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Original scientific article

Predictors of Frailty among Older Adults: A Cross-Sectional Study

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Keywords: frailty; older adults; physical activity; preventive care; social engagement.

ABSTRACT

Introduction: Frailty is a common geriatric syndrome characterized by reduced physiological reserve and increased vulnerability to adverse health outcomes, including falls, hospitalization, functional decline, and mortality. Identifying sociodemographic characteristics and health-related behaviors associated with frailty is essential for planning preventive interventions and improving health outcomes in older adults. Therefore, this study aimed to examine the prevalence of frailty among older adults and to determine its association with sociodemographic characteristics, age, and selected health-related behaviors.

Methods: The study included 156 adults aged 65 and older from Vukovar-Srijem County. Data were collected using a sociodemographic questionnaire that included a health-related behavior section. Frailty was assessed using the Edmonton Frailty Scale. Mann–Whitney U test and Kruskal–Wallis test were used to determine differences in frailty scores between groups, while Spearman's correlation coefficient was used to examine the relationship between age and frailty. Multiple linear regression was used to examine predictors of frailty within the study population.

Results: The median frailty score was 8 (IQR 5–11), indicating mild frailty in the overall sample. Frailty was significantly higher among women, respondents living in rural areas, those with lower education, and those with poorer financial status. Frailty was higher among participants who did not engage in physical activity, did not maintain a proper diet, did not attend regular preventive check-ups, and were not socially active. Age was positively correlated with frailty (rho = 0.534, $P < 0.001$). Multiple linear regression analysis showed that financial status, physical activity, social engagement, and regular preventive check-ups were significant independent predictors of frailty, explaining 55.7% of the variance.

Conclusion: Frailty in older adults is associated with socioeconomic status and health-related behaviors. Interventions aimed at promoting physical activity, preventive care, and social engagement may help reduce frailty and improve health outcomes in older populations.

INTRODUCTION

The aging of the population is one of the most important demographic and public health challenges of modern society. The increase in life expectancy and the increase in the proportion of older people in the population are associated with a higher incidence of chronic diseases, functional limitations, and an increased need for health and social care [1–4]. In this context, special attention is increasingly being focused on the frailty syndrome, which represents one of the key features of vulnerability in old age.

Frailty is most often described as a syndrome of reduced physiological reserves and weakened resistance to stressors, due to which even minor health disorders can lead to a marked deterioration in functional status and other adverse outcomes [4–8]. It is associated with an increased risk of falls, fractures, hospitalization, longer recovery, functional dependence, institutionalization, and mortality [4, 7, 9]. Therefore, early recognition of frailty is important not only in geriatrics but also in everyday clinical and nursing practice, especially in the planning of individualized care and preventive interventions.

Although frailty is closely related to biological aging, its clinical consequences and management extend beyond physiological changes and include adverse health outcomes, increased care needs, and potentially modifiable lifestyle factors [4, 9–11]. Older age is associated with a higher prevalence of frailty [8], while physical inactivity and unfavorable dietary or nutritional factors are associated with poorer physical functioning and health outcomes in older adults [12–19]. This suggests the need to view frailty not solely as a medical problem, but also as an indicator of the broader vulnerability of older adults. Various models and instruments are used to assess frailty, and a widely used tool is the Edmonton Frailty Scale, which allows for a comprehensive assessment of several important areas of functioning in older adults, including cognitive abilities, general health status, functional independence, social support, medication use, nutrition, mood, continence, and functional performance [20]. The advantage of this approach is that it allows for the identification not only of the presence of frailty but also of areas in which targeted interventions are needed.

Although frailty in older age is the subject of a growing number of studies, data on its prevalence and associated factors in the Croatian context are still relatively limited, especially at the level of local and regional communities. There is particularly little research that simultaneously considers sociodemographic characteristics and health-related behaviors, such as physical activity, proper nutrition, preventive examinations, and social activities. This is precisely the research gap that this study seeks to partially fill.

Therefore, this study aimed to examine the prevalence of frailty among older adults in the Vukovar-Srijem County and to determine its association with sociodemographic characteristics, age, and selected health-related behaviors.

METHODS

Study Design

A cross-sectional study was conducted.

Setting and Participants

A total of 156 adults aged 65 years and older from Vukovar-Srijem County participated in the study. The study included older adults living in their own homes as well as nursing home residents.

Data Collection

Participants were recruited from Vinkovci General Hospital and nursing homes. Data were collected between May and June 2024. Completion of the questionnaire took approximately 20 minutes.

Measurements and Instruments

Data were collected using a two-part questionnaire. The sociodemographic questionnaire assessed participants' characteristics and consisted of five items (sex, age, place of residence, educational level, and financial status). Additionally, information on lifestyle habits and health-related behaviors was collected through four items covering physical activity, proper nutrition, preventive check-ups, and partici-

pation in social activities. The Edmonton Frailty Scale was used to assess frailty [20]. Permission to use the instrument was obtained from the University of Alberta [20]. The scale assesses nine domains: cognitive abilities, general health status, functional independence, social support, medication use, nutrition, mood, continence, and functional performance. The scale consists of 11 items. Items 1–5 and 11 are scored from 0 to 2, whereas items 6–10 are scored from 0 to 1. The total score ranges from 0 to 17 points, with 0–5 indicating the absence of frailty, 6–7 vulnerability, 8–9 mild frailty, 10–11 moderate frailty, and 12–17 severe frailty [20].

Statistical Analysis

Descriptive statistics were used to summarize the study variables. Categorical variables were summarized as absolute and relative frequencies, whereas continuous variables were summarized as medians and interquartile ranges (IQRs). Differences in frailty between two groups were examined using the Mann–Whitney U test, and between three or more groups using the Kruskal–Wallis test. The association between age and frailty was assessed using Spearman's rank correlation coefficient. Multiple linear regression analysis was performed to identify independent predictors of frailty. The assumptions of multiple linear regression were assessed before interpretation of the model. The absence of problematic multicollinearity was confirmed by tolerance values ranging from 0.456 to 0.913 and variance inflation factor values ranging from 1.095 to 2.193. The Durbin–Watson statistic was 2.075, indicating no problematic autocorrelation of residuals. The statistical significance level was set at $p < 0.05$. Data were analyzed using IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, NY, USA; 2017), and JASP version 0.17.2.1 (Department of Psychological Methods, University of Amsterdam, Amsterdam, The Netherlands).

Ethical considerations

The study was conducted in compliance with the General Data Protection Regulation (GDPR). Before participation, all participants were informed about the purpose and objectives of the study and provided written informed consent. Participation was voluntary and anonymous, and participants could withdraw at any time without consequences. The study was approved by the Ethics Committee of General County Hospital Vinkovci (Registration No. 2387/3/2024; April 15, 2024). Institutional permissions for data collection were obtained from Family Home "Grim", Vinkovci (April 12, 2024), the Home for the Elderly and Disabled Vinkovci (April 22, 2024), Family Home "Sunce", Vinkovci (March 23, 2024), and the Home for the Elderly and Disabled "Sveti Ante", Mikanovci (April 22, 2024). All procedures were conducted in accordance with the ethical standards of the institutional research committees and the Declaration of Helsinki.

RESULTS

A total of 156 participants were included in the study. Most participants were female (95; 60.9%), lived in urban areas (107; 69%), and had completed primary school education (79; 50.6%). Nearly half of the participants reported a below-average financial status (76; 48.7%) (Table 1). The median age was 80 years (IQR 73.3–85.0).

Table 1. Demographic characteristics of the participants (N = 156)

Characteristics		n (%)
Sex	Male	61 (39.1)
	Female	95 (60.9)
Place of residence	Urban	107 (68.6)
	Rural	48 (31.0)
Education level	Primary school	79 (50.6)
	Secondary school	60 (38.5)
	College degree	9 (5.8)
	University degree	8 (5.1)
Financial status	Below average	76 (48.7)
	Average	61 (39.1)
	Above average	19 (12.2)

Note: Data on place of residence were missing for one participant.

Regarding health-related behaviors, the largest proportion of participants reported never engaging in physical activity (77; 49.4%), occasionally maintaining a proper diet (70; 44.9%), regularly attending preventive medical check-ups (69; 44.2%), and not participating in social activities (91; 58.3%) (Table 2).

Table 2. Distribution of health-related behaviors among participants (N = 156)

Variable	Category	n (%)
Physical activity during life	Daily	27 (17.3)
	Occasionally	52 (33.3)
	Never	77 (49.4)
Proper diet during life	Always	22 (14.1)
	Occasionally	70 (44.9)
	Never	64 (41.0)
Regular preventive medical check-ups	Yes	69 (44.2)
	No	31 (19.9)
	Sometimes	56 (35.9)
Participation in social activities	Yes	24 (15.4)
	No	91 (58.3)
	Sometimes	41 (26.3)

Note: Percentages were calculated based on the total sample of 156 participants.

The median total score on the Edmonton Frailty Scale was 8 points (IQR 5–11), indicating mild frailty according to the Edmonton Frailty Scale classification. No frailty was observed in 26.3% of participants, whereas 21.8% had severe frailty. The remaining participants were classified as vulnerable or as having mild or moderate frailty (Table 3).

