatia, which ensures increased visibility and accessibility within the national and international academic community.

The launch of the UniCath Journal of Biomedicine and Bioethics marks a significant step in advancing academic excellence at the Catholic University of Croatia. By supporting the publication of scholarly work, the journal strengthens the University`s educational mission and promotes the integration of research into teaching and practice. Through the promotion of research and open dialogue at the intersection of biomedicine and bioethics, the journal aims to contribute meaningfully to the global scientific community and to foster a culture of inquiry, integrity, and innovation. It provides a platform for the university to highlight original research, build academic visibility, and engage with the international scholarly discourse.

The Editorial Team

The Catholic University of Croatia: Twenty Years of Academic Mission

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The Catholic University of Croatia marks the twentieth anniversary of its founding this year. Guided by the Apostolic Constitution *Ex corde Ecclesiae*, which affirms that Catholic universities are "born from the heart of the Church" (1), the University was founded by decision of Cardinal Josip Bozanić, Archbishop of Zagreb and Metropolitan. Over the past two decades, it has grown into a recognised institution within the Croatian academic and social community. This growth has been built on the dedicated work of our faculty, researchers, and staff, as well as on the continued confidence that students have placed in this institution. It has been sustained through ongoing cooperation with the Church, the Ministry of Science, Education and Youth, and the wider academic community. Rooted in Christian values and guided by its institutional mission and vision (2), the University continues to foster an academic environment that integrates scientific excellence with ethical responsibility. In line with *Ex corde Ecclesiae*, it affirms its role as a place of research where scholars, through the methods proper to their disciplines, seek to understand reality and contribute to the advancement of human knowledge, while fostering dialogue among different fields for their mutual enrichment (1).

In this context, special mention should be made of the University's scientific journal, *Unicath Journal of Biomedicine and Bioethics*, which, in this jubilee year, publishes its fifth issue. As an important component of the University's academic identity, the journal contributes to the advancement of scientific and professional excellence, enhances the visibility of research achievements across different fields and countries, and upholds high standards of ethical and scientific responsibility.

The journal has grown alongside the University—quietly, steadily, and with purpose. Under the leadership of the Editor-in-Chief, Professor Marta Čivljak, PhD, and with the sustained engagement of the Editorial Board, reviewers, and contributors, it has established itself as a credible and valued voice in biomedical and bioethical scholarship. Much of that credibility rests on the work of our reviewers, whose rigorous and largely unrecognised efforts ensure that what appears in these pages meets the standards of the field.

The celebration of the University's twentieth anniversary provides an opportunity to reflect on past achievements while renewing our commitment to future challenges and opportunities. This issue of the journal reflects both: a record of what has been achieved and a sign of our continued commitment. In this spirit, this issue further enriches the commemoration of this significant milestone.

Aware of the demanding nature of publishing scientific journals, particularly in attaining and maintaining high standards of quality, on behalf of the University leadership and the wider academic community, we extend our best wishes for the continued success of the journal, its editors, and all who contribute to it. We also wish it many future issues and years of meaningful scholarly work that will contribute to both the academic and the wider social community.

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The Comparison of Three Teaching Methods on the Knowledge and Satisfaction of Nursing Students in the Emergency Medical Procedures Class: A Non-Randomised Controlled Study

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Abstract

Background: Nursing education in Croatia is primarily based on traditional frontal teaching methods. There is limited evidence comparing collaborative learning and ICT-based gamification with traditional methods regarding knowledge acquisition and student satisfaction.

Aim: This study compared the effects of three teaching methods - gamification with ICT, collaborative learning, and frontal teaching - on the knowledge and satisfaction of nursing high school students during an emergency medical procedures course.

Methods: This was a non-randomised quasi-experimental study with parallel pretest-posttest groups including 65 fourth-grade nursing high school students in Zagreb, Croatia. Three classes were assigned to gamification with ICT (n=24), collaborative learning (n=18), or frontal teaching (n=23). All groups received eight hours of instruction over two months. Outcomes were measured using a standardised knowledge exam and a satisfaction questionnaire.

Results: A total of 54 participants completed the questionnaire. Baseline knowledge did not significantly differ between the groups. Following the interventions, the gamification and ICT group achieved significantly higher total knowledge scores compared to both the frontal teaching group (p=0.021) and the collaborative learning group (p=0.040). Significant differences were also observed across all specific cognitive domains, including factual knowledge, understanding, and application/analysis. Regarding student satisfaction, the collaborative learning group reported significantly lower perceived teacher support compared to the other two groups.

Conclusion: Gamification with ICT was associated with higher post-intervention knowledge scores than frontal teaching and collaborative learning, while overall student satisfaction did not differ significantly. These findings suggest that gamification with ICT may be a promising approach for improving short-term knowledge acquisition in nursing education.

Keywords: nursing; frontal teaching; collaborative learning; gamification; information and communication technologies

Introduction

Innovative approaches and modalities for educating students in health professions education are constantly being evaluated to improve teaching and learning, with the ultimate goal to improve patient care and outcomes (1).

Traditional frontal teaching implies that the teachers address all the students in the class. The advantage of such teaching is its efficiency; a high number of students can be addressed, a teacher has an overview of the class and insight into student activities. The disadvantage of frontal teaching is the neglect of individual characteristics. It is anticipated that all students will start and finish the planned tasks at the same time, which is not advantageous for students who fall behind or those who are solving tasks faster than others (2). It has been described that many students describe traditional schooling as ineffective and boring, hampering student engagement and motivation (3). Gamification and collaborative learning are more recent methods used to enhance formal education.

The use of educational games as a learning method is considered promising due to the games' abilities to teach and the fact that they reinforce not only knowledge but also important skills such as problem-solving, collaboration, and communication. Games are motivating and engaging, with the possibility of winning serving as a reward. However, creating a full-blown, elaborate instructional game is difficult, time-consuming, and costly. Thus, the "gamification" approach uses game thinking and game design elements in education to foster students' engagement and motivation (4).

Collaborative learning is a method where learners at various performance levels work together in small groups toward a common goal. In such an approach, the learners are responsible for the learning of their peers and also for their own learning. Thus, the success of one learner helps other students to be successful (5). It is based on the idea that students will find it easier to discover, understand, and adopt complex concepts if they discuss, argue with them, and come to common conclusions. Research supports this theory because those who learn in this way learn faster and easier, and knowledge is often longer retained (5).

In Croatia, frontal teaching is still the dominant mode of teaching, where, contrary to the modern educational paradigms, a teacher is still at the centre of the educational process. In 2015, the Ministry of Education and Health of the Republic of Croatia started a project titled "e-Schools: a comprehensive informatisation of school operation processes and teaching processes aimed at the creation of digitally mature schools for the 21st century". Within this project, digital technologies and modern tools were introduced into schools, together with additional information and communication technologies (ICT) for teachers (6). However, it is still unclear whether the new teaching methods are better in terms of knowledge gained and student satisfaction, compared with the traditional frontal teaching.

This study aimed to compare the effects of three teaching methods – gamification with ICT, collaborative learning, and frontal teaching – on the knowledge and satisfaction of nursing high school students during an emergency medical procedures course.

Methods

Study design

This was a non-randomised controlled quasi-experimental study with parallel groups (pretest–posttest design).

Ethics

The Council of the Department of Nursing at the Catholic University of Croatia approved the study protocol on November 20, 2019. Subsequently, the school board of the Medical School Vrapce, Croatia, which is also in charge of overseeing ethics issues in the institution, approved the study protocol on December 20, 2019. The students provided their written consent to participate in the study via e-mail.

Time and place of the study

The study was conducted in the Medical School Vrapce, Croatia, during two months in the second part of the academic year 2019/2020. In the last lesson in the first part of the academic year 2019/2020, students were informed about this study and invited to participate.

Participants

Nursing students in the 4th grade of the nursing medical school Vrapce, aged 18 or 19 years, participated in the study. All students were invited to participate in the study. There were three groups of students, attending classes 4a, 4b and 4c. We excluded all other classes in the school where the study took place, because the researcher conducting the study (MM) teaches emergency medical procedures only to the 4th-grade students.

General baseline knowledge testing

At the beginning of the school year, the students were initially tested for the most relevant learning outcomes from subjects taught during the 3rd year of their studies. Knowledge from the following topics was tested: Anatomy and Physiology, Basic Nursing Care, General Principles of Health and Care, Nursing Care for Healthy Children and Adolescents. This knowledge is considered to be the basic prior knowledge that is supposed to be retained from lower study years to higher study years, and upgraded in higher study years. This knowledge test was conducted in the school independently of this study. We analysed the results of this knowledge to see whether there were any baseline differences in the knowledge of the most relevant learning outcomes among the three groups of students.

Domain-specific baseline knowledge testing

The baseline written knowledge test on Emergency Medical Procedures was conducted on November 21, 2019, independent of the study. The exam content included teaching topics: the historical overview of emergency medical care, ABCDE examination (standardised procedure of physical examination of the patient: A-maintenance of airway patency, B-assessment of respiration, C-assessment of circulation, D-rapid neurological examination, E-detection of the patient and examination from head to toe), state of consciousness, airway obstruction by a foreign body, and maintenance of airway patency. The maximum number of points was 25. We analysed the results of this test to verify whether there were any baseline differences between the groups in the knowledge of emergency medicine.

Interventions

The three teaching methods were applied during the second educational period of the academic year 2019/2020 for two months. During those two months, each class underwent 8 hours of emergency medicine instruction. The teaching topics covered were: bleeding, shock, and chest injuries. Supplementary file 1 lists the teaching units covered during the study and the learning outcomes of each teaching unit.

The students belonged to the same type of studies (nursing), they had the same literature, and the same teacher held classes. However, each class received different teaching methods about emergency medical procedures.

The first experimental group was taught using gamification and ICT, and the second experimental group was taught using collaborative learning. The control group received frontal teaching.

Knowledge assessment and student satisfaction with teaching

Immediately after completing the application of the tested teaching methods (two months from the beginning of teaching within the study), a standard knowledge test and a survey on satisfaction with teaching were conducted among students on March 5, 2020, to determine whether there is a difference in knowledge acquisition and satisfaction among the students.

The written knowledge test contained 15 questions, and the maximum number of points was 31.5. The knowledge test included three parts, assessing different

cognitive aspects of knowledge. The first part assessed knowledge of the facts; it contained 3 questions, with a maximum of 7 points (22% of the total points). The second part assessed understanding; it had 10 questions and a maximum of 16 points (51% of the total points). The third part assessed the application of knowledge, analysis and synthesis; it had 2 questions and a maximum of 8.5 points (27% of the total points).

The knowledge test was conducted at the same time for all students in three different classrooms. The students had 45 minutes for the exam.

We used a questionnaire that was used in the study of Jagic and Jurcic (7). Their questionnaire was adapted from two questionnaires by Oswald et al. from 1989. (8) and Jurić in 1989 (9) for studying the multidimensionality of the classroom-teaching climate. The questionnaire was used to survey student satisfaction with teaching. The questionnaire was delivered in the Croatian language. The instrument contained 68 items and assessed four factors: fear of failure (9 items), teacher support (15 items), class cohesion (18 items), and satisfaction with teaching (20 items) (7). Each item is scored with a Likert scale ranging from 1 to 5, where 1 indicates "completely disagree" and 5 indicates "completely agree".

The translation of the questionnaire into English is available in Supplementary file 2. Additionally, students received socio-demographic questions, including sex, size of the place of residence, mothers' and fathers' education, and mothers' and fathers' employment status.

Data analysis

Data were analysed using descriptive and inferential statistics. Categorical variables were presented as frequencies and percentages, while continuous variables were described using means and standard deviations (M± SD). Normality of distributions was assessed using the Shapiro–Wilk test separately for each factor and teaching group.

For the student satisfaction questionnaire, items 27, 28, 30, 39, 40, 41, 46, 47, 48, 63, 64 and 65 were reverse-scored in accordance with the original instrument so that higher scores consistently reflected more positive perceptions. After reverse scoring, composite factor scores were calculated for each participant by averaging item responses within each factor: fear of failure (9 items), teacher support (15 items), class cohesion (18 items), and satisfaction with teaching (20 items).

Internal consistency of each factor was evaluated using Cronbach's alpha. Group differences in factor scores were analysed at the factor level. For factors with approximately normal distributions and homogeneous variances, one-way analysis of variance (ANOVA) was used. When the assumption of homogeneity of variance was violated, Welch's ANOVA was applied. For factors with non-normally distributed data, the Kruskal–Wallis test was used.

Normality of factor score distributions was examined separately for each teaching group. A deviation from normal distribution was observed only for the fear of failure factor in the collaborative learning group; therefore, non-parametric testing was applied for this factor. Distributions of the remaining three factors did not significantly deviate from normality and were analysed using parametric methods.

Post-hoc comparisons were conducted when overall group differences were statistically significant. Tukey's honestly significant difference (HSD) test was used following standard ANOVA; Games–Howell tests were used following Welch's ANOVA.

Baseline and post-intervention knowledge test scores were analysed using parametric methods, as distributions did not significantly deviate from normality. Group comparisons were performed using one-way ANOVA. Post hoc comparisons were performed using Tukey's test.

All statistical tests were two-tailed, and statistical significance was set at $p<0.05$. Microsoft Excel (Microsoft Inc., Redmond, WA, USA) and IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA) were used for data analyses.

Results

Participants

The study was conducted on a sample of 65 fourth-grade nursing students. The majority of participants were women, and most lived in a city with more than 200,000 inhabitants. Most students' mothers had completed four-year secondary education and were employed, while most fathers had completed secondary education and were also employed (Table 1).

Table 1. *Participants' demographic characteristics*

Variable	N
Sex	
Man	15
Woman	39
Size of the city/village of residence	
Under 2,000 inhabitants	3
2,001 to 5,000 inhabitants	5
5,001 to 10,000 inhabitants	7
10,001 to 200,000 inhabitants	14
More than 200,000 inhabitants	24
Mother's education	
Unknown	1
Higher education	10
Polytechnic	1
Four-year high school	36
Three-year high school	4
Primary school	2
Mother's employment	
Employed	39
Unemployed	12
Student	2
Retired	1
Deceased	0
Father's education	
Unknown	3
Higher education	3
Polytechnic	3
Four-year high school	24
Three-year high school	19
Primary school	2
Father's employment	
Employed	46
Unemployed	1
Student	0
Retired	5
Deceased	1

* The number of responses varies due to missing data.

There were 23 students in the control group receiving frontal teaching, 24 students in the group receiving gamification with ICT, and 18 students in the group receiving collaborative learning. Two months after completion of the intervention, the post-intervention knowledge test was completed by 58 students, as seven students were absent on the testing day. Of those, four students subsequently left due to illness, resulting in 54 completed questionnaires for the analysis of student satisfaction.

General baseline knowledge test results

The baseline knowledge test assessing the most relevant learning outcomes from the lower study year, which was conducted at the beginning of the school year independently of the study, was completed by 64 students. The maximum possible score was 48. Data were normally distributed in all three groups. There were no significant differences in baseline knowledge between the control group receiving frontal teaching (18±8.1; N=22), the intervention group receiving gamification and ICT (20±8.2; N=24), and the intervention group receiving collaborative learning (19±7.6; N=18) (p=0.7852).

Baseline knowledge about emergency medicine

A total of 64 students completed the baseline domain-specific knowledge test on emergency medical procedures. The maximum possible score was 25. Data were normally distributed in all three groups, and baseline knowledge did not differ significantly among the groups (p=0.898). Baseline test results are presented in Table 2.

Knowledge about emergency medicine after the interventions

Following the intervention, significant differences were observed among the three groups in total post-intervention knowledge scores on emergency medical procedures (p= 0.011), as well as across all assessed cognitive domains: knowledge of facts (p=0.017), understanding (p=0.024), and application of knowledge, analysis, and synthesis (p= 0.015).

Post-hoc analyses showed that students in the gamification and ICT group achieved significantly higher total knowledge scores compared with students in the frontal teaching group (p=0.021). No significant difference in total knowledge scores was observed between the collaborative learning group and the frontal teaching group (p= 0.999). Total knowledge scores were also significantly higher in the gamification and ICT group compared with the collaborative learning group (p=0.040) (Table 3).

For the domain knowledge of facts, students in the gamification and ICT group scored significantly higher than those in the frontal teaching group (p=0.012). No significant differences were observed between the collaborative learning and frontal teaching groups (p=0.343), nor between the gamification and ICT and collaborative learning groups (p=0.412) (Table 3). For the domain understanding, there were no significant differences in the gamification and ICT group compared with the frontal teaching group (p=0.089). Also, no significant difference was found between the collaborative learning and frontal teaching groups (p=0.827). Statistical significance was found in the difference between gamification and the collaborative learning group (p= 0.033).

For the domain application of knowledge, analysis, and synthesis, students in the gamification and ICT group achieved significantly higher scores than those in the frontal teaching group (p=0.025). No

Table 2. *Results of the domain-specific baseline knowledge test about emergency medicine procedures before and after the intervention*

Testing time	**Baseline**						**After the intervention**					
Group	Gamification and ICT		Frontal teaching		Collaborative learning		Gamification and ICT		Frontal teaching		Collaborative learning	
Values	N	M (SD)	N	M (SD)	N	M (SD)	N	M (SD)	N	M (SD)	N	M (SD)
Total score	24	17 (4.5)	22	17 (4.2)	18	17 (4.1)	23	23 (5.3)	20	17 (7.7)	15	17 (5.9)
Knowledge of the facts							23	5.3 (1.3)	20	3.9 (1.8)	15	4.6 (1.8)
Understanding							23	10.9 (3.1)	20	8.6 (4.4)	15	7.9 (2.5)
Application of knowledge, analysis and synthesis							23	6.4 (1.6)	20	4.8 (2.1)	15	4.9 (2.3)

Table 3. *Results of the post-hoc test for knowledge about emergency medicine after the interventions*

Knowledge domain	**Comparison**	**MD**	**95% CI**	**P***
Total post-intervention knowledge	A-B	5,367	[0,677; 10,058]	0,021
	B-C	-0,833	[-5,324; 5,157]	0,999
	A-C	5,284	[0,192; 10,376]	0,040
Knowledge of facts	A-B	1,466	[0,273; 2,659]	0,012
	B-C	-0,708	[-2,041; 0,625]	0,412
	A-C	0,758	[-0,537; 2,053]	0,343
Understanding	A-B	2,266	[-0,270; 4,803]	0,089
	B-C	0,692	[-2,142; 3,525]	0,827
	A-C	2,958	[0,205; 5,711]	0,033
Knowledge, analysis, and synthesis	A-B	1,635	[0,175; 3,095]	0,025
	B-C	-0,067	[-1,698; 1,564]	0,995
	A-C	1,568	[-0,164; 3,153]	0,053

Acronyms: A: gamification ICT; B: frontal teaching; C: collaborative learning; I: confidence interval; MD: mean difference; *Tukey Post Hoc test

significant difference was observed between the gamification and ICT group and the collaborative learning group (p=0.053), nor between the collaborative learning and frontal teaching groups (p=0.995).

Reliability and distribution of satisfaction factors

Internal consistency of the satisfaction questionnaire factors was assessed prior to group comparisons. The reliability of the fear of failure scale (9 items) was good (Cronbach's α=0.887), as was the reliability of the teacher support scale (15 items; α=0.895). The class cohesion scale (18 items) and the satisfaction with teaching scale (7 items) demonstrated acceptable internal consistency (α=0.767 and α=0.722, respectively) (Table 4).

Differences between teaching groups after the intervention

Differences between teaching groups after the intervention were analysed at the factor level for four dimensions of student satisfaction – fear of failure, teacher support, class cohesion, and satisfaction with teaching (Table 5).

For fear of failure, no statistically significant differences were observed between the three teaching groups in perceived fear of failure

Table 4. *Reliability and normality of student satisfaction factors*

Factor	Class	Cronbach α	P*
Fear of failure	Gamification and ICT	0.887	0.950
	Frontal teaching		0.010
	Collaborative learning		0.467
Teacher support	Gamification and ICT	0.895	0.085
	Frontal teaching		0.211
	Collaborative learning		0.982
Class cohesion	Gamification and ICT	0.767	0.263
	Frontal teaching		0.253
	Collaborative learning		0.060
Satisfaction with teaching	Gamification and ICT	0.722	0.351
	Frontal teaching		0.269
	Collaborative learning		0.760

* Shapiro Wilk
Acronym: ICT = information and communication technologies

Table 5. *Comparison across teaching groups after the intervention*

Factor	Gamification and ICT; M±SD	Frontal teaching; M±SD	Collaborative learning; M±SD	F/H	df	P
Fear of failure	2.68±0.91	2.52±1.37	2.56±0.69	1.206	2	0.547*
Teacher support	4.04±0.52	4.24±0.5	3.34±0.89	8.705	2	0.001** Post-hoc: C < A, C < B
Class cohesion	3.28±0.44	3.24±0.44	2.7±0.71	3.850	2/28.442	0.033*** Post-hoc: A > C
Satisfaction with teaching	3.04±0.74	2.63±0.84	3.28±0.81	2.811	2	0.069**

*Kruskal-Wallis, ** ANOVA, *** Welch ANOVA

(Kruskal–Wallis test, p=0.547). For teacher support, a statistically significant difference between groups was found for perceived teacher support (one-way ANOVA, p=0.001). Post-hoc analyses showed that students in the collaborative learning group reported significantly lower perceived teacher support compared with both the gamification and ICT group and the frontal teaching group, while no significant difference was observed between the latter two groups.

For class cohesion, group differences were also observed (Welch ANOVA, p=0.033). Post-hoc comparisons indicated significantly higher perceived class cohesion in the frontal teaching group compared with the collaborative learning group, while differences involving the gamification and ICT group did not reach statistical significance. For satisfaction with teaching, differences in overall satisfaction with teaching did not reach statistical significance at the factor level (one-way ANOVA, p=0.069).

Discussion

This study evaluated the impact of different pedagogical approaches on knowledge acquisition and satisfaction among nursing students during emergency medical training. Our findings support the growing body of evidence suggesting that student-centred, active learning environments are more effective for teaching high-stakes clinical content than passive, teacher-centred models.

The success of the gamified approach can be interpreted through Ryan and Deci's Self-Determination Theory (SDT), which posits that motivation is driven by the satisfaction of three basic psychological needs, including autonomy, competence, and relatedness (10). In our study, the gamified elements, likely providing immediate feedback and a sense of progress, addressed these needs more effectively than the frontal method, where students remain passive recipients of information.

Our findings are in line with the systematic review of Andretta et al., published in 2026, which aimed to provide a critical and updated synthesis of the evidence on the use of gamification in basic nursing education (11). The results of the review indicated that gamification is a promising educational strategy in undergraduate nursing education. Across 48 included studies, gamified approaches were associated with improvements in short-term knowledge and performance, as well as consistently positive effects on motivation, engagement, self-efficacy, and satisfaction. Effects appeared stronger when interventions incorporated immediate feedback and opportunities for repeated practice. However, evidence regarding long-term knowledge retention and practical skill development remains limited, as relatively few studies assessed follow-up outcomes and methodological quality was often constrained by quasi-experimental designs and variable risk of bias. Overall certainty of evidence ranged from low to moderate, highlighting the need for more rigorous trials with standardised outcome measures and longer follow-up periods to clarify the sustained educational impact of gamification (11).

Of note, our results showed that while collaborative learning was effective, gamification provided an additional engagement boost. This mirrors findings in other emergency care contexts, where active performers in simulation-based exercises reported higher satisfaction than those in more traditional observational roles (12).

The contrast in satisfaction scores between the experimental group and the frontal group could be an indicator of a fundamental shift in the pedagogical expectations of contemporary nursing students. This generation, frequently described as "digital natives," has been conditioned by highly interactive, multimedia-driven environments, making traditional, unidirectional lecturing feel increasingly obsolete and disconnected from their cognitive styles. Research indicates that when nursing students are exposed to technology-enhanced, active environments, their perceived value of the educational experience increases, as these methods mirror the fast-paced, information-rich reality of modern clinical practice (13).

Lindsø Andersen et al. published a scoping review in 2022, which showed that Generation Z nursing students, a generation immersed in technology, prefer interactive, tech-driven and visually engaging learning approaches, and that traditional lectures may be misaligned with their learning preferences, whereas modern, interactive strategies can better meet their needs (13).

Beyond satisfaction, this transition toward active involvement addresses the development of essential 21st-century competencies. By shifting the locus of responsibility from the teacher to the learner, a core tenet of the "Learning by Teaching" (LbT) model, educators can foster a higher degree of self-confidence and professional agency. For instance, recent studies utilising LbT in nursing skills education have shown that students who take an active role in explaining or demonstrating procedures to their peers achieve a more robust understanding of complex clinical protocols than those who remain passive observers (14).

This empowerment is particularly vital in the chaotic and unpredictable environment of emergency medicine. In such settings, nurses must act with autonomy and critical thinking, traits that are stifled by the standardised frontal model but nurtured by gamified and collaborative simulations that demand real-time decision-making. Furthermore, international research suggests that spike engagement caused by competitive or interactive elements helps bridge the boredom gap often reported in traditional nursing curricula, thereby reducing academic burnout and improving long-term professional identification (15). By integrating these dynamic elements, educators are not just making classes fun, but are systematically building the cognitive resilience required for high-stakes healthcare environments.

The notably lower satisfaction with the frontal method (the current standard in many Croatian schools) suggests a pedagogical mismatch. When students perceive teaching as boring or unmotivating, their cognitive investment drops. Our findings on satisfaction are consistent with research on "Flipped Learning," which found that active methodologies facilitate a better approach to the object of learning, allowing students to discover knowledge rather than just memorise it (16).

However, it is important to note that collaborative learning, despite being effective, can sometimes lead to "socio-cognitive conflict" or unequal participation if not structured correctly. Unequal participation is a known challenge in collaborative learning, and it can negatively affect student satisfaction and learning outcomes unless educators support the group process (17).

In our study, the structured nature of the gamified quizzes may have provided a more consistent framework for all students to participate equally compared to the open-ended nature of collaborative group work.

Implications for nursing curricula and future research

Our findings suggest that Croatian nursing curricula should integrate structured gamified and technology-enhanced active learning strategies, particularly in clinically demanding subjects such as emergency medicine. Rather than fully abandoning frontal teaching, a blended approach that combines concise theoretical instruction with interactive, scenario-based reinforcement may be most effective. Implementation should be accompanied by targeted teacher training in digital pedagogy and structured facilitation of collaborative learning to ensure equitable participation and pedagogical quality.

Future research should prioritise randomised and multicentre studies to strengthen causal inference and generalisability. Longitudinal designs are needed to assess long-term knowledge retention, transfer to clinical performance, and effects on professional identity and burnout. Additionally, studies should examine which specific elements of gamification (e.g., feedback, competition, repetition) drive effectiveness and whether hybrid models combining gamification and structured collaboration yield optimal educational outcomes.

Strengths and limitations

A strength of this study is its comparative framework, which allowed for a direct evaluation of three fundamentally different teaching strategies – frontal, collaborative, and gamified – all implemented within the same educational environment and subject matter. This consistency across groups helped isolate the impact of the teaching methodology itself. Additionally, focusing on emergency medical procedures provides a practical lens through which to measure both technical knowledge acquisition and the subjective satisfaction of students preparing for stressful clinical roles.

The study had several potential limitations. Primarily, the non-randomised approach to group assignment may have allowed for inherent selection bias, as existing class structures were utilised. While the baseline knowledge levels (pre-test scores) were comparable across all groups, unmeasured variables such as individual student motivation or previous experience with digital tools could have influenced the outcomes. Furthermore, the assessment of knowledge gain was limited to short-term results immediately following the intervention. Since emergency medical skills require high levels of long-term retention to be effective in real-world practice, the durability of these learning gains over time remains unknown.

Another limitation is that a single teacher was responsible for implementing multiple instructional methods. While this may have reduced variability related to teaching style, it also raises the possibility that differences in the teacher's motivation or expectations toward particular instructional approaches may have influenced how the methods were delivered, which could have affected the study outcomes.

While gamification is highly effective at sparking immediate engagement and short-term motivation, excessive stimulation through competitive elements can sometimes overshadow deep cognitive processing. Without a long-term follow-up spanning a full academic year, it is difficult to determine whether the high satisfaction and knowledge scores observed would translate into sustained clinical competence or if the novelty of the gamified elements would eventually diminish.

Conclusion

In this study, gamification with ICT was associated with higher post-intervention knowledge scores than frontal teaching and collaborative learning, while student satisfaction did not differ significantly at the overall factor level. These findings suggest that gamification with ICT may be a promising teaching approach in nursing education, particularly for improving short-term knowledge acquisition in emergency medical procedures.

Declarations

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Authors' contributions:
Study design: MM, LP;
Data collection: MM
Data analysis: MM, DČ, LP
Writing of the manuscript: MM, DČ, LP
Revising the manuscript: MM, DČ, LP
Final approval of the manuscript: MM, DČ, LP

Ethics considerations: The Council of the Department of Nursing at the Catholic University of Croatia approved the study protocol on November 20, 2019. Subsequently, the school board of the Medical School Vrapce, Croatia, which is also in charge of overseeing ethics issues in the institution, approved the study protocol on December 20, 2019. The students provided their written consent to participate in the study via e-mail.

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Competing interests: None

Data sharing statement: Raw data collected within the study are available from the corresponding author on request. They are not publicly available because we did not ask participants to consent to public data sharing.

AI disclosure: During the preparation of this work, the authors used the Grammarly tool for language editing. The authors reviewed and

edited the content and take full responsibility for its accuracy and integrity.

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Supplementary file 1.

Overview of teaching units and learning outcomes

Hour	Teaching unit	Learning outcomes
1	Bleeding and methods of stopping bleeding, internal bleeding	- Distinguish different types of external bleeding - Describe methods of stopping bleeding - Compare individual methods of stopping bleeding - Recognise the symptoms of internal bleeding - Clarify procedures for internal bleeding - Clarify procedures for some specific bleeding
2	Shock (definition, shock pathophysiology)	- Define shock - List the four components of the vascular system necessary for normal tissue perfusion - Describe the symptoms and signs of shock in the order in which they develop - Clarify methods to prevent shock
3	Hypovolemic shock	- Explain the mechanism of shock due to hypovolemia - Recognise hypovolemic shock in casualties - List prehospital interventions due to hypovolemia - Analyse the symptoms and signs that occur due to the development of shock
4	Mechanical shock	- Explain the mechanism of shock due to tension pneumothorax - Describe the symptoms and signs of shock due to tension pneumothorax - List prehospital interventions due to shock caused by tension pneumothorax - Explain the mechanism of shock due to cardiac tamponade - Describe the symptoms and signs of shock due to cardiac tamponade - List prehospital interventions due to shock caused by cardiac tamponade
5	Vasodilatory shock	- Explain the mechanism of vasodilatory shock - Describe the symptoms and signs of vasodilatory shock - Clarify emergency medical interventions due to vasodilatory shock - Describe the mechanism of occurrence, symptoms and signs and management of neurogenic shock
6	Chest injuries (tension pneumothorax, open pneumothorax)	- Explain the reasons for the occurrence of open pneumothorax - Describe the symptoms and signs of open pneumothorax - Specify procedures for the management of open pneumothorax - Define tension pneumothorax - Describe the symptoms and signs of tension pneumothorax - Specify procedures for the management of tension pneumothorax - Associate symptoms and signs with a specific care procedure
7	Chest injuries (hemothorax, unstable chest, cardiac tamponade)	- Define hemothorax - Explain the pathophysiology of hemothorax - Distinguish tension pneumothorax and hemothorax - List interventions for the care of patients with hemothorax - Explain the pathophysiology of cardiac tamponade - Create procedures for the care of individual chest injuries
8	Chest injuries (hemothorax, unstable chest, cardiac tamponade)	

Supplementary file 2.

Questionnaire used in the study

Dear students,

This survey is part of a study titled "The comparison of three teaching methods on the knowledge and satisfaction of nursing students in the emergency medical procedures class".

The research is conducted by Mate Maretić under the mentorship of Prof. Livia Puljak, for the purpose of writing a diploma thesis in the field of university nursing studies at the Catholic University of Croatia.

There are no correct or incorrect answers in the survey; we are interested in your personal opinion. Please choose the answers that best reflect your opinions and feelings, and answer all the questions in the survey. The survey refers exclusively to your views on the teaching of emergency medical procedures in the school year 2019/2020.

Completing the survey takes between 15 and 20 minutes and is completely anonymous. So we will not record who you are, and your answers will not be able to be related to a specific person. Please answer all the questions honestly and, if you wish, at any time you can opt out of further completion of the survey.

Thanks again for your valuable contribution to this research.

1. Sex:
a) Man
b) Woman

2. Size of the city/village of residence:
a) Under 2,000 inhabitants
b) 2,001 to 5,000 inhabitants
c) 5,001 to 10,000 inhabitants
d) 10,001 to 200,000 inhabitants
e) More than 200,000 inhabitants

3. Mother's education:
a) Unknown
b) Higher education
c) Polytechnic
d) Four-year high school
e) Three-year high school
f) Primary school

4. Mother's employment:
a) Employed
b) Unemployed
c) Student
d) Retired
e) Deceased

5. Father's education:
a) Unknown
b) Higher education
c) Polytechnic
d) Four-year high school
e) Three-year high school
f) Primary school

6. Father's employment:
a) Employed
b) Unemployed
c) Student
d) Retired
e) Deceased

Please express your attitudes on the following statements. You are expressing your attitude by circling ONLY ONE of the offered answers.

1 - I do not agree at all
2 - I mostly disagree
3 - I neither agree nor disagree
4 - I mostly agree
5 - I completely agree

Fear of failure						
7.	I often make mistakes when solving tests because I am too disconcerted	1	2	3	4	5
8.	I often feel sick before an examination or test	1	2	3	4	5
9.	When I participate in work, I speak or answer questions, if the teacher evaluates me, I speak with a lot of fear	1	2	3	4	5
10.	The night before the test, in most cases, I can't sleep well and can't think of anything other than the test	1	2	3	4	5
11.	When I hear my name (during class), I am immediately overwhelmed by an anxious feeling	1	2	3	4	5
12.	When I see that there is little time left during the test, I easily lose my temper	1	2	3	4	5
13.	Sometimes during class, I don't dare say anything	1	2	3	4	5
14.	When I notice that other students are already done with the test, I prefer to give up immediately or hand in the paper	1	2	3	4	5
15.	It is often difficult for me to finish all my homework on time	1	2	3	4	5

Teacher's support						
16.	The teacher encourages me and prods me in my work	1	2	3	4	5
17.	The teacher seems close and inclined to help and encourage me	1	2	3	4	5
18.	When I don't understand something, the teacher tries to explain it to us one more time	1	2	3	4	5
19.	When a student has a personal problem, the teacher will stand up for the student	1	2	3	4	5
20.	The teacher accepts our opinions even if they differ from his/hers	1	2	3	4	5
21.	If most students in the class disagree with something, the teacher is willing to talk about it	1	2	3	4	5
22.	When a student does something wrong, the teacher first tries to talk to the student instead of punishing the student immediately	1	2	3	4	5
23.	The teacher often asks us for our opinion when something important needs to be decided	1	2	3	4	5
24.	The teacher encourages us to speak and talk freely	1	2	3	4	5
25.	The teacher is always in a good mood during the class	1	2	3	4	5
26.	If we have good suggestions, we can influence the teaching and decide together about the teaching form	1	2	3	4	5
27.	The teacher cares about the success of only a small number of students	1	2	3	4	5
28.	In our school, everyone has to "break through" on their own; one cannot count much on the support of teachers	1	2	3	4	5
29.	The teacher shows an understanding that in the last school hours, we can no longer focus completely on work	1	2	3	4	5
30.	The teacher appreciates only advanced students	1	2	3	4	5

Satisfaction with teaching						
49.	If I could change something about the way teaching is conducted, then I would make big changes	1	2	3	4	5
50.	I would easily accept the permanent suspension of classes	1	2	3	4	5
51.	There are days when I would rather not go to school	1	2	3	4	5
52.	I find the teaching boring and not interesting	1	2	3	4	5
53.	The teacher thinks that his/her subject is the most important	1	2	3	4	5
54.	If I could have an opportunity to study elsewhere (e.g., at home), and just have my knowledge assessed at school, I would immediately choose that	1	2	3	4	5
55.	When it comes to testing, the teacher does not pay attention to whether we have another test that day	1	2	3	4	5
56.	I am satisfied with the teaching	1	2	3	4	5
57.	The content of the subject is interesting to me	1	2	3	4	5
58.	I learn a lot of useful things in class	1	2	3	4	5
59.	Homework is useful	1	2	3	4	5

60.	The school material needs to be explained to me by someone other than the teacher so that I can understand it	1	2	3	4	5
61.	Teacher lectures and work instructions are clear	1	2	3	4	5
62.	The way of interpreting the material is interesting and motivating	1	2	3	4	5
63.	I have too many classes	1	2	3	4	5
64.	In class, we learn things we will never need	1	2	3	4	5
65.	I am bored with the way the teacher teaches	1	2	3	4	5
66.	Classes are mostly dynamic and well-used	1	2	3	4	5
67.	If you are attentive during the class, it is not necessary to study too much at home	1	2	3	4	5
68.	Methods, examples, and tasks facilitate the achievement of learning outcomes	1	2	3	4	5

69.	What do you like about the work of a teacher?
70.	What could a teacher do to make teaching better?
71.	What didn’t you like about the teacher’s work on this subject?