Table 3. Frailty score and frailty categories among participants (N = 156)

Variable	Category	Median (IQR)
Frailty score		8 (5–11)
		n (%)
Frailty category	No frailty	41 (26.3)
	Vulnerable	29 (18.6)
	Mild frailty	23 (14.7)
	Moderate frailty	29 (18.6)
	Severe frailty	34 (21.8)

Note: Frailty categories were determined according to the Edmonton Frailty Scale classification.

Frailty differed significantly according to sex (P = 0.025), place of residence (P = 0.001), educational level (P < 0.001), and financial status (P < 0.001). Higher frailty scores were observed among women, participants living in rural areas, those with lower educational attainment, and those reporting below-average financial status. Post hoc Dunn–Bonferroni analysis confirmed significant differences for educational level and financial status (Table 4).

Table 4. Frailty according to demographic variables (N = 156)

Variable		Frailty Median (IQR)	U/H (df)	*P-value*
Sex	Male	7 (4–10)	2281.0	0.025*
	Female	9 (6–11.5)		
Place of residence (n=155)	Urban	8 (4–10)	1706.0	0.001*
	Rural	10 (7–13)		
Education level	Primary school	10 (8–12)	49.248 (3)	<0.001†
	Secondary school	7 (4–9)		
	College degree	3 (3–5)		
	University degree	2 (2–3.3)		
Financial status	Below average	10 (8–12)	42.581 (2)	<0.001†
	Average	7 (4–10)		
	Above average	2 (2–5)		

Note: U – Mann–Whitney U test statistic; H – Kruskal–Wallis test statistic; df – degrees of freedom; *Mann–Whitney U test; †Kruskal–Wallis test. Data on place of residence were missing for one participant.

Spearman correlation analysis showed a statistically significant positive association between age and frailty (rho = 0.534, *P* < 0.001), indicating that frailty increased with age. Frailty differed significantly according to physical activity during life (*P* < 0.001), proper diet during life (*P* < 0.001), regular preventive medical check-ups (*P* < 0.001), and participation in social activities (*P* < 0.001). Higher frailty scores were observed among participants who never engaged in physical activity, did not maintain a proper diet, did not attend regular preventive medical check-ups, and did not participate in social activities (Table 5).

Table 5. Frailty according to health-related behaviors and social participation (N = 156)

Variable		Frailty	H (df)	*P-value*
		Median (IQR)		
Physical activity during life	Daily	3 (2–8.5)		
	Occasionally	7 (4.75–9)	37.086 (2)	<0.001
	Never	10 (7–12)		
Proper diet during life	Always	4 (2–8.5)		
	Occasionally	8 (5–10)	24.098 (2)	<0.001
	Never	10 (7–12.3)		
Regular preventive medical check-ups	Yes	6 (3–8)		
	No	11 (10–13)	52.086 (2)	<0.001
	Sometimes	10 (7.75–12)		
Participation in social activities	Yes	3.5 (2–6)		
	No	10 (7–12)	51.598 (2)	<0.001
	Sometimes	7 (4–9)		

Note: H – Kruskal–Wallis test statistic; df – degrees of freedom.

Multiple linear regression analysis was performed to identify independent predictors of frailty. The overall regression model was statistically significant, F(9, 145) = 22.482, *P* < 0.001, and explained 55.7% of the variance in frailty according to the adjusted coefficient of determination (adjusted R^2 = 0.557; R^2 = 0.583). Financial status (B = −0.853, β = −0.155, 95% CI −1.670 to −0.035, *P* = 0.041), physical activity (B = 0.841, β = 0.166, 95% CI 0.124–1.559, *P* = 0.022), participation in social activities (B = 0.944, β = 0.183, 95% CI 0.218–1.669, *P* = 0.011), and regular preventive medical check-ups (B = 1.250, β = 0.250, 95% CI 0.613–1.887, *P* < 0.001) were statistically significant independent predictors of frailty. Age did not reach statistical significance in the multivariable model (B = 0.040, β = 0.112, *P* = 0.054), while sex, educational level, place of residence, and proper diet were also not statistically significant. Higher frailty scores were independently associated with poorer financial status, lower physical activity, lower participation in social activities, and less frequent attendance at preventive medical check-ups (Table 6).

Table 6. Multiple linear regression analysis of predictors of frailty

Predictor	B	β	t	*P-value*	95% CI Lower	95% CI Upper
Constant	-1,405		-0.578	0.564	-6.206	3.396
Sex	0,265	0.034	0.565	0.573	-0.663	1.194
Age	0,040	0.112	1.942	0.054	-0.001	0.080
Education level	-0,615	-0.131	-1.643	0.103	-1.355	0.125
Place of residence	0,820	0.100	1.774	0.078	-0.094	1.733
Financial status	-0,853	-0.155	-2.062	0.041	-1.670	-0.035
Physical activity	0,841	0.166	2.317	0.022	0.124	1.559
Social activity	0,944	0.183	2.571	0.011	0.218	1.669
Preventive medical check-ups	1,250	0.250	3.877	<0.001	0.613	1.887
Proper diet	0,398	0.073	1.118	0.266	-0.306	1.101

Note: B – unstandardized regression coefficient; SE – standard error; β – standardized regression coefficient; t – test statistic; *P* – statistical significance; CI – confidence interval. Model statistics: $F(9, 145) = 22.482$, $P < 0.001$; $R^2 = 0.583$; adjusted $R^2 = 0.557$. The analysis included 155 participants.

DISCUSSION

This study aimed to describe the distribution of frailty in the study sample and to examine its associations with sociodemographic characteristics, age, and selected health-related behaviors. The results emphasize the importance of social integration, physical activity, socioeconomic status, and preventive health examinations in the development of frailty.

The data suggest that frailty in older age is not an unavoidable byproduct of aging, but a state significantly influenced by modifiable risk factors. Overall, these results indicate that the frailty syndrome is a complex condition arising from the interaction of biological, psychological, social, and functional factors, rather than solely a consequence of biological aging. Previous research has shown that frailty is associated with increased sensitivity to stressors and a higher probability of adverse outcomes, including falls, hospitalizations, functional impairment, institutionalization, and mortality, which is why this understanding of frailty is particularly important in the field of geriatrics and nursing [7, 21, 22].

Early recognition of frailty is crucial for planning and implementing effective preventive strategies. The median score of 8 points indicates mild frailty according to the Edmonton Frailty Scale classification. The categorical distribution further suggests that frailty extends beyond a small subgroup of the most vulnerable individuals and affects a substantial proportion of the older population.

The findings therefore support the importance of early screening in older age, especially in primary health care and nursing, where timely identification of vulnerable individuals can facilitate the planning of interventions aimed at preserving functional capacity and independence. These results are consistent with evidence showing that the prevalence of frailty varies according to the population and assessment method and that a substantial proportion of older adults are affected [8].

Bivariate analyses showed that frailty was more pronounced in women, participants living in rural areas, participants with lower education and poorer financial status. The higher frailty observed among women is consistent with systematic evidence showing a higher prevalence of frailty among women than men [23]. Multimorbidity and functional limitations, which are common in older adults, may further contribute to the burden of frailty [24]. In addition, the health consequences of widowhood and the possible lack of daily support may be more pronounced in old age, especially if accompanied by social vulnerability and loneliness [25]. Lower levels of education may be associated with lower health literacy, which can make it more difficult for older adults to access, understand, and use health information [26].

Living in rural areas may be associated with poorer access to health services, preventive programs, and organized social activities, which may increase the health and social vulnerability of older adults [27, 28]. Poorer financial status may increase vulnerability to frailty because lower socioeconomic position is consistently associated with a higher prevalence and incidence of frailty [29, 30].

Findings related to health-related behaviors are particularly important. Frailty was higher among participants who did not engage in physical activity, did not maintain a proper diet, did not attend regular preventive medical check-ups, and did not participate in social activities. This pattern suggests that frailty in older age is not only a reflection of age and disease, but also of the long-term effects of lifestyle and level of social inclusion. Physical inactivity can contribute to decreased muscle strength, poorer mobility, and faster functional decline, while poor nutrition can further worsen general health, nutritional status, and resilience. At the same time, the lack of regular preventive examinations may mean less early recognition of health problems and a lower possibility of timely treatment or control of chronic diseases. Not engaging in social activities may be associated with social isolation, lower levels of daily functioning, and weaker psychological resilience, all of which may contribute to greater frailty. Such findings are consistent with literature associating physical activity and adequate nutrition with better health and functional outcomes and social isolation with poorer health outcomes among older adults [10, 12–15, 28].

The positive association between age and frailty was an expected finding and supports the basic theoretical understanding of frailty as a syndrome that develops more frequently with advancing age. With increasing age, there is a gradual decrease in physiological reserves, accumulation of chronic diseases, and a higher risk of functional limitations, which increases the likelihood of developing frailty [6, 8]. However, it is important to note that age did not remain a statistically significant independent predictor in multiple linear regression, although it was on the verge of significance. Such a finding suggests the possibility that part of the influence of age on frailty acts indirectly, through financial status and health-related behaviors.

The most important finding of this study emerged from the multivariate analysis, in which financial status, physical activity, regular preventive examinations and social activities were identified as significant independent predictors of frailty. This means that socioeconomic status and health-related behaviors had the strongest independent association with frailty after controlling for other included variables. At the same time, gender, education, place of residence and diet did not remain statistically significant independent predictors, suggesting that their association with frailty can be at least partially explained by other included variables. The data suggest that frailty in older age is not an unavoidable byproduct of aging, but a state significantly influenced by modifiable risk factors. This distinction is critical for developing interventions that prioritize physical activity, preventive examinations, and social inclusion to mitigate risk levels.

Practical implications

The results of this study may have applications in nursing, primary health care, and public health. Continuous monitoring of older adults should become routine, while special attention should be paid to older people who face financial instability or social isolation. Programs that promote healthy lifestyles and improve access to preventive care are essential for delaying functional decline and maintaining independence. In this way, nurses could be an important link in the early identification of individuals at risk, by providing the necessary education and motivation for changes in health behavior, while connecting patients with available social and medical support.

Study limitations

The results of this study should be interpreted taking into account its limitations. The study was conducted on a relatively small sample of participants from one county, which limits the generalizability of the findings. In addition, it is a cross-sectional study, so it is not possible to conclude cause-and-effect relationships, only about associations between the observed variables. In addition, part of the data is based on self-assessment by participants, which opens up the possibility of response bias. Neverthe-

less, the study provides a valuable contribution to understanding factors associated with frailty in the older population and can serve as a useful basis for future research and the development of preventive programs.

CONCLUSION

Frailty in older adults was associated with socioeconomic status and health-related behaviors, particularly physical activity, regular preventive medical check-ups, and social participation. Although bivariate analyses showed that frailty was positively associated with age and was more pronounced among vulnerable groups of participants, multiple linear regression identified socioeconomic and behavioral factors as the strongest independent predictors of frailty. These findings suggest that frailty is influenced not only by aging but also by modifiable lifestyle and social factors. Physical activity, regular preventive medical check-ups, and social participation may represent relevant targets for future preventive interventions aimed at preserving functional capacity among older adults.

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Author Contributions

Conceptualization, A.B and Š.M.; Methodology, A.B and Š.M.; Software, M.M., M.V.; Validation, A.B and Š.M.; Formal Analysis, M.M., M.V.; Investigation, A.B and Š.M.; Resources, A.B and Š.M.; Data Curation, M.M.; Writing – Original Draft Preparation, A.B., M.M. and Š.M.; Writing – Review & Editing, A.B., M.M. and Š.M.; Visualization, A.B., M.M. and Š.M.; Supervision, Š.M.; Project Administration, A.B.

Declaration of Conflicting Interest

The authors declares no conflict of interest.

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Quality of Life in Patients with Obstructive Sleep Apnea by CPAP Therapy Status: A Comparative Cross-Sectional Study

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ABSTRACT

Introduction: Obstructive sleep apnea (OSA) is a frequently underdiagnosed condition characterized by symptoms such as excessive daytime sleepiness, fatigue, and reduced quality of life (QoL), while continuous positive airway pressure (CPAP) is the gold standard treatment. This study aimed to examine the impact of CPAP therapy on the quality of life of patients with obstructive sleep apnea.

Methods: A comparative cross-sectional study was conducted at the University Hospital Centre Osijek in 100 patients with moderate to severe OSA, comparing pre-CPAP and post-CPAP (≥3 months) groups. Data were collected using a structured questionnaire and the SF-36 health-related quality of life instrument.

Results: Compared with the pre-CPAP group, patients using CPAP therapy for at least three months demonstrated significantly better physical functioning (P = 0.03), mental health (P = 0.02), vitality (P = 0.05), and fewer limitations due to physical (P = 0.02) and emotional problems (P = 0.03). CPAP users also reported less frequent fatigue (P = 0.02), better mood (P = 0.02), and greater satisfaction with social functioning (P = 0.01). Regular CPAP users demonstrated better physical functioning (P = 0.05) and fewer limitations due to physical (P = 0.02) and emotional problems (P = 0.03) than occasional users. Compared with women, men reported better quality of life both before and after CPAP therapy, including better physical functioning (P = 0.03) and better mental health after therapy (P = 0.04).

Conclusion: Patients with OSA receiving CPAP therapy reported significantly better quality of life than those not receiving CPAP therapy, particularly in the domains of physical and mental functioning. Regular CPAP use was associated with better quality of life, especially with improved physical functioning and fewer physical and emotional limitations. Compared with men, women reported poorer quality of life both before and after CPAP therapy, with greater physical and emotional limitations.

INTRODUCTION

Sleep disorders encompass a wide range of conditions that must be recognized, diagnosed, and treated in a timely manner due to their significant impact and serious consequences on overall health. The most common sleep-related breathing disorder is obstructive sleep apnea (OSA). OSA represents a serious medical problem affecting approximately 17% of women and 34% of men between the ages of 30 and 70 years [1], and its prevalence is increasing alongside the growing prevalence of obesity [2]. It is characterized by repeated partial or complete obstruction of the upper airway during sleep, leading to episodes of apnea and hypopnea, breathing interruptions lasting longer than 10 seconds, and intermittent hypoxia [1]. OSA significantly impairs quality of life and increases the risk of cardiovascular and metabolic diseases [1, 3, 4], diabetes [5], depression, and reduced life expectancy [3, 4, 6].

Diagnosis is based on the apnea-hypopnea index (AHI), where an AHI ≥5 accompanied by symptoms such as snoring, daytime sleepiness, nocturnal awakenings, morning headaches, and cognitive disturbances is sufficient for the diagnosis of OSA [7]. It is estimated that nearly 80% to 90% of patients with OSA remain undiagnosed due to failure to recognize mild cases and low awareness of this condition among the general population and healthcare professionals [8].

Among the most important risk factors for OSA are excessive body weight [2, 9], male sex [9, 10], older age [9], anatomical characteristics of the upper airway, alcohol and sedative use [11], smoking [12], and genetic predisposition [13]. Obesity causes fat accumulation in the airway, increasing the risk of obstruction. In men and individuals older than 40 years, upper airway muscle tone declines, while conditions such as septal deviation and enlarged tonsils additionally contribute to the risk [9, 10]. Narrowing of the upper airway and reduced activity of the pharyngeal dilator muscles lead to obstruction during sleep [9, 10]. Episodes of apnea cause hypoxia and hypercapnia, which activate arousal mechanisms and sleep fragmentation [14]. Night-time symptoms include snoring, choking episodes [15], frequent urination, and night sweats [16], while daytime symptoms include fatigue, sleepiness [17], morning headaches [18], and cognitive disturbances [19]. Individuals with OSA are often irritable, anxious, prone to depression [20], and have reduced sexual desire [21]. Men experience greater snoring intensity compared with women, whereas women report snoring and apneas less frequently [22]. Women more commonly complain of daytime fatigue, lack of energy, insomnia, morning headaches, and mood disturbances compared with men [23].

Numerous studies have demonstrated that patients with OSA experience a marked reduction in quality of life (QoL) [24, 25]. QoL is a multidimensional and complex construct, generally understood as encompassing both subjective perceptions and objective conditions related to physical health, material circumstances, social relationships, and emotional well-being [26]. In this context, health-related quality of life specifically reflects how disease and its treatment influence an individual's functional status, level of disability, and everyday activities [26, 27]. Importantly, interventions aimed at improving QoL may contribute not only to better rehabilitation outcomes and overall patient care, but also to the alleviation of disease-related symptoms [27].

CPAP is considered the gold standard treatment for moderate and severe OSA [28]. CPAP keeps the airway open, improves oxygenation, reduces sleep fragmentation, and alleviates symptoms such as daytime sleepiness and cognitive problems [29, 30]. Therapy also has a beneficial effect on mental health [31] and reduces the risk of cardiovascular complications [32, 33]. However, adherence to therapy can be challenging due to discomfort, mucosal dryness, nasal congestion, or psychological discomfort [34]. Education, equipment individualization, and continuous support from healthcare professionals are essential for long-term preservation of patients' quality of life [34–38]. In some cases, physicians may recommend additional treatments, such as the use of humidifiers, mask modifications [39], or even surgical interventions, to maximize the benefits of CPAP therapy [40]. Although CPAP remains the most effective treatment for OSA, it is important to approach treatment with an understanding of each patient's specific needs to ensure optimal therapy use and improvement in patients' quality of life [41–43].

Despite the well-known negative impact of obstructive sleep apnea on health-related quality of life, data on changes following CPAP therapy in the domestic context remain limited. Therefore, this study aimed to compare the quality of life of patients with OSA receiving CPAP therapy and those not receiving CPAP therapy, and to assess differences in quality of life according to sociodemographic characteristics and gender.

METHODS

Study design

This comparative cross-sectional study was conducted at the University Hospital Centre Osijek, Clinic of Neurology, between January and May 2025. Two independent groups of participants were included: patients before initiation of CPAP therapy and patients who had been using CPAP therapy for at least three months. Data were collected from two independent groups representing different stages of CPAP therapy (before initiation and after ≥3 months of use). As different participants were recruited at each time point, the samples were independent.