Thank you for your time

Attitudes and Awareness toward Cosmetic Surgery among Students at the Catholic University of Croatia: A Cross-Sectional Study

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Abstract

Background: Cosmetic surgery has become an increasingly prominent aspect of contemporary healthcare and is closely linked to the global beauty industry, where medical procedures intersect with societal beauty standards and media influence. Procedures are undertaken for a range of reasons, from correcting congenital abnormalities to enhancing appearance and reducing signs of ageing. Attitudes toward cosmetic procedures are shaped by a combination of sociodemographic, cultural, and religious factors.

Aim: To assess the attitudes and awareness of students at the Catholic University of Croatia toward cosmetic surgery, and to examine their main sources of information, as well as differences according to selected sociodemographic characteristics.

Methods: This cross-sectional study was conducted at the Catholic University of Croatia between March and April 2025. Data was collected using an anonymous online questionnaire distributed via official university email addresses. The questionnaire assessed sociodemographic characteristics, awareness, and attitudes toward cosmetic surgery.

Results: A total of 263 students participated. Most respondents were familiar with cosmetic surgery (95%), but only 35% reported a positive attitude toward it. Only 1.1% of respondents stated that cosmetic surgery would negatively affect their relationships. However, 46% believed that others' opinions of them would change if they underwent such a procedure. Attitudes toward the social acceptability of cosmetic surgery in Croatia were divided, and 46% of respondents considered cosmetic surgery to be religiously acceptable. Social media was identified as the primary source of information. Significant differences were observed according to sex, age, religiosity, and study type.

Conclusion: Although awareness of cosmetic surgery is high, positive attitudes remain limited. Students' perspectives are influenced by gender, religious beliefs, and social factors, with social media playing a central role in shaping attitudes toward cosmetic procedures.

Keywords: cosmetic surgery; attitudes; awareness; students; social media; religious beliefs

Introduction

Cosmetic and reconstructive surgery are both branches of plastic surgery. Reconstructive surgery restores function and anatomical integrity after trauma, disease, or congenital anomalies, whereas cosmetic surgery modifies otherwise normal structures to improve appearance, self-confidence, and quality of life. Unlike reconstructive procedures, cosmetic interventions usually lack a functional medical indication and are based on patients' subjective aesthetic expectations.

Media promotion of aesthetic procedures helps shape modern beauty standards and may encourage a culture focused on physical appearance, potentially increasing insecurity and raising questions about the medical necessity and criteria for performing such procedures. The concept of what is considered 'normal' or 'ideal' appearance is highly subjective and may vary across different social and cultural contexts within contemporary society (1–4).

Ethics in Cosmetic Surgery

Ethical risk arises when aesthetic medicine becomes an instrument for satisfying the vanity demands of a wealthy minority or when aggressive, profit-oriented marketing encourages the population to continuously find new "flaws", promoting beauty as a key criterion for success and happiness.

The practice of cosmetic surgery must be based on universally accepted bioethical principles. One of these principles is fairness, which implies equal treatment for all patients. The next principle is beneficence, which requires that the physician acts in the best interests of the patient, seeking to improve their health, self-esteem, and general well-being, while respecting the patient's realistic possibilities and wishes, and minimising perioperative complications. Furthermore, harmlessness builds on the previous two postulates and obliges the physician to avoid any intervention that could cause physical, psychological, or social harm to the patient. Finally, patient autonomy emphasises the individual's right to make independent decisions about his or her own body (5,6).

The therapeutic principle (principle of totality) ethically justifies surgical procedures that preserve or improve physical and psychological health. Procedures like reconstructive surgery or correction of anomalies gain therapeutic legitimacy by supporting mental well-being and social integration, distinguishing them from purely aesthetic interventions (7,8).

The principle of vulnerability recognises that individuals are sensitive to physical, psychological, and social circumstances that may threaten their dignity and well-being. In this context, cosmetic surgery may help individuals experiencing significant psychosocial distress by restoring self-confidence and supporting social integration. This principle therefore, calls for greater sensitivity among medical professionals toward the patient's subjective experience when evaluating the need for intervention (7,8).

Although the present discussion draws primarily on a personalist bioethical and Christian anthropological perspective, which emphasises principles such as beneficence, therapeutic legitimacy, and vulnerability, it is important to note that this represents only one ethical framework. Other ethical perspectives critically examine the normalisation of cosmetic surgery, highlighting the role of media and social pressures, gendered expectations regarding appearance, and potential limitations of individual autonomy in decisions about aesthetic procedures.

Cosmetic Surgery in the Context of Christianity

In the Christian tradition, the body is considered the temple of the soul, with spiritual virtues. Though made of body and soul, man is one (9). Throughout history, moral theologians have generally taken a reserved stance towards cosmetic surgery, primarily because they believed that "God's work" should not be altered and because complex procedures on the face and body were once performed by unskilled persons without medical supervision. A crucial point in the change in the Church's approach was the speech of Pope Pius XII in 1958 at the Congress of Italian Plastic Surgeons, which officially recognised

the legitimacy of this discipline for the first time. The Pope emphasised that each procedure must be judged according to strict medical criteria: an assessment of the physical and psychological burden, the risk of complications, and realistic expected results (10–12).

Within the Christian theological framework, cosmetic surgery, when placed appropriately within a hierarchy of values and guided by the principle of the integrity of the person, does not necessarily contradict God's will, provided that the procedure is justified by proportionate motives and realistic expectations. The common conclusion of moral theologians is that cosmetic surgery is neither intrinsically (morally) good nor evil and is permissible where the intentions are virtuous, the risks are small, the motives proportionate, and the cost reasonable, but is unethical if it is based on vanity, inauthenticity, or encourages social injustice (10).

Religious beliefs are a significant cultural and psychosocial factor in shaping the attitudes of individuals and social groups towards physical appearance, the ageing process, and the acceptability of medical interventions, including cosmetic surgery. Within many religious systems, particularly within the Christian tradition, the emphasis is placed on inner beauty, spiritual values, and moral integrity, with external appearance perceived as secondary and subject to transience. Such a worldview approach may act as a protective mechanism against socially induced pressure from aesthetic norms and modulate the motivation to undergo elective surgical procedures (10–13).

These theoretical and ethical perspectives provide a framework for understanding students' knowledge, attitudes, and perceptions of cosmetic surgery. In the context of the Catholic University of Croatia, such views may also be influenced by Christian values regarding the dignity of the human body and the balance between physical appearance and inner virtues. Examining students' perspectives, therefore, helps to understand better how ethical principles, social influences, and religious beliefs shape attitudes toward cosmetic surgery.

Although cosmetic surgery has been widely studied, a limited number of studies have explored how ethical and religious perspectives influence students' attitudes toward these procedures. Little is known about how students in faith-based academic environments perceive cosmetic surgery in relation to bioethical principles and Christian values. Therefore, this study aims to assess the attitudes and awareness of students at the Catholic University of Croatia toward cosmetic surgery, and to examine their main sources of information, as well as differences according to selected sociodemographic characteristics.

Materials and methods

Study design

This was a cross-sectional study. Based on the study aim, four hypotheses were formulated:

1) Most participants have a positive attitude towards cosmetic surgery.
2) Most participants report being familiar with cosmetic surgery.
3) Most participants identify social media as their primary source of information.
4) Most participants believe that cosmetic surgery is religiously acceptable.

Ethics

The study was approved by the Ethics Committee of the Catholic University of Croatia (decision issued on March 3, 2025, Class: 602-04/25-11/06; Registration Number: 251-498-03-02-25-2). Participants were informed about the purpose of the study, as well as the anonymity and voluntary nature of their participation, and their right to withdraw at any time. Prior to the start of the online survey, all participants were presented with an informed consent form.

Participants

Participants were undergraduate and graduate students at the Catholic University of Croatia, enrolled in both medical (Nursing and Medicine) and in humanities and social science study programmes (Communication Sciences, Psychology, History, and Sociology). Inclusion criteria were being a currently enrolled student at the Catholic University of

Croatia and providing informed consent to participate in the study.

Data Collection and Study Tool

The study was conducted at the Catholic University of Croatia in Zagreb between March 16 and April 29, 2025. Data was collected using an online questionnaire administered via Google Forms. The survey link was distributed to participants through their official university email addresses. The instrument used in this study was a questionnaire adapted from a previously published study by Adedeji et al. (14), which examined awareness and attitudes toward cosmetic surgery among healthcare workers. The questionnaire is freely available and does not require permission for use. It was translated into Croatian and culturally adapted to the local context. It consisted of 26 items.

The first section included questions on participants' sociodemographic characteristics. The second section assessed knowledge and awareness of cosmetic surgery, while the third section focused on attitudes toward cosmetic surgery. Knowledge and awareness were measured using a three-point ordinal scale: (1) No; (2) Not sure; (3) Yes. Two items included multiple-choice response options.

Statistical Analysis

This study primarily presents descriptive statistics and subgroup comparisons. Questionnaire items were analysed individually and were not combined into a composite scale. Categorical data are represented by absolute and relative frequencies. Differences in categorical variables were tested with the $\chi 2$ test and, if necessary, with Fisher's exact test. The normality of the distribution of continuous variables was tested with the Shapiro-Wilk test. Continuous data are described by the median and the limits of the interquartile range. Differences in continuous variables were tested with the Mann-Whitney U test, and between three or more independent groups with the Kruskal-Wallis test (15). All p-values are two-sided. The significance level was set at alpha=0.05. The statistical package MedCalc® Statistical Software version 23.2.1 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2025) was used for statistical analysis. The report on the study was prepared according to the STROBE guidelines for reporting on cross-sectional studies (16). The analytical approach focused on bivariate comparisons. Multivariate analyses were not conducted, and no formal adjustment for multiple comparisons was applied. Ordinal questionnaire responses were analysed as categorical variables.

Results

A total of 263 students at the Catholic University of Croatia participated in the study, representing a response rate of 18.5% of the total student population (N=1420). The sample consisted predominantly of women (231; 88%), while men accounted for 32 participants (12%). Regarding age distribution, most participants were between 20 and 30 years old (189; 72%), followed by those younger than 20 years (39; 15%). Smaller proportions of participants were aged 31–40 years (19; 7%), 41–50 years (14; 5%), and older than 50 years (2; 1%). Other demographic characteristics and the distribution of participants by study programme are presented in Table 1.

Table 1. *Demographic characteristics of the participants*

		Number (%) of participants
Sex	Men	32 (12)
	Women	231 (88)
Age	< 20	39 (15)
	20 – 30	189 (72)
	31 – 40	19 (7)
	41 – 50	14 (5)
	> 50	2 (1)
Living area	Urban	203 (77)
	Rural	60 (23)
Religion	Atheist	6 (2)
	Agnostic	28 (11)
	Believer	229 (87)
Type of studies	Humanities and social science studies	142 (54)
	Medical studies	121 (46)
Level of study	Undergraduate	150 (57)
	Graduate	113 (43)

Most respondents reported being familiar with cosmetic surgery (95%). The majority were aware that cosmetic surgery is available in Croatia (98%) and that it carries certain risks (92%). A positive attitude toward cosmetic surgery was reported by 35% of participants. Social media was identified as the main source of information about cosmetic surgery.

Participants expressed mixed attitudes toward cosmetic surgery. While many respondents indicated they would consider undergoing cosmetic surgery if it were free, a substantial proportion believed that others' opinions of them might change if they underwent such procedures. Only a small proportion of respondents reported that cosmetic surgery would negatively affect their relationships (1.1%, n=3), indicating a very low prevalence of this view. Most respondents also reported that they would openly admit to having undergone cosmetic surgery. Regarding religious perspectives, 46% of participants considered cosmetic surgery to be religiously acceptable.

Comparisons were performed across different subgroups (sex, residence, religiosity, age, and study type). Reported medians refer to individual questionnaire items scored on a three-point Likert scale (1–3), with higher values indicating greater awareness, more positive attitudes, or stronger agreement. Differences in attitudes toward cosmetic surgery according to respondents' sex are presented in Table 2. Women demonstrated higher levels of awareness, more positive attitudes, and greater willingness to undergo cosmetic surgery, whereas men more often perceived cosmetic surgery as negatively affecting relationships.

Students from humanities and social science study programmes were significantly more likely to obtain information through social media, radio, and television, whereas students from health-related programmes more frequently relied on medical literature and health professionals ($\chi 2$ test, $p<0.001$).

A total of 111 participants (42%) considered cosmetic surgery to be justified and necessary in certain cases. Among them, rhinoplasty (nose surgery) was most frequently identified as justified (82; 74%). In contrast, breast augmentation (26; 24%) and face lift procedures (27; 24%) were considered the least justified (Table 3).

Table 2. *Differences in attitudes towards cosmetic surgery according to participants' sex*

	Median (interquartile range)		*p**
	Men Median (IQR)	Women Median (IQR)	
Are you aware of cosmetic surgery?	2 (2-3)	3 (3-3)	**0.02**
Do you have a positive attitude towards cosmetic surgery?	1.5 (1.3-2)	2 (2-3)	**0.03**
If cosmetic surgeries were done for free, would you go for any cosmetic surgery of your choice?	1 (1-2)	2 (1-3)	**0.005**
If you were aware that someone had undergone cosmetic surgery, would it negatively affect your relationship with such a person?	2 (1-2)	1 (1-1)	**0.002**
Undergraduate	150 (57)		

*Mann-Whitney U test

Table 3. *Distribution of respondents according to which cosmetic surgeries they consider necessary*

	Number (%) of participants
Which one(s) of these surgeries do you think is/are necessary?	
Rhinoplasty	82 (74)
Cleft Surgery	75 (68)
Breast Reduction	69 (62)
Abdominoplasty	39 (35)
Liposuction	33 (29)
Mastopexy	28 (25)
Face lift	27 (24)
Breast Augmentation	26 (24)

Discussion

This study aimed to examine students' attitudes, knowledge, and information sources regarding cosmetic surgery at the Catholic University of Croatia, Zagreb. Results show that most students do not hold a positive attitude toward cosmetic surgery, despite being familiar with the topic and citing social media as their main information source. Fewer than half consider cosmetic surgery religiously acceptable, suggesting that gender, cultural, and religious factors shape students' perspectives on cosmetic procedures.

Contrary to expectations, the main hypothesis, according to which most students at the Catholic University of Croatia have a positive attitude towards cosmetic surgery, was not confirmed. This result may suggest a possible influence of the university's religious and value environment on students' attitudes toward interventions perceived as unnecessary or superficial, although this was not directly measured in the study. Women show significantly more positive attitudes toward cosmetic surgery than men. A study by Kasmaei and colleagues among students at Guilan University of Medical Sciences found that sex is a significant predictor of willingness to undergo cosmetic procedures. Compared with men, women reported greater body dissatisfaction, a more negative perception of their physical appearance, and a higher intention to undergo cosmetic surgery (17). Numerous studies that highlight women's greater interest in cosmetic surgery are also supported by a study by Brstilo Lovrić et al, whose aim was to gain insight into the profile of students in the city of Zagreb interested in cosmetic surgery. The study showed that, unlike male students, female students are more interested in cosmetic surgery (18).

The finding that most students identify social media as their primary source of information about cosmetic surgery indicates a strong media influence on attitudes toward body image and beauty, supporting the study's hypothesis. The next study also highlights the role of social media in shaping body perception and attitudes toward cosmetic procedures. A study by Chen involving 252 participants found that greater engagement with social media and photo-editing applications was associated with a higher likelihood of considering cosmetic surgery. Additionally, users of YouTube demonstrated lower self-esteem and greater acceptance of cosmetic surgery (19).

Social media often promotes unrealistic expectations and aesthetic ideals, which can further influence the perceived need for appearance correction. In his 2014 study, Perloff described the interaction between social media use and body image perception as a reciprocal process. People who show more pronounced concerns about their own body image tend to use social media more intensively, especially those platforms that emphasise physical appearance (20). Alghamdi et al., in their study of women in Saudi Arabia, interpret that most participants, as many as 67%, refused cosmetic surgery even if it was offered to them for free (21). This result is confirmed by this study, the results of which show that approximately one-third of the respondents would opt for free cosmetic surgery of their choice. Among those who would accept this offer, women are represented in significantly greater numbers than men.

The last hypothesis, according to which most students consider cosmetic surgery to be religiously acceptable, was rejected. Although just under half of the respondents considered it religiously acceptable to undergo cosmetic surgery, this suggests a possible conflict between personal aesthetic aspirations and religious beliefs, which is particularly important in the context of the students' Catholic identity. Similarly, some previous studies have shown that religious beliefs can have an inhibiting effect on attitudes towards cosmetic procedures, especially when they are seen as an expression of excessive emphasis on external appearance. Such dilemmas have also been observed in international studies, where religiosity, along with fear, often acts as a factor limiting the acceptance of cosmetic procedures. In a study conducted by Al-Bashaireh et al. in 2025, religious reasons influenced 44% of respondents, indicating a strong moral or

ethical stance against cosmetic changes (22).

Of the total number of respondents who believe that cosmetic procedures are justified and necessary in certain circumstances, the largest number cites rhinoplasty as the most accepted procedure, followed by cleft surgery, and then breast reduction. Additionally, in a survey conducted among healthcare professionals in Osogbo, Nigeria, Adedeji et al. concluded that cleft surgery was singled out as the only form of cosmetic surgery that most respondents, 117 (55%) of them, considered necessary (14). These data indicate a clear distinction between cosmetic and reconstructive procedures in the perception of the general population, with surgical correction of cleft palates being predominantly perceived as a procedure with a pronounced functional, psychosocial, and health indication, as opposed to a procedure with purely aesthetic motivation.

Strengths, Limitations, and Future Directions

One of the main strengths of this study is its focus on students at a Catholic university, including both health-related and humanities and social science programmes, providing insight into a diverse population within a specific cultural and institutional context. In addition, the study employed a structured statistical approach, adhered to ethical research standards, and applied an interdisciplinary framework integrating medical, social, and ethical perspectives on attitudes toward cosmetic surgery.