Setting and samples

The study was conducted at the Sleep Disorders Outpatient Clinic, Clinic of Neurology, University Hospital Centre Osijek. The sample included adult patients diagnosed with moderate to severe OSA, defined as an apnea–hypopnea index (AHI) ≥15 events per hour. Participants were divided into two groups: (1) patients initiating CPAP therapy and (2) patients attending follow-up visits after at least three months of CPAP use.

Inclusion criteria were: age ≥18 years, diagnosis of moderate or severe OSA confirmed by polysomnography or polygraphy (AHI ≥15 events/hour), initiation of CPAP therapy (for the first group), use of CPAP therapy for ≥3 months (for the second group), ability to understand and independently complete the questionnaire, and provision of written informed consent. Exclusion criteria were: acute medical conditions at the time of data collection, prior surgical treatment for OSA, discontinuation of CPAP therapy, refusal to participate, or incomplete questionnaires.

Measurements/instruments

Data were collected using a structured questionnaire consisting of three parts. The first part included sociodemographic and clinical characteristics: sex, age, place of residence, marital status, level of education, and comorbidities (diabetes, hypertension, obesity, stroke, myocardial infarction, and other). Clinical variables also included duration of OSA diagnosis, CPAP use (regular or occasional), and average daily duration of CPAP use.

Participants who reported difficulties with CPAP use were asked an additional question regarding the reasons for these difficulties, with predefined response options including: discomfort during use (pressure, pain, irritation), sleep disturbances related to mask use, difficulties adapting to the device, technical problems with the device or mask, and lack of support or instructions for use.

The second part of the questionnaire assessed the participants' perception of daytime symptoms and psychosocial functioning. This section included questions focused on the subjective experience of emotional status, social relationships, and the perceived impact of the disease on everyday life. Specifically, it included questions regarding the presence of anxiety or depressive feelings related to sleep problems, the level of satisfaction with social life, and the perception of support from family and friends in the context of health-related difficulties. Participants were also asked to identify the aspect of health they considered to be most affected by OSA. Responses were collected through self-assessment, providing insight into the subjective evaluation of psychosocial functioning and everyday difficulties associated with the disease.

Quality of life was assessed using the freely available Short Form Health Survey (SF-36) [44]. The validated Croatian version was applied [45, 46]. The SF-36 consists of 36 items grouped into eight domains: physical functioning (PF), role limitations due to physical health (RP), role limitations due to emotional problems (RE), vitality (energy/fatigue) (VT), mental health (MH), social functioning (SF), bodily pain (BP), and general health perception (GH). Scores for each domain were transformed to a standardized scale ranging from 0 to 100, with higher scores indicating better perceived health status and higher quality of

life. Results are presented as a profile of eight subscales, and values above 50 are interpreted as indicative of preserved or good quality of life [44–46].

The SF-36 questionnaire has been validated and widely used in clinical and population-based studies, enabling comparisons across different groups of participants [47–49]. The SF-36 has demonstrated good internal consistency in previous studies, with Cronbach's alpha coefficients typically exceeding 0.70 across most domains [47–49].

Data collection/procedure

Before completing the questionnaire, participants were informed about the aim and purpose of the study. The questionnaire was administered using a paper-and-pencil format and distributed personally during outpatient visits. Participation in the study lasted approximately 10–15 minutes, including providing study information, obtaining written informed consent, and completing the questionnaire.

Ethical considerations

The study was conducted anonymously, and no personal identifying data were collected, ensuring full confidentiality of participants. All procedures were performed in accordance with the General Data Protection Regulation (GDPR) and the ethical principles outlined in the Declaration of Helsinki. Ethical approval for the study was obtained from the Ethics Committee of the University Hospital Centre Osijek (approval number: R1-96-2/2025) and the Faculty of Dental Medicine and Health Osijek (approval number: 2158/97-97-10-25-05).

Statistical data analysis

Categorical variables were presented as absolute and relative frequencies. Numerical variables were described using the median and interquartile range. Differences between categorical variables were analyzed using the χ^2 test. The normality of distribution for numerical variables was assessed using the Kolmogorov–Smirnov test. Because the data were not normally distributed, comparisons of numerical variables between two independent groups were performed using the Mann–Whitney U test. For comparisons involving three or more independent groups, the Kruskal–Wallis test was applied. All *P-values* were two-tailed, and the level of statistical significance was set at $\alpha = 0.05$. Statistical analyses were performed using the IBM SPSS Statistics software, version 22.0 (IBM Corp., Armonk, NY, USA).

RESULTS

The study included 100 participants, of whom 84 (84%) were men, and 16 (16%) were women. The median age was 55 years (interquartile range 48–62 years). The pre-CPAP group included 48 (48%) participants, while the post-CPAP group included 52 (52%) participants. The majority of participants lived in urban areas, had completed secondary school education, and were married. Twenty participants were obese, while 20 participants (20%) had no associated comorbidities (Table 1).

Table 1. General characteristics of participants

Characteristic		Number (%) of participants
CPAP device use	Pre-CPAP group	48 (48)
	Post-CPAP group	52 (52)
Sex	Male	84 (84)
	Female	16 (16)
Age	23 – 40	11 (11)
	41 – 50	24 (24)
	51 – 60	39 (39)
	61 – 70	18 (18)
	≥71	8 (8)
Place of residence	City	61 (61)
	Village	39 (39)
Education level	Primary school	12 (12)
	High school	72 (72)
	College or University degree	16 (16)
Marital status	Single	7 (7)
	Married	80 (80)
	Cohabiting	6 (6)
	Divorced	4 (4)
	Widowed	3 (3)

Characteristic		Number (%) of participants
Comorbidities	None	20 (20)
	Diabetes mellitus	10 (10)
	Hypertension	21 (21)
	Obesity	20 (20)
	Myocardial infarction	2 (2)
	Stroke	1 (1)
	Other	11 (11)
	Combination of multiple comorbidities	15 (15)
Total		100 (100)

A diagnosis of OSA for more than 3 years was reported by 26 (50%) participants, while 3 (6%) participants had been diagnosed with OSA for less than 6 months. Regular CPAP use was reported by 44 (85%) participants, while 8 (15%) used the device occasionally. Of the total 52 participants using CPAP, 22 (42%) used it for 4–6 hours daily, while 24 (46%) participants used CPAP for more than 6 hours per day. Among the 20 participants who experienced difficulties while using the CPAP device, 9 (45%) reported discomfort during use as the main reason. Significant symptom improvement after initiation of CPAP therapy was reported by 31 (60%) participants, partial improvement by 17 (33%), while 2 (4%) participants reported no improvement and 2 (4%) were unsure (Table 2).

Table 2. CPAP use and treatment-related characteristics (N = 52)

Characteristic		Number (%) of participants
How long have you had a diagnosis of obstructive sleep apnea?	Less than 6 months	3 (6)
	6 months – 1 year	7 (14)
	1 – 3 years	16 (30)
	More than 3 years	26 (50)
Do you use the CPAP device regularly?	Yes, regularly	44 (85)
	Yes, occasionally	8 (15)
If you use it, how many hours per day do you use it on average?	Less than 2 hours	1 (2)
	2 – 4 hours	5 (10)
	4 – 6 hours	22 (42)
	More than 6 hours	24 (46)
Difficulties during use (n = 20)	Discomfort during use	9 (45)
	Problems sleeping with the mask	7 (35)
	Difficulty adapting to the device	1 (5)
	Technical problems with the device	3 (15)
Have you noticed symptom improvement after starting CPAP therapy?	Yes, significant improvement	31 (60)
	Yes, partial improvement	17 (33)
	No, no improvement	2 (4)
	Not sure	2 (4)

Compared with the pre-CPAP group, significantly more participants in the post-CPAP group rated their current physical condition as excellent, whereas participants in the pre-CPAP group more frequently rated their physical condition as poor (P = 0.02). Compared with the pre-CPAP group, significantly more participants reported frequent daytime fatigue, whereas participants in the post-CPAP group reported fatigue considerably less often (P = 0.02). Significantly more participants in the post-CPAP group reported no difficulties with physical activity due to sleep problems, whereas participants in the pre-CPAP group more often reported occasional difficulties (P = 0.01). Compared with the pre-CPAP group, participants in the post-CPAP group more frequently reported feeling motivated and in a good mood during the day (P = 0.02). Participants in the post-CPAP group were also more likely to report satisfaction with their social life, whereas participants in the pre-CPAP group were more often dissatisfied (P = 0.01) (Table 3).

Table 3. Self-assessment of symptoms and daily functioning by CPAP therapy status

Question	Answer	Number (%) of participants		*P-value**
		Pre-CPAP group	Post-CPAP group	
How would you rate your current physical condition?	Excellent	0 (0)	7 (14)	0.02
	Very good	8 (17)	8 (15)	
	Good	24 (50)	29 (59)	
	poor	16 (33)	7 (14)	
	Very poor	0 (0)	1 (2)	
How often do you feel tired during the day?	Never	0 (0)	3 (6)	0.02
	Rarely	6 (12)	14 (27)	
	Occasionally	20 (42)	25 (48)	
	Often	20 (42)	10 (19)	
	Always	2 (4)	0 (0)	
Do you have difficulties with physical activity due to sleep problems?	Never	6 (12)	14 (27)	0.01
	Rarely	11 (23)	19 (36)	
	Occasionally	25 (53)	18 (35)	
	Often	6 (12)	1 (2)	
Do you feel cheerful and motivated during the day?	Always	1 (2)	4 (8)	0.02
	Mostly	20 (42)	31 (60)	
	Occasionally	17 (35)	15 (29)	
	Rarely	10 (21)	2 (4)	
Do you have problems with concentration and memory?	Never	7 (15)	8 (15)	0.85
	Rarely	13 (27)	18 (35)	
	Occasionally	23 (48)	21 (40)	
	Often	5 (10)	5 (10)	
Do you feel anxiety or depression due to sleep problems?	Never	11 (23)	15 (29)	0.38
	Rarely	14 (29)	18 (35)	
	Occasionally	15 (31)	15 (29)	
	Often	8 (17)	3 (6)	
	Always	0 (0)	1 (2)	
How satisfied are you with your social life?	Completely satisfied	18 (37)	16 (30)	0.01
	Mostly satisfied	16 (33)	30 (58)	
	Undecided	5 (10)	5 (10)	
	Mostly dissatisfied	9 (19)	1 (2)	
Do you feel supported by your family and friends regarding your health problems?	Always	26 (54)	37 (71)	0.20
	Mostly	18 (37)	12 (23)	
	Occasionally	4 (8)	2 (4)	
	Rarely	0 (0)	1 (2)	
Which aspect of your health do you consider to be most affected by obstructive sleep apnea?	Physical health	32 (67)	36 (69)	0.74
	Mental health	11 (23)	8 (15)	
	Social relationships	3 (6)	5 (10)	
	Other	2 (4)	3 (6)	
Total		48 (100)	52 (100)	

Note: *χ^2 test

Compared with the pre-CPAP group, participants in the post-CPAP group reported significantly better physical functioning (P = 0.03), fewer limitations due to physical problems (P = 0.02) and emotional problems (P = 0.03), greater vitality (P = 0.05), and better mental health (P = 0.02) (Table 4).

Table 4. Quality of life about CPAP device use (N = 100)

SF-36 domains	Median (IQR)		*P-value**
	Pre-CPAP group (n = 48)	Post-CPAP group (n = 52)	
Physical functioning (PF)	55 (30 – 83)	67,5 (50 – 95)	0,03
Role–physical (RP)	37,5 (0 – 75)	75 (6,25 – 100)	0,02
Role–emotional (RE)	66,7 (0 – 100)	100 (41 – 100)	0,03
Vitality/ energy (VT)	52,5 (40 – 70)	60 (45 – 75)	0,05
Mental health (MH)	54 (41 – 68)	66 (52 – 84)	0,02
Social functioning (SF)	62,5 (50 – 87)	62,5 (50 – 87)	0,66
Bodily pain (BP)	65 (45 – 90)	77,5 (45 – 97)	0,19
General health (GH)	55 (40 – 65)	55 (50 – 70)	0,46

Note: *Mann-Whitney U test

Participants who regularly used the CPAP device had significantly better physical functioning than participants who used the CPAP device occasionally (P = 0.05). Participants who regularly used the CPAP device also had fewer limitations due to physical problems (P = 0.02) and emotional problems (P = 0.03) than participants who used the CPAP device occasionally (Table 5).

Table 5. Quality of life according to the frequency of CPAP device use (N = 52)

SF-36 domains	Median (IQR)		*P-value**
	Regular users (n = 44)	Irregular users (n = 8)	
Physical functioning (PF)	72,5 (50 – 95)	50 (25 – 60)	0,05
Role–physical (RP)	75 (25 – 100)	12,5 (0 – 62,5)	0,02
Role–emotional (RE)	100 (33 – 100)	83 (0 – 100)	0,03
Vitality/ energy (VT)	60 (50 – 75)	57,5 (15 – 73)	0,49
Mental health (MH)	68 (52 – 8)	74 (44 – 84)	0,83
Social functioning (SF)	75 (50 – 87)	68,75 (40 – 100)	0,86
Bodily pain (BP)	77,5 (46 – 100)	82,5 (19 – 100)	0,83
General health (GH)	60 (51 – 70)	60 (45 – 85)	0,73

Note: *Mann-Whitney U test

In the pre-CPAP group, men had significantly better physical functioning than women (P = 0.03) and reported significantly less bodily pain (P = 0.05). Women in the pre-CPAP group had significantly greater limitations due to physical problems (P = 0.03) and emotional problems (P = 0.02) than men. Among men, those in the post-CPAP group reported significantly better mental health than those in the pre-CPAP group (P = 0.04). Women in the post-CPAP group had significantly poorer physical functioning (P = 0.01), significantly greater limitations due to physical problems (P = 0.02) and emotional problems (P = 0.02), and reported significantly greater bodily pain (P = 0.02) than men in the post-CPAP group (Table 6).

Table 6. Comparison of quality of life between men and women in the pre-CPAP and post-CPAP groups

SF-36 domains	Median (IQR)				*P-value**			
	1. Males before	2. Females before	3. Males after	4. Females after	1 vs 2	1 vs 3	2 vs 4	3 vs 4
Physical functioning (PF)	65 (42.5 – 85)	20 (10 -65)	75 (55 – 95)	25 (17.5 –60)	0.03	0.07	0.58	0.01
Role–physical (RP)	50 (0 – 100)	25 (0 – 75)	75 (25 –100)	25 (0 – 75)	0.03	0.05	0.83	0.02
Role–emotional (RE)	100 (16.7 –100)	33 (0-66.7)	100 (66-100)	66.7 (0 – 83.3)	0.02	0.57	0.03	0.02
Vitality/ energy (VT)	60 (42.5 – 70)	45 (40 -50)	60 (45 – 75)	45 (35 –57.5)	0.11	0.24	>0.99	0.07
Mental health (MH)	56 (44 – 74)	48 (24-60)	68 (52 – 88)	52 (42 – 60)	0.15	0.04	0.74	0.06
Social functioning (SF)	62.5 (50 – 87.5)	62.5 (50-87.5)	62.5 (50 -87.5)	50 (31-87.5)	0.89	0.53	0.51	0.29
Bodily pain (BP)	67.5 (45 – 95)	40 (22.5-90)	77.5 (55 –100)	45 (17.5-66)	0.05	0.27	>0.99	0.02
General health (GH)	55 (40 – 67.5)	55 (40 – 60)	55 (50 – 70)	60 (42.5 –70)	0.52	0.66	0.58	>0.99

*Mann-Whitney U test. Comparisons: 1 vs 2 = males vs females (pre-CPAP); 1 vs 3 = males (pre-CPAP) vs males (post-CPAP); 2 vs 4 = females (pre-CPAP) vs females (post-CPAP); 3 vs 4 = males vs females (post-CPAP).

DISCUSSION

The results of this study indicate that patients with OSA who used CPAP therapy for three or more months reported significantly better quality of life than patients assessed before CPAP initiation. Compared with the pre-CPAP group, participants in the post-CPAP group reported reduced fatigue, better mood, better perceived general health, and better social functioning. Participants who regularly adhered to therapy and men had significantly better results in the domains of physical functioning and limitations due to physical and emotional difficulties compared with those who used therapy irregularly and women. Studies conducted worldwide confirm that untreated OSA is associated with lower scores in most domains of quality of life, particularly vitality, physical and mental health, and social functioning [36, 50]. Snoring and night-time restlessness affect the sleep of partners [51], while chronic fatigue and reduced mental clarity make daily activities and social interactions more difficult [52].

The results of this study showed that participants in the post-CPAP group reported better quality of life across multiple domains than those in the pre-CPAP group, which is consistent with recent findings in the literature [36, 53]. In this study, the SF-36 questionnaire showed significant improvements in the areas of physical functioning, limitations due to physical and emotional difficulties, vitality, and mental health. This pattern suggests that CPAP therapy may affect not only respiratory parameters but also has a broader impact on daily functioning and subjective perception of health. Similar results were described in a study conducted in Lithuania [53], where after 3 months of CPAP treatment, improvements were observed in the areas of energy, emotional limitations, and general health status measured by the SF-36 questionnaire, as well as a reduction in daytime sleepiness [53].

Compared with the pre-CPAP group, participants in the post-CPAP group rated their physical condition better, experienced daytime fatigue less frequently, and had fewer difficulties with physical activity related to sleep disorders. An increase in motivation and improved mood was also observed, suggesting a beneficial association with therapy on emotion-

al functioning. These findings are consistent with a study conducted in Croatia in 2024 [36], which emphasized that CPAP therapy significantly reduces daytime fatigue and improves overall quality of life, while subjective perception of improvement plays a key role in patient adherence to therapy. Studies indicate significant improvement in overall quality of life with regular CPAP use, especially in the domains of daytime sleepiness and cognitive functioning [54].