However, several limitations should be acknowledged. The relatively short study period and modest sample size may limit the generalisability of the findings to a broader student population. Furthermore, the predominance of female participants may have influenced the overall attitudes reported and limited the robustness of gender comparisons. The use of exclusively bivariate statistical analyses also restricts the ability to identify independent predictors of attitudes toward cosmetic surgery. In addition, direct comparability with previous studies is limited due to differences in conceptual frameworks and study designs.

Future research should include larger and more diverse samples, ideally across multiple universities, to better examine the influence of cultural and religious contexts on attitudes toward cosmetic surgery. Studies with more gender-balanced samples are also warranted. Moreover, the use of multivariate statistical methods would allow for the identification of independent predictors of attitudes. Finally, combining quantitative and qualitative approaches could provide a deeper understanding of the underlying reasons for positive or negative attitudes, including the influence of specific media content, social media trends, and influencers.

Conclusion

The findings indicate that most students do not hold a positive attitude toward cosmetic surgery, with social media identified as the primary source of information. Fewer than half of respondents consider cosmetic surgery to be religiously acceptable. Female students showed a greater inclination toward cosmetic procedures, whereas male students more often reported that a partner's cosmetic surgery could affect relationships. Overall, attitudes toward cosmetic surgery appear to be shaped by a combination of gender, religious beliefs, and social influences.

Declarations

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Ethics considerations: The study was approved by the Ethics Committee of the Catholic University of Croatia, which confirmed that the study

was conducted in accordance with the Code of Ethics of the Catholic University of Croatia and applicable legal regulations. The decision was issued on March 3, 2025 (Class: 602-04/25-11/06; Registration number: 251-498-03-02-25-2).

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Patients' Perception of Nurses' Communication in a University Hospital Center Zagreb: A Cross-Sectional Study

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Abstract

Background: Communication between nurses and patients is crucial for the quality of healthcare, as well as for patient satisfaction and safety. Research shows that effective communication increases trust and leads to better treatment outcomes, while its absence can result in dissatisfaction.

Aim: This study aimed to examine patients' perceptions of communication with nurses and to identify factors influencing it.

Methods: A cross-sectional study was conducted at the University Hospital Centre (UHC) Zagreb during March and April 2025. Hospitalised patients from the Department of Internal Medicine were included. Data were collected using a customised survey questionnaire and analysed using descriptive and inferential statistical methods.

Results: A total of 309 participants took part in the study. The average satisfaction score with communication was 4.41 on a scale from 1 to 5. The highest satisfaction was recorded for approachability, kindness, and consistency in care, while the lowest scores were given for nurse introductions (average 4) and family involvement (average 4.1). A statistically significant association was found between patient gender and satisfaction with communication, with male patients giving higher average ratings (4.5) than female patients (4.3; p=0.007), as well as between the presence of support from loved ones and satisfaction with communication, where patients with support rated communication higher (4.43) compared to those without support (3.97; p=0.031). No statistically significant association was found between patient age or type of hospital accommodation and satisfaction with nurse communication.

Conclusion: The majority of patients participating in the study had a positive perception of communication with nurses. The results highlight the importance of continuous development of communication skills and may serve as a basis for improving work organisation and nurse education in Croatian hospitals.

Keywords: nurse-patient relations; patient satisfaction; communication; nursing care; hospitals

Introduction

Communication in nursing represents a fundamental process of exchanging information, emotions, and attitudes between nurses and patients, as well as among members of the healthcare team, through verbal, nonverbal, and written forms. It is a two-way process in which patients express their concerns and fears, while nurses provide information about illness, treatment, and rehabilitation, demonstrating empathy, honesty, and discretion (1). Clear and accurate communication in healthcare settings is essential for patient involvement in care and decision-making, and numerous studies have confirmed that effective communication significantly contributes to quality care and patient recovery (2,3).

Effective communication requires a wide range of skills, including active listening, clarity of expression, understanding of patients, and empathy. Nurses, as healthcare professionals who spend the most time with patients, face daily challenges related to communication that extend beyond information exchange to building trust, providing emotional support, recognising individual needs, and respecting cultural and personal differences (2,3). In addition to verbal communication, nonverbal communication—such as facial expressions, gestures, posture, and physical distance—plays a crucial role in nurse–patient interactions. Active listening, involving full attention and awareness of both verbal and nonverbal messages, is essential for understanding patients' needs.

High-quality communication improves treatment outcomes, increases patient satisfaction, and contributes to nurses' professional satisfaction. Therefore, the development of communication skills is a key component of nursing education and continuous professional development, as these skills are necessary for delivering humane, safe, and effective healthcare (8). Poor communication, on the other hand, may lead to misunderstandings, patient confusion, and compromised safety (9).

Empathy is a concept frequently emphasised in the literature on nursing communication. Empathic communication enables nurses to better understand patients' emotions and experiences, fostering trust and improving the quality of care and treatment outcomes. Although its importance is widely recognised, empathic communication is not yet clearly defined in the scientific literature, particularly in hospital settings, highlighting the need for further research (3,4).

Several studies have identified significant barriers to effective communication, including language differences, workload, staff shortages, organisational factors, family interference, and stressful working environments (5,7). These barriers negatively affect nurses' motivation, emotional well-being, and ability to establish meaningful relationships with patients. Research also shows that patient dissatisfaction and complaints are often related to a lack of empathy, respect, and individualised care, which can reduce trust in the healthcare system (6).

Although some of the cited studies originate from healthcare and cultural contexts different from Croatia, they were included because they address universal dimensions of nurse–patient communication—such as empathy, respect, and clarity—which are consistently recognised as fundamental components of quality nursing care across diverse settings.

Overall, existing evidence clearly indicates that the quality of communication between nurses and patients is a crucial determinant of healthcare outcomes. Despite extensive research, there remains a need for further investigation into factors influencing communication perception, particularly within specific healthcare contexts such as large clinical hospital centers in Croatia. Such research is necessary to identify existing weaknesses, support continuous improvement of communication skills, and enhance the overall quality of nursing care.

This study aimed to examine patients' perceptions of the communication of nurses and to identify the factors influencing it.

Materials and Methods

Study design

A cross-sectional study was conducted.

Ethics

The study protocol was approved by the Ethics Committee of the University Hospital Centre Zagreb (approval number: 02/013 AG, March 3, 2025). This approval ensured compliance with ethical standards of the research process, including the protection of participants' rights, dignity, and safety. Prior to participation, all patients provided written informed consent, which explained the purpose of the study, data usage, anonymity, and the right to withdraw from the study at any time without any negative consequences for their care. The informed consent form specified that all collected data would be used solely for scientific purposes.

Study Setting and Period

The study was conducted at the Department of Internal Medicine, University Hospital Centre Zagreb (UHC), Croatia. Data were collected during March and April 2025. This time frame allowed for an adequate period of data collection.

Participants

The study population consisted of adult hospitalised patients. A convenience sample was used, comprising patients aged 18 years or older who were hospitalised at the Department of Internal Medicine, University Hospital Centre (UHC), Zagreb, during the study period. Patients with cognitive impairments that prevented them from completing the questionnaire were excluded from the study.

Procedures

The study used a questionnaire originally developed and validated in the study *Patients' perceptions of nurses' communication in public hospitals of Harari Regional State, Eastern Ethiopia* by Yazew Bekele et al., published in SAGE Open Medicine in 2022 (1). The instrument uses a Likert-type response scale. For the purposes of this study, the questionnaire was translated and culturally adapted to the Croatian context, including minor linguistic modifications and the exclusion of one item not applicable to nursing practice in Croatia. Although a pilot test was conducted to assess clarity and comprehensibility, the Croatian version of the questionnaire has not undergone full psychometric validation. Therefore, the results should be interpreted with caution.

The questionnaire used in this study consisted of three parts. The first part included five items related to participants' sociodemographic characteristics, such as gender, age, level of education, employment status, and perceived support from family and/or friends during treatment.

The second part comprised four items assessing hospitalisation-related characteristics, including length of hospital stay, previous hospitalisation experience, type of hospital room (single or shared), and perception of the hospital environment (e.g., noise and activity level).

The third part consisted of 24 items assessing patients' perceptions of nurses' communication during hospitalisation. Responses were measured using a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The items covered multiple dimensions of nurse–patient communication, including respect and courtesy, empathy, emotional support, responsiveness to patient needs, clarity and accuracy of information, involvement of patients and their families in care, protection of privacy and confidentiality, as well as verbal and nonverbal communication behaviours. The item related to informing patients about test results was excluded from the original questionnaire, as this responsibility does not fall within the scope of nursing practice in Croatia.

The questionnaires were completed anonymously. Paper-based questionnaires were distributed to patients during hospitalisation. Although nurses employed at the Department of Internal Medicine assisted in facilitating access to patients, data collection was organised in a way that ensured that nurses were not present during questionnaire completion and did not influence patients' responses.

Data Analysis

The first step of data analysis involved describing the basic characteristics of the participants and their responses. For categorical variables, such as sex, age groups, or type of hospital accommodation, frequencies and percentages were calculated.

For continuous variables, such as ratings of different aspects of nurses' communication (e.g., kindness, clarity of information, family involvement), means (arithmetic averages) and standard deviations were calculated.

Data were analysed using descriptive and inferential statistical methods. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as means and standard deviations. Differences between groups were examined using a t-test and ANOVA. Statistical significance was set at $p<0.05$. All analyses were performed using appropriate statistical procedures to address the study objectives. All statistical analyses were performed using SPSS version 28 (IBM Corp., USA), which enables accurate and reliable data processing.

Results

A total of 309 hospitalised patients participated in this study. During the study period, questionnaires were distributed to 322 eligible patients, of whom 309 completed and returned the questionnaire, corresponding to a response rate of 96%. The socio-demographic characteristics of the participants are presented in Table 1. The distribution by sex showed an almost equal representation of males and females in the sample. Of the total number of participants, 162 (52%) were female, and 147 (48%) were male. Regarding age distribution, the largest proportion of participants were aged over 65 years, comprising a total of 99 patients. Other age groups were relatively evenly represented, although younger patients accounted for a slightly smaller proportion, indicating a higher frequency of hospitalisation among the older population (Table 1).

Analysis of educational level showed that most of participants (N=141; 46%) had completed secondary education. As shown in Table 1, a smaller proportion of participants had higher educational attainment, including college or university education, indicating a predominance of secondary education among hospitalised patients.

Characteristics of Hospitalisation and Hospital Stay Conditions

Hospitalisation characteristics of the participants and conditions of hospital stay are presented in Table 2. Regarding the length of hospitalisation, stays longer than five days were the most frequently reported, representing the largest proportion of the sample. In terms of previous hospitalisation experi-

Table 1. *Socio-demographic characteristics of participants (n = 309)*

Characteristic	Category	Frequency	Percentage (%)
Gender	Female	162	52
	Male	147	48
Age	18–24 years	13	4.2
	25–34 years	26	8.4
	35–44 years	35	11
	45–54 years	61	20
	55–64 years	75	24
	65+ years	99	32
Level of education	Primary school	40	13
	Secondary school	141	46
	College	53	17
	Undergraduate degree	20	6.5
	Graduate degree	47	15
	PhD	8	2.6

ence, the majority of participants (80%) reported having been hospitalised previously.

Regarding the type of accommodation, the majority of participants (85%) were accommodated in shared rooms during hospitalisation. Furthermore, when asked whether the hospital environment was noisy and busy, most participants (68%) did not perceive it as noisy (Table 2).

Perception of Nurses' Communication

The mean scores of patients' ratings of various aspects of nurses' and communication are presented in Table 3 and provide insight into patients' perceptions of healthcare staff communication during hospitalisation.

The highest mean scores were recorded for items related to direct and expected

Table 2. *Characteristics of hospitalisation and conditions of stay (n = 309)*

Characteristic	Category	Frequency	Percentage (%)
Family support	Yes	299	96.8
	No	10	3.2
Length of hospital stay	1–2 days	42	14
	3–4 days	64	21
	≥5 days	203	66
Previous hospitalisation	Yes	246	80
	No	63	20
Type of room	Private	45	15
	Shared	264	85
Noise level	Noisy	98	32
	Quiet	211	68

Table 3. *Average ratings of patients' perceptions of nurses' communication at UHC Zagreb (n = 309)*

Variable	Mean	SD
1. The nurse greeted me upon admission.	4.7	0.60
2. Nurses were helpful and showed care to reduce stress, anxiety, hopelessness, and pain.	4.6	0.76
3. Nurses respected my privacy and confidentiality.	4.6	0.77
4. Nurses showed me empathy.	4.3	1.03
5. Nurses earned my trust.	4.5	0.78
6. When I had physical or psychological needs, nurses provided appropriate support.	4.5	0.74
7. Nurses introduced themselves.	4.0	1.22
8. Nurses were attentive to my physical and psychological needs.	4.6	0.67
9. Nurses addressed my concerns/complaints.	4.4	0.90
10. Nurses gave me time to express my feelings to them.	4.2	1.05
11.Nurses addressed me by name.	4.3	1.07
12. Nurses responded to my calls for help.	4.6	0.69
13. Nurses maintained appropriate eye contact during communication.	4.3	0.91
14. Nurses discussed my preferences regarding medication administration.	4.4	0.93
15. Nurses encouraged me and my family to communicate freely.	4.3	0.95
16. Nurses were humble and kind during communication.	4.5	0.81
17. Nurses made efforts to clarify all my doubts.	4.3	0.93
18. Nurses displayed pleasant nonverbal gestures.	4.3	0.88
19. Nurses provided accurate information about the tests I needed.	4.4	0.90
20. Nurses sought my consent before performing procedures.	4.5	0.88
21. Nurses used appropriate tone and voice.	4.4	0.84
22. Nurses communicated with my family and included them in the care process.	4.1	1.07
23. Nurses delivered care according to the agreed plan.	4.6	0.64

nurse–patient interactions. For example, the statement "Nurses provided care as agreed" received a very high mean score of 4.6, indicating a high level of professionalism and consistency in patient care.

Factors Associated with the Perception of Nurses' Communication

This section focuses on factors associated with patients' satisfaction with communication with nurses, specifically sex, age, type of accommodation (private or shared room), and perceived support from family and friends, as presented in Table 4. The results indicate a difference in communication ratings according to patient sex. Male patients reported a higher mean satisfaction score for communication (4.52), whereas female patients reported a slightly lower mean score (4.31). This difference was statistically significant (p=0.007), indicating that male patients were more satisfied with communication with nurses than female patients.

Analysis of mean satisfaction scores across age groups showed that perceptions of communication slightly increased with age; however, the oldest age group was not necessarily the most satisfied. The highest mean score was reported by patients aged 55–64 years (4.53), while patients older than 65 years rated communication at 4.46. Younger age groups also reported high levels of satisfaction, with mean scores ranging from 4.23 to 4.42.

The type of accommodation (private or shared room) was not significantly associated with perceptions of communication with healthcare staff. Patients in private rooms reported a mean score of 4.42, while those in shared rooms had a mean score of 4.41. The difference was minimal and not statistically significant (p=0.884).

The presence of support from family members or friends during hospitalisation emerged as an important factor associated with satisfaction with communication. Patients who received support from close persons reported a mean score of 4.43, whereas patients without such support reported a substantially lower mean score of 3.97. This difference was statistically significant (p=0.031), indicating a positive influence of emotional and practical support on patients' communication experiences with nurses.

Discussion

This study, conducted among a convenience sample of hospitalised patients, showed that patients generally reported a high level of satisfaction with nurses' communication, with mean scores above 4.0 on a 1–5 scale. The highest-rated aspects were respect for privacy, professionalism, and consistency in care delivery, while the lowest-rated aspects were nurse introductions and family involvement. These findings indicate that patients value fundamental human and professional qualities, in line with previous research.

Similar results were observed in Bekele et al. (2020) in Harar, Ethiopia, where patients rated privacy and consent highly, while

Table 4. *Statistically significant factors associated with patient perceptions of nurses' communication at UHC Zagreb (n = 309)*

Factor	Category	Mean Satisfaction Score	p-value
Patient sex	Female	4.31	0.007
	Male	4 .52	
Patient age	Younger age groups	4.23-4.42	
	55-64 years	4.53	
	65+ years	4.46	
Types of hospital accommodation	Private room	4.42	0.884
	Shared room	4.41	
Support from Family / Friends	Yes	4.43	0.031
	No	3.97	

formal communication elements, such as introductions and family inclusion, received lower scores (1). Empathetic and consistent communication has been highlighted as key to patient satisfaction in other studies, including Babaii et al. (2021) in Iran (4).

Significant associations were found between patient satisfaction and sex as well as family support, while age and room type showed no significant effect. Male patients rated communication higher than females, contrasting with findings from Ethiopia, where women reported greater satisfaction. This may reflect cultural differences in expectations; in Croatia, men may have lower expectations or evaluate communication less critically. Similar gender patterns were reported in Sweden, where women more frequently expressed dissatisfaction, suggesting that gender differences in perception may be context-dependent.

Older patients (65+) rated communication highly, but the highest satisfaction was among those aged 55–64, consistent with Iranian and Ethiopian studies where older patients exhibit greater tolerance and lower expectations (5,1). Family support emerged as a crucial factor, significantly enhancing patient satisfaction, aligning with previous studies. Emotional support reduces stress and fosters a sense of security, facilitating communication.

Unlike Bekele et al., no significant difference was observed between private and shared rooms, suggesting that professional nursing care in Croatian public hospitals compensates for the physical environment. Overall, the average satisfaction score in this study (4.41/5) was considerably higher than in Ethiopia (41.9% positive perception), although low-rated aspects—introductions and family involvement—were consistent across contexts (1).

Prior research has identified barriers to effective nurse–patient communication, including workload, fatigue, time constraints, and organisational factors such as staff shortages, stress, and motivation (7,10). Although patients in this study rated communication highly, these systemic challenges may still limit consistency in practice. Empathy and interpersonal skills remain crucial, as they help reduce patient anxiety and improve outcomes (3,4).

In conclusion, patients value basic human approachability, kindness, and consistency, whereas formal communication and family involvement are less consistently practiced. These findings align with the international literature but also highlight context-specific factors, such as the standardized quality of care in Croatian hospitals.

Strengths and Limitations

A major strength of this study is that it provides valuable insight into hospitalised patients' perceptions of nurses' communication at one of Croatia's largest clinical centers, UHC Zagreb. Including patients from various departments of the Clinic for Internal Medicine allowed for diverse experiences and perspectives, offering a broader view of communication satisfaction.