In this study, participants who regularly used the CPAP device had significantly better results in the domains of physical functioning and limitations due to physical and emotional difficulties compared with those who used therapy irregularly. Lo Bue et al. reported improvements in mental health and psychological well-being among CPAP users who adhered to therapy, but emphasized that side effects such as mask discomfort, claustrophobia, nasal dryness, and skin irritation still affect therapy adherence [55]. In the present study, among participants who reported difficulties with CPAP use, the most common issues were discomfort during use (45%) and problems sleeping with the mask (35%), followed by technical problems (15%) and difficulties adapting to the device (5%). These findings are consistent with previous literature, which highlights mask-related discomfort, sleep disturbances, and technical issues as the most frequently reported side effects of CPAP therapy [56]. Such adverse effects may negatively impact adherence and consequently reduce the overall effectiveness of treatment [56]. A literature review by López-López et al. emphasized that education, technical support, and multidimensional approaches (particularly the role of nurses) significantly increase long-term CPAP adherence [57]. Continuous support from healthcare professionals, including motivational interventions [37], regular check-ups, and progress monitoring, may help resolve problems associated with CPAP device use and ensure better adherence to therapy [38]. Regular adherence to CPAP therapy is associated with better quality of life across multiple domains; however, actual effectiveness in clinical practice depends on proper education, technical adjustment of the device, psychological support, and an individualized approach to increase successful adherence to therapy [37, 38, 57].

The results of this study indicate that men reported better physical functioning, fewer physical and emotional limitations, and less pain than women. These findings are consistent with international studies showing that women experience a greater decline in quality of life compared with men with similar AHI levels [58, 59]. Furthermore, women with OSA have reduced work productivity and higher rates of sick leave and divorce compared with women without OSA, while such an association has not been found among men [58, 59]. Compared with men, women from both groups had poorer quality of life, with greater physical and emotional limitations and more pronounced pain in this study. The results are consistent with previous studies showing that women with OSA have poorer quality of life and greater physical and emotional difficulties compared with men, while CPAP therapy improves outcomes in both genders, although gender differences may persist after treatment [60, 61]. Women also more frequently report anxiety, fatigue, and limitations in daily activities [62].

Limitations

This study has several limitations. The relatively small sample size and single-center design limit the generalizability of the findings. The cross-sectional design does not allow firm causal conclusions, and the use of self-assessment measures may be subject to participant bias. The sample was predominantly male (84%), which reflects the epidemiology of OSA but may limit the interpretation of gender-based differences. Additionally, the cross-sectional design does not allow evaluation of temporal changes in CPAP adherence or the long-term effects of therapy. Longitudinal studies are needed to better assess these outcomes.

Recommendations for Future Research

Future studies should include larger, multicentre samples, as well as longitudinal studies following the same patients over time to better understand the long-term effects of CPAP therapy and adherence. It is also recommended to include additional factors such as psychosocial and socioeconomic variables, health literacy, and barriers within the healthcare system. Furthermore, experimental or quasi-experimental studies should evaluate targeted interventions aimed at improving CPAP adherence, thereby providing higher-level evidence on their effectiveness.

Implications for Clinical Practice and Education

The results of this study emphasize the importance of timely diagnosis and continuous use of CPAP therapy in patients with OSA to improve the physical and psychological aspects of quality of life. In clinical practice, particular emphasis should be placed on educating patients about proper device use and the importance of regular adherence to therapy, since regular CPAP use was associated with better outcomes. The findings also indicate the need for an individualized treatment approach, taking into account gender differences and the specific needs of patients. In the context of healthcare education, programs should be developed to strengthen healthcare professionals' competencies in supporting patients with OSA, including recognizing barriers to adherence and providing psychosocial support.

CONCLUSIONS

The results of the study show that patients with OSA who had been using CPAP therapy for at least three months reported significantly better quality of life than those in the pre-CPAP group, particularly in the domains of physical and psychological functioning, vitality, and limitations due to physical and emotional problems. Compared with the pre-CPAP group, participants in the post-CPAP group also reported less fatigue, better mood, better perceived general health, and better social functioning. Regular adherence to therapy was associated with better quality-of-life outcomes, while men reported better physical functioning and fewer physical and emotional limitations than women. These findings highlight the importance of regular adherence to CPAP therapy and support an individualized approach to optimizing quality of life in patients with OSA.

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The authors declares no conflict of interest.

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Protecting patient privacy in the digital era: A cross-sectional study among nursing students

Patient Privacy in the Digital Era

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Keywords: social media; patient privacy; nursing students; data protection.

ABSTRACT

Introduction: Protecting patient privacy and confidentiality is a fundamental ethical and professional responsibility in healthcare and has become increasingly important in the era of digitalization. This study aimed to examine nursing students' attitudes toward patient privacy protection and to assess differences according to sex, age, and year of study.

Methods: A cross-sectional study was conducted between April and May 2024 among 176 undergraduate and graduate nursing students at the Faculty of Dental Medicine and Health Osijek, Croatia. Data were collected using an anonymous questionnaire developed for this study. Descriptive statistics and nonparametric tests were used for data analysis.

Results: Most participants reported respecting patient privacy (97.2%), rarely or never searching for patient information on social media (88.9%), not taking photographs with patients (88.1%), not posting patient photographs on social media (96.6%), and frequently or always adhering to ethical principles (98.3%). Female participants demonstrated significantly greater respect for patient privacy (P = 0.05), communicated more frequently with patients' family members (P = 0.04), and more often closed patients' room doors during nursing care or medical procedures (P = 0.04). Male participants reported significantly more frequent unprofessional behaviors, including discussing patients' diagnoses with friends (P = 0.01), accessing acquaintances' medical records during breaks (P = 0.002), and commenting on patients' appearance with colleagues (P = 0.02). Significant differences according to age and year of study were also observed in several privacy-related behaviors, including social media use and professional conduct.

Conclusion: Nursing students demonstrated a high level of awareness regarding patient privacy and ethical responsibility. However, differences according to sex, age, and year of study suggest the need for continued education on professional ethics, digital professionalism, and responsible use of social media throughout nursing education.

INTRODUCTION

The rapid development of digitalization and information technology has introduced new challenges to ensuring data privacy [1]. Data protection regulations apply across all healthcare settings and govern the conduct of healthcare professionals both within and outside the workplace [2]. Violation of the right to privacy and confidentiality is subject to legal sanctions, particularly in healthcare [3]. Discussing patients and their health conditions with healthcare professionals not directly involved in patient care, commenting on patients' personal characteristics, or giving preferential treatment constitute violations of privacy and equality.

Professional experience and nurses' level of education influence communication with patients, respect for patients' rights, and preservation of data confidentiality [4]. Upon admission, patients should be informed about their right to privacy, including how their personal data will be used. Patients also have the right to request that healthcare professionals do not discuss their health condition with family members or friends without their consent [3, 5]. Informing patients before procedures supports decision-making, improves the quality of nursing care, and contributes to better outcomes [6]. During nursing care, nurses should ensure an individualized approach and equal attention to every patient regardless of personal characteristics or medical condition. Respect for ethical standards also includes protecting patient privacy during diagnostic, therapeutic, and nursing procedures [7]. Nurses should ensure patient privacy by using privacy screens, and healthcare professionals not directly involved in patient care should not enter the room during procedures [8].

Internet use poses one of the major challenges in data protection and requires secure data transmission. Data encryption reduces the risk of information leakage [9, 10]. Many healthcare institutions also apply strict access control measures, including password protection and biometric authentication [3]. The use of the internet and smartphones enables searching for patient information on social media, taking and posting photographs with patients, and communicating with patients, all of which may compromise privacy [1, 8, 10]. Such practices may unintentionally disclose patient information, resulting in legal liability and damage to the reputation of healthcare professionals and healthcare institutions [1, 3]. The widespread use of social media, artificial intelligence, and data linkage presents additional challenges to protecting patient privacy, particularly when publishing health data and conducting research using social media platforms [11, 12].

Despite increasing digitalization, patient privacy remains one of the fundamental ethical principles of nursing practice. International studies indicate that nursing students generally demonstrate a high level of awareness regarding data confidentiality; however, challenges related to digital technologies remain, particularly in relation to information sharing and maintaining professional boundaries on social media platforms [13]. Systematic reviews further highlight the professional and ethical challenges associated with social media use among nursing students, particularly regarding patient privacy and confidentiality [14].

In Croatia, few studies have examined nursing students' attitudes toward patient privacy protection in the era of digitalization. Existing research has mainly focused on preserving patient dignity and privacy or on nursing documentation and professional responsibility [15], without specifically addressing challenges arising from the digital environment. This lack of empirical evidence highlights the need for further research among nursing students in Croatia.

Therefore, this study aimed to examine nursing students' opinions regarding the protection of patient privacy in the era of digitalization and to determine whether opinions differ according to age, sex, and year of study.

METHODS

Study design

A cross-sectional study was conducted between April and May 2024.

Participants

The study included 176 participants. The participants were undergraduate and graduate nursing students from the Faculty of Dental Medicine and Health Osijek.

Instruments

Data were collected using an anonymous questionnaire developed for this study based on previously published literature [16, 17]. The questionnaire consisted of two parts: demographic characteristics and items/questions related to the protection of patient privacy. The first part included seven socio-demographic questions addressing participants' characteristics, year of study, and employment status. The second part included questions related to patient privacy protection. Participants responded to each item/question by selecting one of the provided response options. Responses were scored using a five-point Likert scale (1 – never; 2 – rarely; 3 – sometimes; 4 – often; 5 – always).

Data collection / Procedure

The questionnaires were distributed by the principal investigator or designated contact persons. All participants were informed about the purpose of the study and were assured that participation was completely anonymous and that their identity could not be determined from their responses during data analysis or presentation of results. The questionnaire required approximately 10 minutes to complete. All stages of the study were conducted in accordance with the General Data Protection Regulation (GDPR).

Ethical considerations

The study was conducted in accordance with the ethical principles of scientific research while ensuring anonymity and confidentiality of participant data. Participation in the study was voluntary, and all participants were informed in advance about the aim and purpose of the research. Completion of the questionnaire was considered to constitute informed consent to participate in the study.

Statistical data analysis

Categorical variables were presented as absolute and relative frequencies. Numerical variables were summarized using the mean and standard deviation or the median and interquartile range, as appropriate. Differences between categorical variables were tested using the chi-square test (χ^2 test). The normality of distribution of numerical variables was assessed using the Kolmogorov–Smirnov test. Due to deviations from normal distribution, differences between two independent groups were analyzed using the Mann–Whitney U test. Differences among three or more independent groups were analyzed using the Kruskal–Wallis test. All *P*-values were two-tailed. The level of statistical significance was set at $\alpha = 0.05$.

Statistical analysis was performed using SPSS statistical software (version 22.0, SPSS Inc., Chicago, IL, USA).

RESULTS

A total of 176 participants were included in the study. The mean age of participants was 29.9 years (SD = 8.5), ranging from 19 to 55 years. The average length of work experience was 8.65 years (SD = 8.2), ranging from 1 to 32 years. Most participants (n = 120; 68.2%) reported using social media exclusively for personal purposes (Table 1).

Table 1. Participant characteristics and patterns of social media use

Participant characteristics		n (%)
Sex	Male	43 (24.4)
	Female	133 (75.6)
Age (years)	19 – 24	59 (33.5)
	25 – 29	45 (25.6)
	30 – 34	16 (19.1)
	≥35	56 (31.8)
Year of study	First-year undergraduate	39 (22.2)
	Second-year undergraduate	38 (21.6)
	Third-year undergraduate	37 (21.0)
	First-year graduate	30 (17.0)
	Second-year graduate	32 (18.2)
Place of residence	Urban	82 (46.6)
	Rural	94 (53.4)
Are you employed as a nurse/ technician?	Yes	150 (85.2)
	No	26 (14.8)
Years of work experience (Employed participants)	Not employed	26 (14.8)
	1–5	57 (32.4)
	6–10	33 (18.8)
	11–15	17 (9.7)
	≥16	43 (24.4)
Type of secondary school completed	Medical school	145 (82.4)
	General grammar school	18 (10.2)
How often do you check your social media accounts?	Once a week or less	40 (22.7)
	Several times a week	21 (11.9)
	Once daily	31 (17.6)
	2–5 times daily	47 (26.7)
	≥6 times daily	37 (21.0)
Usual purpose of social media use	Exclusively personal	120 (68.2)
	Mostly personal, less professional	40 (22.7)
	Equally personal and professional	13 (7.4)
	Mostly professional, less personal	2 (1.1)
	Exclusively professional	1 (0.6)
Social media profile includes	Facebook	43 (24.4)
	Facebook and Instagram	44 (25.0)
	YouTube	3 (1.7)
	Instagram	17 (9.7)
	TikTok	2 (1.1)
	Combination of multiple platforms	67 (38.1)
Total		176 (100)

Nursing students' opinions on maintaining patient privacy are presented in Table 2.

Table 2. Opinions of nursing students on maintaining patient privacy

Question	Number (%) of respondents				
	1	2	3	4	5
How often did you give more attention to younger patients than to older patients?	65 (36.9)	47 (26.7)	41 (23.3)	17 (9.7)	6 (3.4)
How often did you respect patient privacy?	1 (0.6)	2 (1.1)	2 (1.1)	44 (25.0)	127 (72.2)
How often did you respect the privacy of patients with disabilities?	0 (0.0)	1 (0.6)	4 (2.3)	52 (29.5)	119 (67.6)
How often did you have contact with patients' family members?	20 (11.4)	23 (13.1)	45 (25.6)	68 (38.6)	20 (11.4)
How often did you search for information about a patient on social media?	110 (62.5)	43 (24.4)	22 (12.5)	1 (0.6)	0 (0.0)
How often did you take a photograph with a patient during hospitalization?	155 (88.1)	16 (9.1)	5 (2.8)	0 (0.0)	0 (0.0)
How often did you post photographs of patients on social media?	170 (96.6)	4 (2.3)	1 (0.6)	0 (0.0)	1 (0.6)
How often did you use a privacy screen to protect an immobile patient's privacy during nursing care?	8 (4.5)	34 (19.3)	37 (21.0)	39 (22.2)	58 (33.0)
How often did you use a privacy screen during medical procedures on an unconscious patient?	13 (7.4)	24 (13.6)	35 (19.9)	54 (30.7)	50 (28.4)
How often did you close the patient's room door during nursing care or medical procedures?	2 (1.1)	9 (5.1)	24 (13.6)	47 (26.7)	94 (53.4)
During diagnostic and therapeutic procedures, how often did other staff enter the patient's room?	10 (5.7)	47 (26.7)	83 (47.2)	28 (15.9)	8 (4.5)
How often did you inform patients before diagnostic or therapeutic procedures?	3 (1.7)	4 (2.3)	12 (6.8)	51 (29.0)	106 (60.3)
How often did you use social media to communicate with patients?	153 (86.9)	15 (8.5)	6 (3.4)	2 (1.1)	0 (0.0)
How often did you search an acquaintance's medical records/documentation during a break?	90 (51.1)	59 (33.5)	24 (13.6)	2 (1.1)	1 (0.6)
How often did you behave unprofessionally toward patients of a different religion?	156 (88.6)	5 (2.8)	3 (1.7)	1 (0.6)	11 (6.3)
How often did you discuss patients and their diagnoses privately with friends?	65 (36.9)	66 (37.5)	37 (21.0)	7 (4.0)	1 (0.6)
How often did you comment on a patient's appearance with colleagues?	75 (42.6)	65 (36.9)	31 (17.6)	5 (2.8)	0 (0.0)
How often were better-dressed patients given priority during diagnostic or therapeutic procedures?	151 (85.8)	20 (11.4)	4 (2.3)	1 (0.6)	0 (0.0)
How often did ethical principles guide your professional practice?	0 (0.0)	0 (0.0)	3 (1.7)	47 (26.7)	126 (71.6)

Note. 1- never; 2- rarely; 3- sometimes; 4- often; 5- always

Statistically significant sex differences were observed. Women reported significantly more frequent adherence to patient privacy (P = 0.05), contact with patients' family members (P = 0.04), closing the room door during nursing care or medical procedures (P = 0.04), and informing patients before performing

diagnostic and therapeutic procedures (P = 0.008). In contrast, men reported significantly more frequent unprofessional behaviors, including discussing patients and their diagnoses privately among friends (P = 0.01), searching acquaintances' records during breaks (P = 0.002), commenting on patients' appearance in front of colleagues (P = 0.02), and giving priority to better-dressed patients during diagnostic and therapeutic procedures (P = 0.01) (Table 3).

Table 3. Nursing students' opinions on maintaining patient privacy according to sex

Question	Median (IQR)		*P-value**
	Male	Female	
How often did you give more attention to younger patients than to older patients?	2 (1 – 2)	2 (1 – 3)	0.08
How often did you respect patient privacy?	5 (4 – 5)	5 (5 – 5)	0.05
How often did you respect the privacy of patients with disabilities?	5 (4 – 5)	5 (4 – 5)	0.72
How often did you have contact with patients' family members?	3 (2 – 4)	4 (3 – 4)	0.04
How often did you search for information about a patient on social media?	1 (1 – 2)	1 (1 – 2)	0.20
How often did you take a photograph with a patient during hospitalization?	1 (1 – 1)	1 (1 – 1)	0.14
How often did you post photographs of patients on social media?	1 (1 – 1)	1 (1 – 1)	0.15
How often did you use a privacy screen to protect an immobile patient's privacy during nursing care?	4 (2 – 5)	4 (3 – 5)	0.64
How often did you use a privacy screen during medical procedures on an unconscious patient?	4 (3 – 4)	4 (3 – 5)	0.51
How often did you close the patient's room door during nursing care or medical procedures?	4 (3 – 5)	5 (4 – 5)	0.04
During diagnostic and therapeutic procedures, how often did other staff enter the patient's room?	3 (2 – 3)	3 (2 – 3)	0.90
How often did you inform patients before diagnostic or therapeutic procedures?	4 (4 – 5)	5 (4 – 5)	0.008
How often did you use social media to communicate with patients?	1 (1 – 1)	1 (1 – 1)	0.91
How often did you search an acquaintance's medical records/documentation during a break?	2 (1 – 3)	1 (1 – 2)	0.002
How often did you behave unprofessionally toward patients of a different religion?	1 (1 – 1)	1 (1 – 1)	0.27
How often did you discuss patients and their diagnoses privately with friends?	2 (1 – 3)	2 (1 – 2)	0.01
How often did you comment on a patient's appearance with colleagues?	2 (1 – 3)	2 (1 – 2)	0.02
How often were better-dressed patients given priority during diagnostic or therapeutic procedures?	1 (1 – 2)	1 (1 – 1)	0.01
How often did ethical principles guide your professional practice?	5 (4 – 5)	5 (4 – 5)	0.28

Note. *Mann-Whitney U test; 1- never; 2- rarely; 3- sometimes; 4- often; 5- always

Statistically significant age-related differences were observed. Older respondents more often reported giving greater attention to younger patients (*P* = 0.002), whereas respondents aged 19–24 more often reported respecting the privacy of disabled patients (*P* = 0.03). Respondents aged 30–34 also more frequently reported having contact with patients' family members (P = 0.01), while respondents aged ≥30 more often reported commenting on patients' appearance (P = 0.05) (Table 4).