The main limitation is the restricted generalisability of the results. Although 309 patients participated, this sample represents only a small proportion of the annual hospitalised population at UHC Zagreb (59,943 patients in 2022) and includes only one clinic. Thus, the findings may not be representative of all hospitalised patients at UHC Zagreb or other hospitals in Croatia. Younger patients were underrepresented, and the cross-sectional design prevents establishing causal relationships between factors and communication perceptions. Additionally, the questionnaire used in this study was not formally validated, as it represents a translated version of an existing instrument; therefore, the findings should be interpreted with caution and may serve as a basis for future validation and pilot research.

Recommendations for Future Research

Future studies should consider a longitudinal design to monitor communication perceptions throughout hospitalisation, capturing dynamic changes and factors influencing satisfaction at different stages. Including nurses' perspectives would provide valuable

insight into their experiences, challenges, and training needs related to patient communication. Given that the questionnaire used in this study was not formally validated, future research should also focus on its validation and psychometric evaluation. Cross-country comparisons within Europe could further reveal sociocultural influences on communication perceptions. Finally, intervention studies assessing the impact of communication training programmes for nurses could contribute to improving care quality and patient satisfaction.

Conclusion

The study demonstrates that hospitalised patients generally perceive communication with nurses and medical technicians positively, with the highest satisfaction reported for basic human kindness, courtesy, and consistency in care. Lower ratings for nurse introductions and family involvement highlight areas for improvement and potential targets for staff training. Male patients and those with family support reported higher satisfaction, while room type did not significantly influence perceptions, suggesting that standardised professional care can mitigate environmental differences. These findings emphasise the critical role of clear, empathetic, and consistent communication in enhancing patient experience and guiding organisational and educational interventions.

Declarations

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Perceived Patient-Centered Infertility Care and Interest in Less Invasive Treatment Options: A Cross-Sectional Study

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Abstract

Background: Infertility is a significant medical and psychosocial burden for couples. Patient-centred care (PCC) promotes informed decision-making by integrating patients' values and preferences. Within this approach, it is important to provide information about all therapeutic options, including less invasive treatments such as Restorative Reproductive Medicine (RRM).

Aim: To assess perceived patient-centred infertility care among couples undergoing treatment at the University Hospital Sveti Duh in Zagreb, and to examine the importance they attribute to being offered less invasive treatment options before medically assisted reproduction (MAR).

Methods: This cross-sectional study was conducted between January and April 2022 at the University Hospital Sveti Duh in Zagreb. The survey combined sociodemographic questions with selected items from the Patient-Centredness Questionnaire – Infertility (PCQ-I). The study included couples undergoing infertility treatment during the study period.

Results: A total of 101 couples participated in the study. Care was generally perceived as mostly or fully patient-centered. No significant link was found between being offered less invasive methods and overall satisfaction (p=0.34). However, respondents interested in less invasive treatments rated the domain of respect for patients' values and needs significantly lower compared to those not interested (median 2.3 vs 2.7; p=0.007). Married women reported significantly lower satisfaction than unmarried women in several PCC domains, including communication (median 2.42 vs 2.83; p=0.007) and overall patient-centeredness (median 2.49 vs 2.85; p<0.001).

Conclusion: While infertility care at the University Hospital Sveti Duh has been largely perceived as patient-centred, less invasive and restorative reproductive options remain insufficiently offered and integrated. Greater awareness and availability of restorative and fertility-awareness-based approaches may help strengthen shared decision-making and better align infertility care with patient-centred principles.

Keywords: infertility, patient-centred care, restorative reproductive medicine, medically assisted reproduction, patient satisfactions

Introduction

Infertility affects around one in six couples globally and has multifactorial medical, emotional, and social implications (1). The causes of infertility are numerous and not fully defined, and some are diagnosed using controversial diagnostic methods (2). The approach to infertility treatment generally does not involve physiologically based fertility awareness methods (FABM) despite their proven benefits in improving pregnancy rates, providing more comprehensive diagnostic evaluation, and less invasive targeted treatment, therefore leaving the medical approach to couples incomplete (3, 4). FABMs are evidence-based methods that are used to track, monitor, and interpret daily physical signs of the female menstrual cycle, such as cervical mucus monitoring, basal body temperature measurement, and urinary hormone monitoring. Despite the broad range of diagnostic and therapeutic options, the clinical approach often defaults to medically assisted reproduction (MAR), while physiological and less invasive approaches remain underutilized. It has been shown that in certain circumstances, such as in cases of polycystic ovary syndrome and in idiopathic (unexplained) infertility, MAR procedures are not more effective than waiting for natural conception (5, 6). The risk of overtreatment, complications, and financial costs of MAR should not be neglected (7).

The patient-centred care (PCC) model shifts the focus of healthcare from procedure-centred to person-centred care. It emphasizes respect for individual`s values, active patient participation, and transparent communication (8). In infertility treatment, integrating PCC enhances trust, compliance, and overall satisfaction with care (9, 10).

Restorative Reproductive Medicine (RRM) represents a clinically effective, physiologically based approach that identifies and treats underlying causes of infertility. RRM is based on monitoring the female fertility cycle and describes infertility as a consequence of multiple chronic health conditions that could be properly recognized and treated, resulting in fertility restoration. RRM includes cervical mucus monitoring, mild ovulation induction, ultrasound assessment of the menstrual cycle, timed intercourse, and monitoring of hormonal changes with different supplementation. Few studies have shown comparable or superior outcomes to MAR, with lower rates of complications and multiple pregnancies with significant cost savings (11-13). However, RRM is rarely offered as a standard option in Croatia, limiting couples' ability to make informed choices consistent with their values.

This study aimed to assess how patient-centred care is perceived among couples undergoing infertility treatment at the University Hospital Sveti Duh in Zagreb and to evaluate their attitudes toward receiving less invasive treatment options before MAR.

Materials and methods

Study design

This was an observational cross-sectional study.

Ethics

The study was conducted in alignment with the institutional Codes of Ethics. The research protocol was reviewed and approved by the Ethics Committee of the University Hospital Sveti Duh, Zagreb, Croatia (Approval No. 012-6791). All participants provided informed consent before participation in the study.

Participants

The study included couples diagnosed with infertility, defined as the failure to achieve a clinical pregnancy after 12 months of regular, unprotected intercourse, or after six months if the female partner was older than 35 years. Participants were recruited among couples undergoing infertility treatment at the University Hospital Sveti Duh in Zagreb. Couples with a history of recurrent spontaneous miscarriages, as well as those who had achieved pregnancy following previous fertility treatment, were also included.

Couples were eligible for inclusion if they had been trying to conceive for one year or less, if the female partner was over 40 years of age, or if they had a history of recurrent spontaneous miscarriages.

Data collection and study tools

The study was conducted between January and April 2022 at the University Hospital Sveti Duh in Zagreb. After providing written informed consent, participants completed the questionnaire while waiting for their appointment. One member of each couple completed the questionnaire on behalf of the couple, providing a single response per couple.

The questionnaire consisted of two parts: a demographic and clinical section, and a subset of items from the Patient-Centredness Questionnaire – Infertility (PCQ-I), assessing the domains of information, communication, patient involvement, and respect for patient values (10). Although the PCQ-I has demonstrated reliability across seven domains of patient-centred care—accessibility, information, communication, patient involvement, respect for patient values, continuity and transition, and competence (10)—this study focused on selected domains relevant to patients' familiarity with treatment options and their decision-making processes. Additional questions explored respondents' views on less invasive treatment approaches, such as restorative reproductive medicine (RRM), before medically assisted reproduction (MAR).

Statistical analysis

Descriptive statistics and inferential analysis were performed to explore relationships between perceptions of PCC and sociodemographic or clinical variables. The normality of distribution for continuous variables was tested using the Shapiro–Wilk test. Continuous data were described using the median and interquartile range (IQR) boundaries. Differences in continuous variables between two independent groups were tested with the Mann–Whitney U test (with the corresponding difference and 95% confidence interval). Differences between groups were assessed using the Kruskal–Wallis test. When significant differences were found, pairwise comparisons were performed using Conover's post hoc test with Bonferroni correction. The internal consistency of the questionnaire was assessed using Cronbach's alpha coefficient, which was 0.898. All p-values were two-tailed, and the significance level was set at $\alpha=0.05$. Statistical analysis was performed using MedCalc® Statistical Software version 23.2.1 (MedCalc Software Ltd., Ostend, Belgium; https://www.medcalc.org; 2025).

Results

Slightly more than half of respondents (52.5%) evaluated their infertility care as predominantly or fully patient-centred. No statistically significant association was found between the importance attributed to being offered less invasive treatments and overall PCC scores (P=0.35). However, a significant difference was observed in the domain of respect for patients' values and needs.

The highest-rated domain was information provision, indicating that medical staff offered clear and satisfactory explanations regarding treatment. In contrast, the lowest-rated domains were communication and patient involvement, indicating potential areas for improvement in shared decision-making in the process of infertility treatment.

The results showed a significant difference in the domain of respect for patients' values and needs according to respondents' views on less invasive treatment options. Participants who considered it important to be offered less invasive treatments before MAR rated this domain significantly lower compared with those who reported that this was not important (Table 1). Differences in perceived PCC were also observed according to marital status. Unmarried women reported higher overall PCC scores than married women. Specifically, married women rated the domains of information, communication, and respect for patients' values and needs significantly lower than unmarried women (Table 2).

Table 1. *Comparison of patient-centred care domains according to participants' attitudes toward less invasive infertility treatment methods*

Domain	Yes	No	Not important	P*
Information	3.0 (1–3)	3.0 (3–3)	3.0 (3–3)	0.26
Communication	2.4 (1.7–2.8)	2.8 (2.3–3.0)	2.7 (2.4–3.0)	0.07
Involvement in own treatment	2.3 (2–2.7)	2.7 (2–3)	2.3 (2.2–3)	0.43
Respect for patients' values and needs	2.3 (1.9–2.8)	2.7 (2.5–3)	2.7 (2.4–3)	0.007†
Overall patient-centredness	2.5 (1.7–2.9)	2.7 (2.2–3)	2.7 (2.4–2.9)	0.34

Values are reported as median (interquartile range).
* Kruskal–Wallis test (with Conover post hoc test)
† Significant at $P < 0.05$

Table 2. *Comparison of patient-centred care domains according to marital status*

Domain	Yes	No	Not important	P*
Information	2.0 (1–3)	3.0 (3–3)	1.0	0.02†
Communication	2.42 (2.0-2.9)	2.83 (2.58–3.0)	0.29	0.007†
Involvement in own treatment	2.33 (2.0-2.7)	2.67 (2.33–3.0)	0.30	0.05
Respect for patients' values and needs	2.43 (2.14–2.86)	2.71 (2.57–3.0)	0.29	0.01†
Overall patient-centredness	2.49 (1.93–2.84)	2.85 (2.63–2.98)	0.37	<0.001†

* Mann–Whitney U test
† Significant at $P < 0.05$

Discussion

The findings of this study indicate that infertility care at the University Hospital Sveti Duh is generally perceived as patient-centred. However, several dimensions of care—particularly communication and patient involvement – appear to be less developed. While participants rated the domain of providing information about treatment highly, lower scores in the domains of communication and respect for patients' values and needs suggest opportunities to strengthen shared decision-making during infertility diagnosis and treatment.

Although no significant differences were observed in overall PCC scores according to the importance of introducing less invasive procedures such as RRM before MAR, participants who considered it important to be offered such options rated the domain of respect for patients' values and needs significantly lower compared with those who reported that this was not important. This finding suggests that limited awareness and availability of less invasive, restorative approaches may affect patients' perceptions of whether their values and preferences are adequately acknowledged during infertility care. Restorative reproductive medicine methods are considered less invasive since they do not include follicle aspiration or egg retrieval, in vitro fertilisation, and embryo cultivation or transfers. Unfortunately, conventional medical education and professional guidelines rarely include RRM, limiting both physician familiarity and patient access (13).

Other studies have shown that clinicians often underestimate the importance of some elements of patient care and tend to assume that their only goal is to achieve pregnancy (14, 15). Couples often have additional expectations from health providers, such as a better understanding of fertility issues, improvement of overall health, and maintaining a close relationship with their partner (14). Therefore, the physicians should familiarize themselves with patients' preferences, respecting their values and preferences. Encouraging the patient to talk about their attitudes is an important step for

the implementation of patient-centred care and for the shared decision-making process, since it was shown that this could be the most neglected dimension of care in the treatment of infertility (15).

Our study has also shown that women who are not married had a better experience of overall medical care. In contrast, married women tended to rate the domains of information, communication, and respect for patients' values and needs lower (Table 2). These lower scores among married women suggest possible differences in their expectations or experiences regarding communication and respect for patient values during treatment.

This study used the PCQ-I questionnaire, which has been previously used in several countries (the Netherlands, Slovakia, Slovenia, Portugal, Iran, and New Zealand) (10, 16-19). These international studies have shown that patients have similar opinions on PCC care, feeling insufficiently involved in decisions and inadequately informed about alternatives (16-19). Introducing RRM as a systematic option could address these needs while aligning care with PCC ethics and bioethical principles of beneficence, autonomy, and non-maleficence.

Strengths and limitations of the study

This study has several strengths. It provides one of the first insights into patients' perceptions of patient-centred infertility care in Croatia using elements of the PCQ-I instrument. In addition, the study explores the perceived importance of less invasive treatment options within infertility care, a topic that has received limited attention in the regional literature.

However, several limitations should be considered. The cross-sectional design does not allow conclusions about causal relationships between perceptions of patient-centred care and views on less invasive treatment options. The study was conducted in a single tertiary care institution with a relatively modest sample size, which may limit the generalizability of the findings to other healthcare settings. Furthermore, only selected domains of the PCQ-I questionnaire were used rather than the full validated instrument, which may have restricted the comprehensiveness of the assessment of patient-centred infertility care. Finally, the results are based on self-reported perceptions of care, which may be influenced by subjective expectations or response bias.

Future research should employ the full version of the PCQ-I questionnaire on larger samples and across multiple healthcare institutions in Croatia to provide a more comprehensive assessment of patient-centred infertility care. During the preparation of this study, a simplified version of the PCQ-I was also developed, which may facilitate easier data collection and statistical analysis in future research (16). Furthermore, administering the PCQ-I after integrating restorative approaches such as Restorative Reproductive Medicine (RRM) into infertility treatment programs could help evaluate how fertility education and cycle monitoring contribute to a more holistic, individualized, and patient-centred model of care.

Overall, the findings highlight the importance of strengthening patient-centred infertility care through improved communication, respect for patients' values, and greater involvement of couples in treatment decisions.

Conclusion

Restorative and fertility-awareness-based methods represent less invasive approaches that align with the principles of patient-centred care. However, their limited inclusion in education and clinical practice may limit couples' access to comprehensive information about available treatment options.

Strengthening professional training and systematically integrating restorative approaches such as RRM into fertility care pathways may help broaden treatment choices and support respect for patients' values and informed decision-making.

Declarations

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Association Between Internet Addiction and Physical Activity in High School Students: A Cross-Sectional Study

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Abstract

Aim: The aim of this study was to examine the association between Internet addiction and physical activity among students enrolled in vocational health-oriented secondary schools.

Methods: A cross-sectional study was conducted among 157 students from two vocational health-oriented secondary schools. Data were collected using the Internet Addiction Test for Adolescents (IAT-A) and the Physical Activity Questionnaire for Adolescents (PAQ-A). Since the data were not normally distributed, nonparametric statistical methods were used. Group differences were analysed using the Mann–Whitney U test and the Kruskal–Wallis test, while the association between Internet addiction and physical activity was examined using Spearman's rank-order correlation.

Results: The median PAQ-A score was 2.40 (IQR 2.05–3.05), indicating generally low levels of physical activity among participants. Students who attended Physical and Health Education (PHE) demonstrated significantly higher physical activity levels compared with those who did not (Mann–Whitney U = 2166, p = 0.013, r = 0.24). Most students exhibited mild levels of Internet addiction (59.2%). No statistically significant differences in Internet addiction or physical activity were observed across most sociodemographic variables. Furthermore, no significant association was found between Internet addiction and physical activity (ρ = 0.026, p = 0.745).

Conclusion: No statistically significant association between Internet addiction and physical activity was observed in this sample. Participants demonstrated relatively low levels of physical activity and predominantly mild levels of Internet addiction. These findings suggest that Internet use and physical activity may represent independent behavioural domains in adolescents, highlighting the need for targeted interventions to promote physical activity regardless of Internet use patterns.

Keywords: internet addiction; physical activity; adolescents; students; physical education

Introduction

The Internet has become an integral component of modern life, providing substantial opportunities for education, communication, and entertainment, yet its excessive or inappropriate use may result in significant adverse consequences. Over a relatively short period, the Internet has become a dominant and highly sophisticated medium with a profound impact on the needs and behaviours of children and adolescents (1). Although Internet addiction has not yet been fully recognised, one subtype—Internet Gaming Disorder—has been included in the latest edition of the *Diagnostic and Statistical Manual of Mental Disorders* as a condition requiring further study (2). Internet addiction shares several characteristics with substance-related addictions, including those related to alcohol and drugs (3). Problematic Internet use is commonly defined as excessive engagement in online activities that negatively affect mental and physical health, as well as social, academic, and professional functioning (4). Researchers have increasingly focused on identifying diagnostic criteria and understanding the underlying mechanisms and consequences of Internet addiction (5). Some authors suggest that Internet addiction may be suspected when an individual spends more than 38 hours per week online, excluding occupational or academic requirements (6). Internet addiction has been associated with a wide range of social and health-related problems, including sleep disturbances, fatigue, weakened immune function, and increased susceptibility to illness. Psychological symptoms commonly associated with problematic Internet use include depression and anxiety (7).

Adolescents often use the Internet as a coping mechanism, which may further reinforce addictive patterns of behaviour. The prevalence of Internet addiction has been shown to increase significantly during adolescence, ranging between 4% and 18%, making this a critical period for preventive interventions (8). Earlier exposure to the Internet has been identified as a risk factor for the development of problematic use, while dysfunctional family environments may further increase vulnerability (9). A large European study involving 12,000 adolescents reported severe Internet addiction in 4.4% of participants (10). Therefore, preventive strategies should focus on strengthening emotional and social competencies, promoting responsible Internet use, and considering gender differences in behavioural patterns (11).

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure above resting levels (12). A substantial body of evidence confirms that physical activity plays a crucial role in the prevention and management of chronic diseases (13). Lower levels of physical activity are often observed among children from lower socioeconomic backgrounds, primarily due to limited access to organised sports and recreational opportunities (14). In addition to serving as behavioural role models, parents act as facilitators by enrolling children in sports clubs and supporting their participation in physical activities (15).

Compared with previous decades, contemporary children and adolescents increasingly adopt sedentary lifestyles, spending substantial amounts of time using computers, mobile devices, and television, often at the expense of physical activity (16). A large international study conducted across 71 countries among adolescents aged 11–18 years reported that 25.4% of participants did not engage in any form of physical activity, while only 22.9% were physically active on five or more days per week. Additionally, 16.9% of adolescents reported engaging in sedentary behaviour for more than five hours per day (17).

Physical and Health Education (PHE) is implemented throughout the educational system. Its primary objective is the acquisition and refinement of motor skills, knowledge, and habits that satisfy the fundamental human need for movement. Through structured instruction and the development of lifelong habits, PHE contributes to the formation of essential competencies, including adaptability to evolving work and life conditions, responsibility, solidarity, moral values, self-esteem, and acceptance of diversity (18). Notably, some vocational

health-oriented secondary schools provide limited or no structured physical education classes, even though for many students such classes represent the primary opportunity for organised physical activity. Students enrolled in health-oriented educational programmes, including future nurses and other healthcare professionals, represent a particularly relevant population. Reduced physical activity combined with an increased risk of problematic Internet use may have long-term implications for their physical and mental health. Moreover, as future healthcare providers, their health behaviours may influence their professional role modelling and health promotion practices.

Given these considerations, it is important to examine whether an association exists between Internet addiction and physical activity within this specific educational context. Understanding this relationship may inform the development of targeted interventions aimed at promoting physical activity, particularly in settings where formal physical education is limited or absent. Therefore, the aim of this study was to examine the relationship between Internet addiction and physical activity among secondary school students enrolled in vocational health-oriented educational programmes. The primary outcome of this study was the level of Internet addiction measured using the Internet Addiction Test for Adolescents (IAT-A), while physical activity level measured by the PAQ-A was examined in relation to Internet addiction and selected sociodemographic characteristics. We hypothesised that higher levels of Internet addiction would be associated with lower levels of physical activity.

Methods

Study design

This was a cross-sectional study.

Ethics

The study was approved by the Ethics Committee of the Catholic University of Croatia (REG. NO.: 498-15-06-24-005). Participation was voluntary and anonymous. All participants were informed about the purpose of the study prior to data collection. Written informed consent was obtained from all participants, and for minors, parental or guardian consent was secured in accordance with institutional and ethical guidelines.

Participants and data collection

The study sample included fourth-year students from two vocational health-oriented secondary schools: the Vinogradska School of Nursing and the Zagreb Health School. A voluntary response sampling method was applied, which may introduce selection bias, as students with a greater interest in the topic may have been more likely to participate. Consequently, this sampling approach may limit the generalizability of the findings beyond the studied population.

Data were collected using an online survey administered via the LimeSurvey platform between February 1 and April 10, 2024. The survey consisted of a structured questionnaire including sociodemographic items and two standardised self-report instruments.

Internet addiction was assessed using the Internet Addiction Test for Adolescents (19), a 20-item self-report questionnaire designed to measure problematic Internet use among adolescents. Each item is rated on a five-point Likert scale ranging from 1 (rarely) to 5 (always), with higher scores indicating greater levels of Internet addiction. An example item includes: "How often do you stay online longer than intended?" Total scores range from 20 to 100. Based on established criteria, scores were categorised as follows: 20–49 indicating normal use, 50–79 mild addiction, and 80–100 moderate to severe addiction. In the present study, the IAT-A score was primarily treated as a continuous variable in statistical analyses. Physical activity was assessed using the Physical Activity Questionnaire for Adolescents (PAQ-A), a validated self-administered instrument designed to measure general levels of physical activity over the previous seven days among adolescents aged approximately 14–19 years (20). The questionnaire consists of nine items, of which eight are scored on a 5-point scale, while the ninth item identifies respondents who were unable

to be physically active due to specific circumstances during the previous week. The first item assesses participation in sports during leisure time, with responses ranging from 1 (no participation) to 5 (seven or more times). Items 2–7 evaluate physical activity during school lessons, breaks, lunch, after school, evenings, and weekends, with scores assigned according to activity intensity. The final PAQ-A score is calculated as the mean of the eight scored items, ranging from 1 (low physical activity) to 5 (high physical activity) (20). Permission to use the instrument was obtained. Internal consistency reliability was assessed using Cronbach's alpha coefficient. The IAT-A demonstrated high internal consistency (α=0.89), while the PAQ-A showed good reliability (α=0.80), indicating that both instruments consistently measured the intended constructs within this sample.

Statistical Analysis

Statistical analysis was performed using JASP statistical software. Descriptive statistics were calculated for all variables and are presented as means and standard deviations for continuous variables, and as frequencies and percentages for categorical variables.

For the IAT-A scale, the Shapiro–Wilk test indicated a statistically significant deviation from normality ($W=0.891$, $p<0.001$). Similarly, the PAQ-A scores significantly deviated from normality ($W=0.768$, $p<0.001$). Given these findings, nonparametric statistical methods were applied in subsequent analyses. Differences between two independent groups were analysed using the Mann–Whitney U test, while comparisons across more than two groups were performed using the Kruskal–Wallis test. When appropriate, post hoc pairwise comparisons with Bonferroni correction were conducted. Associations between Inter-net addiction and physical activity were examined using Spearman's rank-order correlation coefficient. Categorical variables were compared using the chi-square (χ^2) test. The level of statistical significance was set at $p<0.05$. Effect sizes were calculated where appropriate and interpreted according to standard guidelines.

Results

Sociodemographic Characteristics of the Participants

A total of 157 students participated in the study. Most participants lived in a family home (n=135; 86%), while 22 students (14%) resided in a student dormitory. Regarding family structure, the majority of participants lived with both parents (n=127; 81%), 25 students (16%) lived with a single parent, and 5 students (3%) reported living without parental care. Most students reported an average economic status (n=133; 85%), while 17 participants (11%) reported above-average economic status and 7 (4%) reported below-average economic status. In terms of school affiliation, 55 students (35%) were enrolled in the Vinogradska School of Nursing, and 102 students (65%) attended the Zagreb Health School.

Table 1. *Differences in physical activity scores*

Variable	N	Median	IQR (Q1–Q3)	Mean Rank	U	p	r
School							
Vinogradska School of Nursing	55	1.80	1.33–2.60	66.51	2118	0.011	0.24
Zagreb Health School	102	2.26	1.71–2.74	85.74			
PHE							
Yes	100	2.26	1.71–2.74	85.84	2166	0.013	0.24
No	57	1.86	1.39–2.58	67.00			

IQR – interquartile range (Q1–Q3); U – Mann–Whitney U test;
r – effect size (rank-biserial correlation); PHE – Physical and Health Education.

Differences in Physical Activity Scores According to School and Participation in Physical Education

Analysis of differences in physical activity according to school and participation in Physical and Health Education (PHE) is presented in Table 1. Students from the Zagreb Health School demonstrated significantly higher levels of physical activity (median=2.26; IQR 1.71–2.74) compared with students from the Vinogradska School of Nursing (median=1.80; IQR 1.33–2.60), with a statistically significant difference (Mann–Whitney U=2118, p=0.011). The effect size was small to moderate (r=0.24).

Similarly, students who participated in Physical and Health Education had higher physical activity levels (median=2.26; IQR 1.71–2.74) compared with those who did not participate (median=1.86; IQR 1.39–2.58), and this difference was statistically significant (Mann–Whitney U=2166, p=0.013), with a small to moderate effect size (r=0.24).

Distribution of Internet Addiction Levels

Table 2 presents the distribution of Internet addiction levels among 157 participants. Normal Internet use was observed in 49 students (31.2%), while the majority (n=93; 59.2%) demonstrated mild addiction. Moderate addiction was identified in 13 participants (8.3%), and severe addiction in 2 participants (1.3%). Overall, most students exhibited mild levels of problematic Internet use.

Table 2. *Distribution of Internet Addiction Levels*

Internet Addiction Level	N	%
Normal	49	31.2
Mild	93	59.2
Moderate	13	8.3
Severe	2	1.3
Total	**157**	**100.0**

Internet Addiction and Physical Activity According to Sociodemographic Characteristics

No statistically significant differences in Internet addiction levels were observed according to gender (U=1414.00; p=0.942), residence in a dormitory (U=1236.50; p=0.209), study programme (U=2669.00; p=0.618), disciplinary measures (U=746.50; p=0.117), participation in Physical and Health Education (U=2690.50; p=0.560), family structure (U=0.771; p=0.680), or socioeconomic status (Kruskal–Wallis=0.799; p=0.671).

Similarly, physical activity levels did not differ significantly according to family structure (U=1435.50; p=0.450), residence in a student dormitory (U=1325.50; p=0.420), disciplinary measures (U=994.00; p=0.966), gender (U=1190.50; p=0.221), or socioeconomic status (Kruskal–Wallis=0.799; p=0.671).

Association Between Internet Addiction and Physical Activity

No statistically significant association was found between Internet addiction and physical activity (Spearman's ρ=0.026, p=0.745).

Discussion

The main finding of this study is that no statistically significant association between Internet addiction and physical activity was detected in this sample of students. This finding does not necessarily indicate the absence of a relationship between these variables, but rather that no association was identified under the conditions of this study. It is possible that the relationship between Internet use and physical activity is more complex and influenced by additional factors not captured in the present analysis. Several potential confounding variables may have influenced the observed results. Factors such as sex, sleep patterns, mental health status, academic stress, purpose of Internet use, and participation in organised sports may affect both Internet use and physical activity levels. Future studies should include these variables in multivariate models to better understand the underlying relationships.

Similar findings have been reported in a study conducted among 589 Vietnamese adolescents, where no significant association between Internet addiction and physical activity was identified, and overall physical activity levels were low in both groups (21). Likewise, research among Malaysian

students found no significant relationship between social media addiction and physical activity, although more than half of the participants showed signs of problematic use (22).

However, other studies have reported a significant negative association, suggesting that higher levels of physical activity are linked to lower levels of Internet addiction and that physical activity may serve as a protective or therapeutic factor (23). Meta-analyses further indicate that physical activity interventions can significantly reduce Internet addiction symptoms in adolescents and may represent one of the most effective intervention strategies (24,25). Research among Chinese students similarly demonstrated that higher physical activity is associated with lower risk of Internet addiction and improved psychological well-being (26).

Contrasting results have also been reported. A study conducted among Polish and Portuguese students during the COVID-19 pandemic found a positive association between physical activity and Internet addiction, possibly reflecting increased use of online platforms and digital tools promoting physical activity (27). Longitudinal research from Switzerland showed that lower participation in sports predicted a higher risk of problematic gaming behaviour over time (28). Additionally, findings from Croatian university students indicate that increased time spent gaming is associated with lower physical activity and increased sedentary behaviour (29).

Although several sociodemographic variables did not show statistically significant differences, these findings are still important as they may indicate that Internet addiction is not strongly influenced by these characteristics in this population, or that the effects are subtle and require larger samples to detect.

In the present study, students who attended Physical and Health Education (PHE) classes demonstrated higher levels of physical activity compared with those who did not, emphasising the importance of structured physical education. Previous research similarly indicates that participation in school-based physical education significantly increases the likelihood of maintaining physical activity during adolescence and adulthood, while also contributing to improved cognitive performance and academic outcomes (30). The growing integration of technology into daily life suggests that combining digital tools with physical activity promotion may represent a promising approach. Educational and monitoring applications can support physical activity engagement, although excessive recreational technology use should be carefully managed (18).

Limitations

This study has several limitations. The use of a voluntary response sample may have introduced selection bias, limiting the generalizability of the findings. Additionally, the use of self-reported measures may be subject to recall and social desirability bias. Given the cross-sectional design of the study, causal relationships between variables cannot be established. Despite these limitations, the study contributes to the growing body of research on adolescent health behaviours and highlights the need for further investigation into the complex relationship between Internet use and physical activity. Future research should consider longitudinal designs and objective measures of physical activity.

Strengths

Despite these limitations, this study contributes to the limited body of research examining the relationship between Internet addiction and physical activity among adolescents in vocational health-oriented education. Understanding these behaviours is particularly important, as habits formed during adolescence may have long-term health implications.

Implications for Future Research

Future studies should include larger and more diverse samples across multiple regions

to enhance generalizability. The use of objective measures of physical activity, such as accelerometers, is recommended. Additionally, digital monitoring tools could improve the accuracy of Internet use assessment. Further research should focus on specific student populations, particularly those with limited access to structured physical education, in order to develop targeted interventions promoting healthy behaviours despite increasing digital engagement.

Conclusion

In this study, no statistically significant association between Internet addiction and physical activity was detected among students from vocational health-oriented secondary schools. The participants generally demonstrated relatively low levels of physical activity and predominantly mild levels of Internet addiction. These findings should be interpreted with caution due to the cross-sectional design of the study, which does not allow causal conclusions. The relationship between Internet use and physical activity may be influenced by additional factors not examined in this study.

Further research, particularly using longitudinal designs and including a broader range of behavioural and psychosocial variables, is needed to better understand the complex interactions between Internet use and lifestyle behaviours in adolescents.

Declarations

Authors contributions: M.J. and VM contributed to data collection, data analysis, and drafting of the manuscript. D.G. contributed to the conception and design of the study and critical revision of the manuscript. I.M. contributed to the conception and design of the study, supervision, and critical revision of the manuscript.

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Fetal Behaviour Assessment as a Predictor of Future Neurological Development in Children: A Review

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Abstract

The development and implementation of three- and four-dimensional ultrasound in clinical practice have enabled both qualitative and quantitative assessment of fetal movements, including analysis of the fetal face. Ultrasound studies of fetal behaviour, compared with morphological assessments, have demonstrated that fetal behavioural patterns directly reflect the developmental and maturational processes of the fetal brain. This suggests that changes in fetal movements may allow the prenatal identification of neurological impairment.

Recently, a four-dimensional ultrasound-based prenatal screening approach for assessing fetal behaviour has been introduced. In this context, the Kurjak Antenatal Neurodevelopmental Test (KANET) has emerged as a 4D ultrasound-based scoring system for evaluating fetal neurobehavior and identifying fetuses at risk of later neurodevelopmental impairment.

This study presents a narrative review of the literature, based on a structured literature search, on fetal behaviour in normal and high-risk pregnancies, with particular emphasis on the potential for prenatal prediction of neurological development using this screening approach. The findings suggest that four-dimensional ultrasound-based prenatal assessment may be associated with postnatal neurodevelopment. However, scoring systems such as KANET should be interpreted with caution, as they remain promising but not yet definitive predictive tools.

Keywords: fetal behaviour; three-/four-dimensional ultrasound; KANET

Introduction

Although moderate or severe neonatal brain damage has traditionally been considered the result of intrapartum hypoxic-ischemic insult, it is now clear that antenatal factors such as prematurity and infections play a major role in its aetiology (1). Neonatal brain damage may subsequently result in cerebral palsy, which is one of the most common congenital chronic motor disorders of childhood, affecting 2 per 1000 live-born children (2). Contrary to prior beliefs that the global increase of caesarean sections would decrease the incidence of cerebral palsy, the number of affected children remains relatively high (3). Moreover, advances in neonatal and obstetric care and the increasing survival of the very preterm and very low birth weight infants may contribute to the increasing incidence of cerebral palsy in developed countries (4). Perinatal brain injury and cerebral palsy are among the most litigated conditions in modern medicine, resulting in substantial compensation claims mostly based on the belief that these disorders are related exclusively to intrapartum events, such as the use of forceps and vacuum deliveries, or failure to perform a caesarean delivery, while antenatal factors are often neglected. Taking all of the above into consideration, it is clear that investigations into fetal and neonatal neurological development are essential in both the scientific and legal fields (2).

Since basic neurodevelopmental studies have concluded that fetal movements reflect developmental and maturational processes within the fetal central nervous system, it may be speculated that studying fetal behaviour allows for the assessment of the optimality of fetal brain development (5). Furthermore, these findings supported the hypothesis that changes in fetal movements and behaviour could be used for the prenatal diagnosis of fetal neurological impairment (6-9). The first scientific studies of fetal behaviour were conducted centuries ago, with the first report published at the end of the 18th century (10). Later, in 1885, Preyer drew the attention of the scientific community by publishing an entire chapter about fetal behaviour in his book *Specielle Physiologie des Embryo* (11).

Throughout history, maternal registration of fetal movements and obstetric auscultation of fetal heartbeats were the only methods for assessing fetal well-being in utero. Maternal registration of fetal movements can be considered a direct assessment of fetal behaviour, recorded by the mother and subsequently analysed by her healthcare professional. This method is well accepted and widely used in clinical practice as a first indicator of fetal health due to its simplicity. Nevertheless, the technique of maternal counting of fetal movements has several limitations: the optimal number of movements and the ideal duration of counting have not yet been established. Another disadvantage is its limited sensitivity, since maternal awareness of fetal movements is influenced by placental position and fetal presentation.

A major advancement in the assessment of fetal behaviour was achieved with the development of two-dimensional ultrasound (2D US), which enabled direct visualisation of fetal anatomy and activity. With the implementation of ultrasound into clinical obstetric practice, a new window into the intrauterine environment was opened, which enabled the observation of fetal behaviour within its natural environment. This possibility encouraged many investigators to study fetal behaviour. Their findings, when compared with morphological studies, demonstrated that fetal behavioural patterns are direct reflections of developmental and maturational processes within the fetal central nervous system.

Methodology

This study presents a narrative review based on a structured literature search, evaluating fetal neurobehavioral development using prenatal assessment techniques and examining their association with neonatal neurological outcomes. A literature search was performed using PubMed, Scopus, and Web of Science. Publications from 1837 to 2024 were included, encompassing various assessment methods and insights into fetal neurodevelopment throughout history.

Studies were considered eligible if they investigated fetal spontaneous movements,

neurobehavioral states, and patterns, assessed by different ultrasound techniques (2D, 3D, and 4D), magnetic resonance imaging, and various neonatal neurological examinations. This review synthesizes publications analysing continuity from prenatal to postnatal neurobehaviour. Both physiological and high-risk pregnancies were included. This review primarily included systematic reviews, original research articles, and observational studies. Case reports were generally excluded due to their limited evidential value, although exceptional cases documenting rare neurobehavioral patterns were cited for illustrative purposes. We also excluded studies that were unavailable in full text or lacked sufficient methodological details.

Since this is a review of previously published data, there was no patient involvement, and formal ethical approval was not required.

Fetal behaviour in normal pregnancies

The first two-dimensional ultrasound studies of fetal behaviour described the onset and patterns of fetal movements from the first trimester to the end of the third trimester (12-14). All the assessed movements were described in detail regarding their quantity, quality, and first appearance (12-14). Although early embryonic development is characterized by embryonic immobility, the first spontaneous movements appear at around 7.5 gestational weeks, with most other movements emerging by the end of the first trimester (12-14). These first spontaneous movements can be described as slow flexion and extension movements of the fetal trunk accompanied by passive change in position of fetal extremities, which is why they have been described as "worm-like movements'' (15). By the end of the 9th week of gestation, these movements are replaced by more energetic movements called ''startle movements'' (15). General movements, which are of great importance in fetal behaviour assessments, start to appear in the first trimester and are the most frequent movement pattern between 9 and 14 weeks of gestation (15, 16).

In the second trimester, all the fetal movements, except startle movements, increase in frequency and become more complex and consolidated, especially with the beginning of the third trimester (15-17). The periods of fetal quiescence begin to increase, and the rest-activity cycles become recognizable. These changes in fetal behaviour coincide with the basic neurodevelopmental studies, which indicate that this period is crucial for the primary motor cortex to begin controlling fetal behaviour and voluntary movements. The frequency of general body movements, which tend to increase from the 9th week onwards, gradually declines during the last trimester (18). Simultaneously, with the decrease in the number of general movements, an increase in all types of facial movement occurs, along with increased complexity of each (18). The consolidation and organization of fetal movements in the third trimester were primarily recognized by Nijhuis, who clearly stated that from the 36th gestational week onwards, normal fetuses develop clearly defined fetal behavioural states (Fetal states 1 through 4) (15).

As mentioned in the introduction, the first extensive study on fetal behaviour started with the introduction of two-dimensional ultrasound, which enabled the visualisation of the fetus and its movements. Since then, fetal movements have been studied longitudinally in both low and high-risk pregnancies (12-14). Since two-dimensional ultrasound has some technical limitations regarding the assessment of movement quality, the mentioned studies were based mainly on the quantification of specific movements. Although the parameters of normality were set for all individual movements, this was not enough to conclude fetal neurobehavioral development, since the technical limitations of the available technology could not be surpassed.

The introduction of new ultrasound techniques, three- and four-dimensional ultrasound (3D/4D US), opened a new perspective for the study of fetal behaviour by providing the capability of simultaneous spatial imaging of the entire fetus and its movements. 3D/4D US added the possibility of further qualitative assessment of fetal and even embryonic movements, including

their complexity and variability. Initially, they were primarily used to describe normal fetal movements and behaviour, their continuity into postnatal life, as well as aspects of fetal awareness (19-28). Three- and four-dimensional ultrasound enabled the observation of fetal face in three dimensions, which is important for the assessment of fetal facial expressions in near real time, indicative of the maturational processes of the primary motor cortex. Facial expressions such as smiling, pouting, or scowling can also be observed during the third trimester by 4D ultrasound. Fetal eye movements can also be detected, including nystagmoid eye movements between 15 and 17 weeks (29). The fetus shows blinking by opening and closing the eyelids at 23 to 26 weeks, and from 30 weeks onwards, clusters of rapid eye movements are observed (30).

Fetal behaviour in high-risk pregnancies

As we have mentioned previously, the whole idea of prenatal assessment of fetal behaviour was first based on the presumption that differences in fetal motility could be found between normal and abnormal pregnancies and that changes in fetal behaviour could lead to conclusions about the impaired prenatal neurological development and even postnatal sequelae. Abnormal motor behaviour was first prenatally assessed and described using 3D and 4D US in a case of an anencephalic fetus (31). This is a cephalic disorder that results from a neural tube defect and is usually diagnosed in the first trimester, with the termination of the pregnancy in most cases. In certain circumstances, these pregnancies continue due to religious or personal reasons, providing a good model for the study of fetal behaviour. When longitudinal studies were performed, the findings unexpectedly revealed how abundant fetal behaviour was in the first and early second trimester, coinciding with the time when the control of fetal behaviour is mainly under lower control centres (31, 32). As the pregnancy continues, at the end of the second and especially in the third trimester, the ontogenetic shift of motor control from lower to upper control centres occurs, which is reflected in fetal behaviour (31, 32). The fetal movement repertoire changed; the movements became jerky and simple, and facial movements were rare or absent (31, 32).

Intrigued by fetal motility, researchers studied fetal behaviour in various pathological conditions. The first study of fetal behaviour using 4D US showed that the median value of all movement patterns differed between normal fetuses and those with intrauterine growth restriction (IUGR). Statistical evaluation revealed significant differences in the distribution of movements between these groups. A tendency for IUGR fetuses to exhibit less behavioural activity than normal fetuses was noted in all observed movement patterns, with statistical correlation for hand-to-head and head retroflexion movements in the third trimester (33). On the other hand, with the use of 3D/4D US, it became possible to determine the fetal behaviour as normal even in cases of unfavourable intrauterine conditions, such as intrauterine growth restriction, fetal hypoxaemia, and preterm labour (34).

Earlier studies investigating diabetes-related influences on fetal movement patterns revealed delayed emergence of fetal motor activity, with a delay of 1 to 2 weeks in almost all observed movement patterns emerging in the first 12 weeks of gestation. Only fetal breathing-like movements were observed for the first time at the same gestational age as in normal fetuses (35). Moreover, compared with normal pregnancies, fetal breathing-like movements in late diabetic pregnancy were not influenced by Braxton Hicks contractions and did not show a clear-cut state-dependency, supporting the conclusion that the neural mechanism underlying fetal breathing-like movements differs from that in normal pregnancy (36).

Furthermore, maternal exposure to certain environmental factors can impact short-term intrauterine development and overall infant health. These factors can cause modifications and "reprogramming" of organ structure, particularly in organs with greater plasticity, such as the brain, leading to neurodevelopmental alterations. Some studies have investigated the impact of

air pollution, smoke, stress, depression, anxiety, and obesity that increase the state of maternal inflammation and therefore play a role in neurodevelopment (37). Additionally, even modest maternal alcohol intake has been shown to reduce fetal eye movements, disorganize behavioural state organization (rapid eye movement sleep being affected in particular), and suppress fetal breathing activity almost completely (38). Maternal smoking is another parameter with a negative influence on fetal behaviour. It has been shown that fetuses less than 37 weeks of gestation whose mothers smoke throughout pregnancy have a delayed onset of behavioural response to the maternal voice (39).

Collectively, these studies provided a promising basis for the development of the 3D/4D ultrasound investigations of fetal behaviour in high-risk pregnancies to predict neurobehavioral postnatal development.

Introduction of the Kurjak Antenatal Neurodevelopmental Test (KANET)

Since fetal behavior reflects fetal well-being and brain development, authors highlighted its clinical and research importance, but these ideas have not been widely adopted in clinical practice for fetal neurological assessment (40, 41). Although several different tests for assessing fetal behavior were suggested, they were not used routinely due to their complexity, observer variability, and time consumption. Among these methods, general movements (GM) were preferred because they show continuity from prenatal to postnatal life (42). General movements can be described as holokinetic movements, which are periodic bursts involving the entire fetal body in the first trimester. The potential prognostic value of evaluating GM for predicting fetal neurobehavioral state has been extensively studied both before and postnatally (42-43). GM assessment relies solely on recognizing global patterns of qualitatively different motor behaviors and has shown predictive value comparable to magnetic resonance imaging, with sensitivity for consistently abnormal GMs around 98–100%, although specificity is lower, especially in preterm infants (42). Conversely, De Vries emphasized the importance of GM and proposed including their assessment as part of routine antenatal sonographic care. In cases of abnormal GM findings, she recommends advanced sonographic examinations, focusing on head movements, including the eyes and jaw, as well as the torso and limbs (44). The author also noted the advantages of four-dimensional ultrasound over two-dimensional ultrasound for future fetal behavior research (44).

Ultrasound evaluation of fetal body movements has previously been integrated into a test of fetal well-being for assessing the fetal biophysical profile (BPP). This test combines prenatal quantitative ultrasound evaluation and fetal heart rate monitoring, using a scoring system commonly referred to as Manning's score (45). Although BPP can be sufficiently used as a method of fetal surveillance for predicting acute or chronic fetal hypoxia, its utility in assessing fetal neurobehavioral conditions is quite limited. Neonatal neurological evaluation can be performed using the Amiel-Tison neurologic assessment at term, which has a scoring system and a complete procedure that takes approximately 5 minutes (46). The Amiel-Tison Neurological Assessment at term age (ATNAT) focuses on infant responses that depend on the corticospinal control system, a stage of maturation that can be clinically explored. This test, which is helpful in the recognition of prenatal brain damage, was used as a model for creating a new prenatal neurologic assessment test due to its utility, effectiveness, and simplicity of performance. As previously mentioned, there is continuity from fetal to neonatal behaviour, in terms of all facial and hand movements directed toward the head, except the Moro reflex, which is present only in neonates (23). In addition, multiple studies using 3D/4D US have shown that fetal and embryonic movements constantly expand in their repertoire and frequency, whereas the second and third trimesters are characterized by the progressive organization of fetal activities into complex and clearly distinct behavioural patterns (47-51). Following the ultrasound studies in normal pregnancies, several

investigations using the same ultrasound methodology confirmed differences in fetal movements and behaviour in normal pregnancies as compared to high-risk pregnancies with respect to cerebral palsy (34, 52-54). All these findings were used to create a platform for the new ultrasound evaluation test of fetal neurobehavior. Kurjak and his group developed a new scoring system for the fetal neurobehavioral state based on prenatal assessment of fetal movements by 3D/4D sonography to enable more objective evaluation of fetal movements and comparison among professionals and across different centres (55, 56). The test was named the Kurjak Antenatal Neurodevelopmental Test (KANET), and it is the first structured and systematic test that uses 4D US technology to assess the functional development of the central nervous system of the fetus in a similar way that neonates are examined postnatally for brain damage by neonatal neurological tests. The selection of parameters to be included in the test was very extensive, with GM being added based on a developmental approach to the neurological assessment and on the theory of emergence of GM from central pattern generators (42). Other parameters included in KANET are those that have already been shown to be sufficient in ATNAT, such as overlapping sutures and the neurological thumb (55).

The two main advantages of the 4D US incorporated in KANET, compared with 2D US, are the detailed evaluation of fetal facial movements and improved assessment of the quality of all other fetal movements (55). For example, a hand does not just move or flex as in a two-dimensional image; now we can assess simultaneously its rotation, supination, pronation, individual finger movements, direction of the movement, and, most importantly, the overall impression of quality and complexity of the movement.

In the first version of KANET the following ten parameters were incorporated: isolated head flexion, overlapping cranial sutures and head circumference, isolated eye blinking, facial alteration, mouth opening (yawning or mouthing), isolated hand and leg movements, hand-to- face movements, finger movements and thumb position, and Gestalt perception of general movements (overall perception of the body and limb movements with their qualitative assessment) (55). The KANET was standardized in Osaka, Japan, on the 24th of October 2010 to make it more reliable, reproducible, and practical for fetal medicine specialists (56). According to the Osaka Consensus Statement, the KANET should be performed in the third trimester of pregnancy, between 28 and 38 weeks, and fetuses should be examined while they are awake. If the fetus is asleep, the assessment should be postponed by 30 minutes or until the following day, with a minimum interval of 14-16 hours. The newly modified KANET test should include 8 instead of 10 quantitatively and qualitatively assessed parameters: facial and mouth movements are combined in one category, and isolated hand movements and hands-to-face movements are combined in another (56). First studies on the use of KANET in normal pregnancies have shown that a normal prenatal KANET score is significantly predictive of a normal postnatal neurological outcome (57), while newborns with abnormal or borderline KANET scores should undergo postnatal follow-up (58-62). Infants should be followed until at least 24 months of age, when a diagnosis of disabling or non-disabling cerebral palsy can ultimately be established (62).

Could assessment of fetal behaviour predict the future neurological development of children?

There is substantial evidence showing that many neurological problems in infants and children, from minor cerebral dysfunction to cerebral palsy, originate from the prenatal, rather than the perinatal or postnatal periods, raising the question of whether the prenatal assessment of fetal behaviour could predict the future neurological development of children. If we could answer this complex question, we could not only prepare parents and professionals for the delivery of a child with some form of disability but also provide information regarding the gestational age at which brain injury occurred, which could be important in medico-legal circumstances. In

addition, findings on normal or abnormal fetal behaviour could also serve as a basis for investigations into possible future therapies.

With the introduction of KANET, we might believe that we are on the right path in fetal neurobehavioral assessment, but we cannot - and should not - be so bold at the moment as to say we can diagnose neurological disorders prenatally. The complexity of this problem is illustrated by the fact that the brain continues to develop intensively in the postnatal period as well, and we should not forget that the fetus grows in a different environment than an infant, mainly due to the lack of gravity (63).

We must be realistic and consider that even the clinical assessment of muscle tone, strength, and control of voluntary movements for early detection of infants at risk for cerebral palsy has been frustrating, because as many as 43% of 7-year-old children with cerebral palsy had a normal newborn neurological examination (64).

In addition to 3D and 4D ultrasound, MR imaging has also been investigated by various researchers as a diagnostic tool for assessing fetal behaviour. A study conducted at the Robert Steiner MRI Unit, Hammersmith Hospital, analysed the correlation between fetal motor behaviour, brain MR imaging, and postnatal outcome. Cine MR imaging was used to record sequences of fetal behaviour from 18 weeks of gestation until term in fetuses divided into two groups based on their normal and abnormal findings on standard brain MR imaging. The infants were monitored for four years to determine whether MR imaging of fetal motor function could predict postnatal neurodevelopment. This study showed that fetal behaviour observed by cine MR imaging correlated with the neuropathology identified by standard brain MR imaging and was predictive of future postnatal neurodevelopmental outcomes (65).

Some pathological fetal conditions, such as fetal growth restriction (FGR) caused by suboptimal placental function, are associated with altered brain development. During the third trimester, from 28 weeks of gestation onward, neurogenesis is completed, and at this stage, neuronal complexity increases primarily through axonal and dendritic growth accompanied by synaptogenesis. If placental function is reduced during this period, it can lead to the disturbance of the cerebral cortex morphology, affecting both white and grey matter, with the latter being affected more significantly (66). Considering this, we suggest that specific algorithms for fetuses at higher risk of neurodevelopmental disturbance should include more detailed in utero fetal behaviour monitoring and imaging to improve the prediction of adverse neurodevelopmental outcomes to which these fetuses are more susceptible. Another important point to keep in mind is that neuropaediatricians can directly evaluate the neonate, while obstetricians have only an indirect view inside the uterus when evaluating the fetus that is free from gravity and therefore able to perform more complex motor tasks than the neonate.

Conclusion

In conclusion, our preliminary work on the prenatal ultrasound evaluation of fetal neurobehavior, in correlation with long-term neuropediatric follow-up, appears promising in addressing whether 4D ultrasound-based prenatal assessment can predict postnatal neuromotor development in both low- and high-risk pregnancies. However, a scoring system such as KANET, although promising as a screening tool, should be interpreted with caution, as it is not yet a definitive predictor of future neurodevelopmental outcomes. Therefore, postnatal monitoring and close follow-up remain essential.

Declarations

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Semaglutide in the Era of Blockbuster Pharmaceuticals: A Narrative Review of Clinical, Economic, and Policy Dimensions

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Abstract

The blockbuster drug model has become a central driver of growth in the pharmaceutical industry, generating substantial economic and healthcare impacts. Semaglutide, a glucagon-like peptide-1 (GLP-1) receptor agonist marketed under brand names such as Ozempic (subcutaneous, 0.25–1 mg for type 2 diabetes), Wegovy (subcutaneous, 2.4 mg for obesity), and Rybelsus (oral formulation), represents a contemporary example of a blockbuster pharmaceutical innovation demonstrating strong clinical performance alongside remarkable commercial success. This narrative review examines the clinical, economic, and policy dimensions of semaglutide's market trajectory. Since its approval, semaglutide has significantly improved glycemic control, promoted weight reduction, and reduced cardiometabolic risk, while becoming a major contributor to Novo Nordisk's financial growth and market leadership, most notably through the commercial launch of Ozempic, which served as a primary catalyst for the company's rise to become one of the world's most valuable pharmaceutical corporations. Its rapid global adoption has expanded the therapeutic landscape for metabolic diseases and stimulated further pharmaceutical innovation. However, increasing demand, off-label utilization, supply shortages, access disparities, reimbursement challenges, and rising healthcare costs have introduced important regulatory, ethical, and sustainability considerations. Semaglutide illustrates the evolving relationship between biomedical innovation, pharmaceutical economics, and healthcare policy, highlighting both the benefits and challenges of blockbuster drug success in modern healthcare systems.

Keywords: semaglutide; Ozempic; blockbuster drugs; economic impact

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Introduction

The term *blockbuster* originated in the film industry and was later adopted in the pharmaceutical domain to describe highly profitable drugs. Their market success, typically reflected in annual revenues exceeding one billion US dollars, is driven by broad therapeutic applicability, demonstrated clinical effectiveness, and the ability to address unmet medical needs. Since the late 1980s, blockbuster drugs have become a cornerstone of pharmaceutical business models, serving as key drivers of economic stability, market growth, and innovation. Backed by substantial investments in research and development, as well as extensive commercialization strategies, these therapies represent both scientific progress and economic value creation. Their global reach enables treatment across diverse populations, contributing to improved health outcomes and broader public health benefits. Concurrently, blockbuster drugs remain fundamental to the financial sustainability and long-term innovative performance of the pharmaceutical industry (1–3). Semaglutide (Ozempic), a next-generation antihyperglycemic therapy for the contemporary management of type 2 diabetes, exemplifies the modern blockbuster drug model and represents a highly impactful product in the global pharmaceutical marketplace. Developed by Novo Nordisk, semaglutide emerged from research and development efforts that positioned it for broad clinical applicability and sustained market relevance. Its financial performance has significantly enhanced the company's capital strength, expanded its global footprint, and reinforced its long-term competitive advantage. The case of semaglutide highlights how pharmaceutical innovation can simultaneously address pressing global health needs and generate substantial economic value within an increasingly competitive industry landscape (4,5).

The Clinical and Commercial Success of Semaglutide

Semaglutide (Ozempic), a glucagon-like peptide-1 (GLP-1) receptor agonist, represents a major therapeutic advancement in the management of type 2 diabetes. Its pharmacological action encompasses enhanced glucose-dependent insulin se-cretion, suppression of glucagon release, delayed gastric emptying, and reduced appetite, collectively resulting in improved glycemic regulation and weight reduction. Despite the availability of multiple effective antihyperglycemic therapies, an unmet need persisted for a treatment capable of achieving superior glycemic control while simultaneously providing cardiovascular and renal protection. Such benefits include preservation of renal function, reduction in blood pressure, and prevention of cardiovascular events, which remain common complications among patients with type 2 diabetes. Accordingly, the development of a more efficacious therapeutic approach was warranted for patients with inadequate disease control despite diet, physical activity, oral antihyperglycemic medications, or insulin therapy (6). Novo Nordisk, the developer of semaglutide, has established itself as a global leader in the management of diabetes and obesity. The company's research framework emphasizes not only therapeutic intervention but also prevention and sustained improvement of patient outcomes. Through continued investment in research and development, Novo Nordisk has combined molecular innovation with comprehensive disease management strate-gies.

The first glucagon-like peptide-1 (GLP-1) receptor agonist, exenatide, was approved by the U.S. Food and Drug Administration (FDA) in 2005, marking the beginning of a new therapeutic class for the management of type 2 diabetes. In the years that followed, additional GLP-1 receptor agonists, such as liraglutide and dulaglutide, were introduced, progressively expanding treatment options and improving glycemic management. Despite these advances, limitations related to dosing frequency, adherence, and the magnitude of metabolic benefits remained. Semaglutide represents a next-generation

agent within this class, characterized by once-weekly subcutaneous administration (0.25 mg, 0.5 mg, and 1 mg; Ozempic), improved pharmacokinetic stability due to albumin binding and structural modifications, and more pronounced effects on glycemic control and body weight.

An oral formulation of semaglutide (Rybelsus, 7 mg and 14 mg) was subsequently approved, further broadening its clinical applicability. These advantages significantly contributed to the rapid expansion in the clinical use of GLP-1 receptor agonists following the introduction of semaglutide (7).

The U.S. Food and Drug Administration approved semaglutide (Ozempic, 0.25–1 mg subcutaneous) for the treatment of type 2 diabetes in December 2017. Randomized clinical trials consistently confirmed its effectiveness in improving glycemic control, promoting weight reduction, improving cardiometabolic risk factors, and supporting renal function (8–14). During clinical development, researchers observed significant weight loss among treated patients, attributed to both central and peripheral mechanisms, including reduced caloric intake, decreased appetite between meals, enhanced satiety, and delayed gastric emptying, effects mediated through GLP-1 receptor activation in the hypothalamus and gastrointestinal tract. These findings subsequently supported the development and approval of a higher-dose subcutaneous formulation (semaglutide 2.4 mg; Wegovy) specifically indicated for chronic weight management in adults with obesity or overweight with at least one weight-related comorbidity.

These effects are primarily attributed to GLP-1–mediated signaling that influences central appetite regulation pathways. Clinical trials of higher-dose semaglutide (2.4 mg; Wegovy) have demonstrated average body weight reductions of approximately 15–16% from baseline, with some participants achieving reductions exceeding 20% (15,16). It should be noted that such pronounced weight loss data largely derive from trials conducted at the obesity-indicated dose, rather than from the diabetes-indicated formulation (Ozempic, 0.25–1 mg). Although semaglutide was originally developed and approved for the management of type 2 diabetes, its notable weight-reducing effects led to a substantial increase in off-label use among individuals without diabetes, raising important considerations regarding equitable access, drug supply, and appropriate prescribing practices.

Semaglutide is marketed by Novo Nordisk under distinct brand names, each corresponding to a specific formulation, indication, and dosing regimen, a distinction of considerable clinical and regulatory importance. Ozempic is a once-weekly subcutaneous formulation of semaglutide approved for the management of type 2 diabetes, administered at doses of 0.25 mg, 0.5 mg, and 1 mg. Rybelsus is the first oral formulation of semaglutide, approved for type 2 diabetes at doses of 7 mg and 14 mg. Wegovy is a higher-dose once-weekly subcutaneous formulation (2.4 mg) approved for chronic weight management in adults with obesity or overweight with at least one weight-related comorbidity. The approval of Wegovy further expanded the therapeutic role of semaglutide and contributed to the growth of pharmacological treatment options for obesity. Clinicians have increasingly incorporated semaglutide into individualized treatment strategies, particularly in patients presenting with the concurrent burden of type 2 diabetes and obesity — a clinical phenotype increasingly referred to as "diabesity" (16).

Diabesity represents a major global health concern, and even modest weight reduction of 5% has been associated with meaningful metabolic and cardiovascular benefits (16). Semaglutide's ability to induce clinically significant weight loss, particularly at the 2.4 mg dose (Wegovy), has broadened its therapeutic potential beyond type 2 diabetes, positioning it as a key agent in modern weight management strategies. The growing clinical success of semaglutide has also stimulated research into additional therapeutic indications, including metabolic dysfunction-associated steatohepatitis (MASH), chronic kidney disease, cardiovascular risk reduction

in non-diabetic populations, and addiction-related behaviours, reflecting the broad physiological reach of GLP-1 receptor activation.

Metabolic dysfunction-associated steatotic liver disease (MASLD) is highly prevalent in patients with type 2 diabetes and is characterized by metabolic dysfunction and progressive liver injury. In a phase 2 randomized controlled trial, semaglutide demonstrated a significantly higher rate of metabolic-associated steatohepatitis (MASH) resolution without worsening of fibrosis compared with placebo (17).

Clinical trials have evaluated the effects of semaglutide on major adverse cardiovascular events, demonstrating significant reductions in cardiovascular risk (18–20). Cardioprotective effects have been attributed to improvements in glycemia, blood pressure, body weight, and direct anti-inflammatory and endothelial-protective mechanisms. Semaglutide has additionally demonstrated improvements in renal outcomes, including reduced albuminuria and slower progression of chronic kidney disease (18–20).

Impact on Corporate Portfolio and Market Position

Annual reports from Novo Nordisk document the rapid revenue growth attributable to semaglutide (Ozempic). Sales increased from USD 284 million in 2018 to USD 3.24 billion in 2020, reflecting accelerating global adoption following initial market authorization. In the first nine months of 2023, semaglutide (Ozempic) generated approximately USD 4.8 billion in the third quarter alone, representing approximately 52% of Novo Nordisk's total revenue of USD 23.6 billion for that period. These figures illustrate the substantial commercial impact of semaglutide and its central role in Novo Nordisk's financial performance and capacity for continued research investments (21).

The commercial success of semaglutide has profoundly transformed Novo Nordisk's position in the global pharmaceutical landscape. At its peak market capitalization in 2023, Novo Nordisk briefly became Europe's most valuable publicly traded company. From a specialized diabetes-focused pharmaceutical company, Novo Nordisk has evolved into a global corporation employing approximately 60,000 people across more than 80 countries. The rising global prevalence of obesity and type 2 diabetes has further increased demand for effective metabolic therapies, consolidating the company's position as a leading player in the global pharmaceutical market (22).

In 2023, Novo Nordisk's stock price increased by 54%, with the company holding 33.3% of the global diabetes value market and 54.3% of the GLP-1 segment, according to data from the independent data provider IQVIA. Semaglutide (Ozempic) represented a dominant share of diabetes product revenue. Analysts project continued market expansion (23).

The commercial success of semaglutide has stimulated mergers, acquisitions, and strategic partnerships within Novo Nordisk's broader corporate strategy. Among these, the acquisition of Dicerna Pharmaceuticals in 2021 expanded the company's research capacity in RNA-based therapies targeting metabolic and liver diseases (24). With patent protection for semaglutide expected until approximately 2031, the molecule is projected to remain a key driver of Novo Nordisk's commercial performance in the near term. However, patent expiry will likely stimulate the entry of biosimilar and generic competitors, with potential implications for drug pricing, market share, and patient access (25).

Adverse and Regulatory Considerations

Despite its clinical efficacy, semaglutide is associated with a recognized adverse effect profile that warrants careful consideration. Gastrointestinal adverse effects, including nausea, vomiting, diarrhea, and constipation, are among the most frequently reported, particularly during dose escalation. More serious complications, including gastroparesis and intestinal obstruction, have been reported in post-marketing surveillance. Additionally, the prescribing information carries a boxed warning regarding the risk of thyroid C-cell

tumors observed in animal studies, and caution is advised in patients with a history of pancreatitis (26).

Another important consideration relates to the long-term management of therapy. Although semaglutide has demonstrated substantial benefits in weight reduction, the optimal duration of treatment and long-term maintenance strategies remain under investigation. Evidence suggests that individuals who discontinue treatment often regain a significant proportion of the lost weight, indicating that sustained therapy or additional lifestyle interventions may be necessary to maintain therapeutic benefits (27).

The growing demand for semaglutide, particularly for weight management, has significant implications for health policy across Europe. Increased off-label use has contributed to supply shortages, prompting regulatory measures in several countries aimed at prioritizing access for patients with type 2 diabetes.

Considerable variation across healthcare systems regarding the reimbursement of semaglutide for obesity indications has further shaped equitable access. These developments highlight broader challenges related to drug availability and the sustainability of healthcare expenditure in the context of rapidly expanding therapeutic demand (28,29).

Conclusion

Semaglutide has demonstrated significant clinical benefits across multiple therapeutic domains, including glycemic control, weight reduction, blood pressure management, cardiovascular risk reduction, and renal function preservation. This narrative review highlights how semaglutide exemplifies the modern blockbuster drug model, simultaneously addressing major unmet clinical needs and generating substantial commercial success. Simultaneously, rising healthcare expenditures, off-label utilization, supply shortages, access disparities, and reimbursement challenges raise important economic and policy considerations that extend beyond clinical efficacy. The success of semaglutide has stimulated broader pharmaceutical innovation and regulatory adaptation, while also exposing systemic tensions between drug pricing, equitable access, and the long-term sustainability of the healthcare system. Pharmaceutical companies, payers, and regulators must collectively address these challenges to ensure that the benefits of pharmacological innovation are accessible in diverse healthcare settings. Overall, semaglutide represents a compelling contemporary example of how biomedical innovation can reshape pharmaceutical economics, healthcare policy, and global therapeutic markets, underscoring the need for robust evidence-based frameworks to guide its continued clinical and commercial development.

Declarations

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"During the preparation of this work, the author(s) used [NAME TOOL/SERVICE] for [REASON/ACTION]. After using [NAME TOOL/SERVICE], the author(s) reviewed and edited the content and take full responsibility for its accuracy and integrity."

Basic grammar, spelling checks, and reference management tools do not require disclosure. If no AI tools were used, this statement is not necessary.

Vancouver/NLM Quick Citation Guide (Supplementary Material)

a) In-text citation

- Use regular (round) parentheses. This is correct format: ( ).
- When citing multiple references in parentheses, do not include spaces after the commas. This is correct format: (1,3,5).
- Consecutive references can be shown as a range with a hyphen, without spaces. This is correct format: (1–5).
- Reference numbers follow order of appearance in text, not alphabetical.
- Reference numbers are re-used every time the same reference appears. Each source keeps the same reference number throughout the text; do not assign a new number when citing the same source again.

Examples in text:

- (1) - single reference.
- (1,3,5) - multiple separate references.
- (1–5) - consecutive range.

b) Reference list

There are different kinds of references. The following instructions cover several most common types of references.

Author names: In all types of references, author names are listed as Surname followed by Initials (e.g., Smith AB, Jones CD). There are no periods after initials and no comma before initials. Word "and" is not used before last author. There is no need to remove accents and special signs from letters (diacritics are kept). For example, name Ivan Černi is written as such, not as Ivan Cerni.

Citation Format Guidelines for Journal Articles

Authors:

- List up to 6 authors.
- If there are more than 6, list the first 6 authors followed by et al.
- Organization/institution can be listed as author if no individual authors are specified; no et al. is used in that case.
- Plain text, no italics

Article Title:

- Use sentence case (capitalize only the first word and proper nouns or acronyms).
- Plain text, no italics.

Journal Name:

- In italics.
- Use the official NLM abbreviation. Use only official NLM journal abbreviations as listed in the NLM Catalog; do not create your own abbreviations.
- If no abbreviation exists, use full journal title, still in italics.

Year, Volume, Issue, Pages:

- Format: YYYY;volume(issue):pages.
- Plain text, no extra labels like "vol." or "no."

DOI:

- Include if available.
- Format: doi:10.xxxx/xxxxx
- Plain text, no "https://"

Example References - Journal Articles

1. Reference with ≤6 authors

Author A, Author B, Author C, Author D, Author E. Article title goes here. Journal Name. 2024;18(3):123-130. doi:10.1234/journal.2024.01803

2. Reference with >6 authors (use et al.)

Author A, Author B, Author C, Author D, Author E, Author F, et al. Article title goes here. Journal Name. 2024;18(3):123-130. doi:10.1234/journal.2024.01803

3. Reference with an organization as author

Name of Organization. Article title goes here. Journal Name. 2024;18(3):123-130. doi:10.1234/journal.2024.01803

Citation Format Guidelines for Books/Textbooks

Authors:

- List up to 6 authors.
- If there are more than 6, list the first 6 authors followed by et al.
- Organization/institution can be listed as author if no individual authors are specified; no et al. is used in that case.
- Plain text, no italics.

Title:

- Use sentence case (capitalize only the first word and proper nouns or acronyms).

- In italics.

Edition:

- Include if second or later edition (e.g., 2nd ed., 3rd ed.).
- Not required for first edition.
- Plain text, no italics.

Place, Publisher, Year:

- Format: City: Publisher; Year.
- Plain text, no italics.

Chapters in Edited Books:

- Chapter authors first, then "In: Editor(s), editors."
- Include page range for the chapter (p. xx–yy).

Example References - Books / Textbooks

1. Reference with individual authors (first edition - no edition number needed)

Author A, Author B. Title of the book. City: Publisher; 2023.

2. Reference with individual authors (later edition - include edition number)

Author A, Author B. Title of the book. 3rd ed. City: Publisher; 2023.

3. Reference with an organization as author

Name of Organization. Title of the book. 3rd ed. City: Publisher; 2023.

Citation Format Guidelines for Final Papers / Theses / Dissertations

Author:

- List up to 6 authors.
- If there are more than 6, list the first 6 authors followed by et al.
- Plain text, no italics.

Title:

- Use sentence case (capitalize only the first word and proper nouns or acronyms).
- Plain text, no italics.

Type of Work:

- Specify the type of work (e.g., [final paper], [bachelor's thesis], [master's thesis], [dissertation]).
- Use square brackets, following the title.
- Plain text, no italics.

Place, Publisher, Year:

- Format: City: Institution; Year.
- List the name of the institution (e.g., University, Faculty).
- Plain text, no italics.

Example References - Final Papers / Theses / Dissertations

1. Final Paper (or Undergraduate Thesis)

Author A. Title of the final paper [type of work]. City: Institution; Year.

2. Master's Thesis

Author A. Title of the master's thesis [master's thesis]. City: Institution; Year.

3. Dissertation

Author A. Title of the dissertation [dissertation]. City: Institution; Year.

Citation Format Guidelines for Internet Sources

Authors:

- List up to 6 authors.
- If there are more than 6, list the first 6 authors followed by et al.
- Organization/institution can be listed as author if no individual authors are specified; no et al. is used in that case.
- Plain text, no italics.

Title:

- Use sentence case (capitalize only the first word and proper nouns or acronyms).
- Plain text, no italics.

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- Specify the Type / Medium (e.g., [Internet])
- Use square brackets, following the title.
- Plain text, no italics.

Year / Access Date:

- Year of publication.
- [cited YYYY Mon DD] if the page may change over time. Optional if the page is static.
- Plain text, no italics.

URL:

- Full URL after "Available from:"
- Plain text, no italics.
- Do not place a period after a URL (a link).

Example References – Internet Sources

1. Reference with individual authors

Author A, Author B. Title [Internet]. 2023. Available from: https://www.example.com

2. Reference with an organization as author

Name of Organization. Title [Internet]. 2023. Available from: https://www.example.com

3. If the page may change over time, include access date

Name of Organization. Title [Internet]. 2023 [cited 2025 Nov 10]. Available from: https://www.example.com

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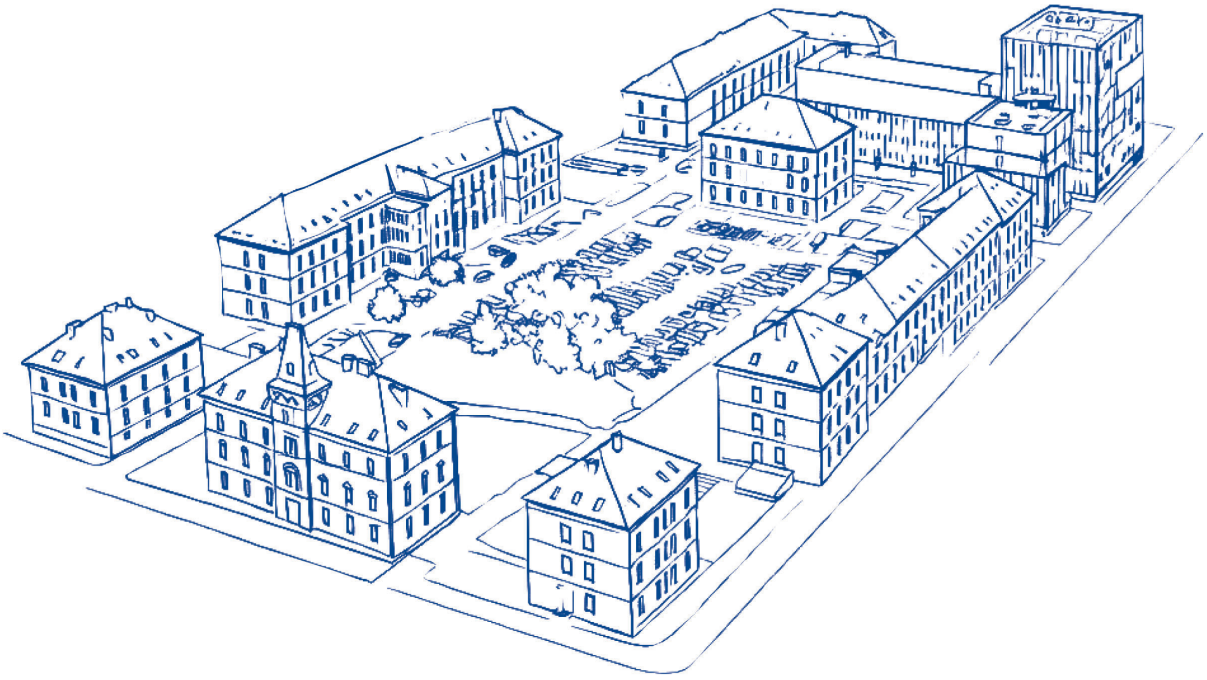

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