Table 4. Nursing students' opinions on maintaining patient privacy in relation to age

Question	Median (interquartile range)				*P-value**
	19 – 24	25 – 29	30 – 34	≥35	
How often did you give more attention to younger patients than to older patients?	2 (1 – 3)	2 (1 – 3)	1.5 (1 – 2.75)	2.5 (2 – 3.75)	0.002
How often did you respect patient privacy?	5 (5 – 5)	5 (5 – 5)	5 (4 – 5)	5 (4 – 5)	0.19
How often did you respect the privacy of patients with disabilities?	5 (5 – 5)	5 (4 – 5)	5 (4.25 – 5)	5 (4 – 5)	0.03
How often did you have contact with patients' family members?	3 (2 – 4)	3 (2 – 4)	4 (3.25 – 4)	4 (3 – 4)	0.01
How often did you search for information about a patient on social media?	1 (1 – 2)	1 (1 – 2)	1 (1 – 2)	1 (1 – 2)	0.86
How often did you take a photograph with a patient during hospitalization?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1.75)	1 (1 – 1)	0.15
How often did you post photographs of patients on social media?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	0.28
How often did you use a privacy screen to protect an immobile patient's privacy during nursing care?	4 (3 – 5)	4 (3 – 5)	3 (2 – 4)	4 (3 – 5)	0.71
How often did you use a privacy screen during medical procedures on an unconscious patient?	4 (3 – 5)	4 (3 – 5)	4 (2 – 4)	4 (2.25 – 4)	0.22
How often did you close the patient's room door during nursing care or medical procedures?	5 (4 – 5)	4 (4 – 5)	5 (3.25 – 5)	4 (3.25 – 5)	0.16
During diagnostic and therapeutic procedures, how often did other staff enter the patient's room?	3 (2 – 3)	3 (2.5 – 3)	3 (2.25 – 3)	3 (2 – 3)	0.81
How often did you inform patients before diagnostic or therapeutic procedures?	5 (4 – 5)	4 (4 – 5)	4 (4 – 5)	5 (4 – 5)	0.08
How often did you use social media to communicate with patients?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	0.84
How often did you search an acquaintance's medical records/documentation during a break?	1 (1 – 2)	2 (1 – 2)	1.5 (1 – 2)	1 (1 – 2)	0.38
How often did you behave unprofessionally toward patients of a different religion?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	0.49
How often did you discuss patients and their diagnoses privately with friends?	2 (1 – 2)	2 (1 – 2.5)	2 (1 – 2.75)	2 (1 – 3)	0.94
How often did you comment on a patient's appearance with colleagues?	1 (1 – 2)	2 (1 – 2)	2 (1 – 3)	2 (1 – 3)	0.05
How often were better-dressed patients given priority during diagnostic or therapeutic procedures?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	0.10
How often did ethical principles guide your professional practice?	5 (4 – 5)	5 (4.5 – 5)	5 (4 – 5)	5 (4 – 5)	0.64

Note. Kruskal–Wallis test. 1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always.

Statistically significant differences according to the year of study were observed in contact with patients' family members ($P < 0.001$), searching for patient information on social media ($P = 0.006$), taking photographs with patients ($P = 0.009$), posting patients' photographs on social media ($P = 0.001$), informing patients before diagnostic and therapeutic procedures ($P = 0.001$), commenting on patients' appearance ($P < 0.001$), and giving priority to better-dressed patients during diagnostic and therapeutic procedures ($P < 0.001$) (Table 5).

Table 5. Nursing students' opinions on maintaining patient privacy according to year of study

Question	Median (interquartile range)					*P-value**
	1st year undergraduate	2nd year undergraduate	3rd year undergraduate	1st year graduate	2nd year graduate	
How often did you give more attention to younger patients than to older patients?	1 (1 – 1)	2 (1 – 3)	2 (1 – 3.5)	3 (2 – 4)	2 (1.25 – 3)	< 0.001
How often did you respect patient privacy?	5 (4 – 5)	5 (4 – 5)	5 (4 – 5)	5 (4 – 5)	5 (4 – 5)	0.99
How often did you respect the privacy of patients with disabilities?	5 (5 – 5)	5 (4 – 5)	5 (5 – 5)	4 (4 – 5)	5 (4 – 5)	< 0.001
How often did you have contact with patients' family members?	2 (1 – 3)	4 (3 – 4.25)	4 (3 – 4)	4 (3 – 4)	4 (3.25 – 4)	< 0.001
How often did you search for information about a patient on social media?	1 (1 – 1)	1 (1 – 2)	1 (1 – 2)	1 (1 – 2)	2 (1 – 2.75)	0.006
How often did you take a photograph with a patient during hospitalization?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 2)	0.009
How often did you post photographs of patients on social media?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	0.001
How often did you use a privacy screen to protect an immobile patient's privacy during nursing care?	4 (2 – 5)	4 (2.75 – 4)	5 (3 – 5)	3.5 (3 – 5)	3.5 (2 – 4)	0.14
How often did you use a privacy screen during medical procedures on an unconscious patient?	4 (3 – 5)	4 (2.75 – 5)	4 (3 – 5)	4 (2 –4.25)	4 (2 – 4)	0.18
How often did you close the patient's room door during nursing care or medical procedures?	4 (4 – 5)	5 (4 – 5)	5 (4 – 5)	4 (3.75 – 5)	4 (3 – 5)	0.08
During diagnostic and therapeutic procedures, how often did other staff enter the patient's room?	3 (2 – 4)	2 (2 – 3)	3 (2 – 3)	3 (2 – 3)	3 (3 – 3)	0.09
How often did you inform patients before diagnostic or therapeutic procedures?	4 (4 – 5)	5 (5 – 5)	5 (4 – 5)	4 (4 – 5)	5 (4 – 5)	0.001

Question	Median (interquartile range)					*P-value**
	1st year undergraduate	2nd year undergraduate	3rd year undergraduate	1st year graduate	2nd year graduate	
How often did you use social media to communicate with patients?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	0.19
How often did you search an acquaintance's medical records/documentation during a break?	2 (1 – 2)	1 (1 – 2)	1 (1 – 2)	2 (1 – 2)	2 (1 – 2)	0.49
How often did you behave unprofessionally toward patients of a different religion?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	0.32
How often did you discuss patients and their diagnoses privately with friends?	2 (2 – 3)	2 (1 – 3)	2 (1 – 3)	1.5 (1 – 2)	2 (1 – 2)	0.32
How often did you comment on a patient's appearance with colleagues?	1 (1 – 2)	2 (1 – 2)	1 (1 – 2)	2 (1 – 3)	2 (2 – 3)	< 0.001
How often were better-dressed patients given priority during diagnostic or therapeutic procedures?	1 (1 – 1)	1 (1 – 1)	1 (1 – 1)	1 (1 – 1.25)	1 (1 – 2)	< 0.001
How often did ethical principles guide your professional practice?	5 (5 – 5)	5 (4 – 5)	5 (4.5 – 5)	5 (4 – 5)	5 (4 – 5)	0.25

Note. Kruskal–Wallis test. 1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always.

DISCUSSION

The results of this study indicate that the majority of participants respect patient privacy, rarely or never search for patient information on social media, and frequently or always adhere to ethical principles. Additionally, approximately half of the students reported checking their social media accounts several times daily. A study conducted in China demonstrated an association between social media use and behaviors related to patient privacy protection among nursing students [13]. A systematic review identified risks such as inappropriate content sharing, breaches of confidentiality, and the blurring of boundaries between personal and professional identity, which may lead to potential violations of patient privacy [14]. As future healthcare professionals, nursing students gain access to patient information during clinical training and process such information as part of their educational activities. Clinical practice represents a critical period in which students develop professional identity and moral values that shape their future careers [18].

The results of this study also showed that female participants demonstrated higher levels of respect for patient privacy, particularly during nursing care and medical procedures, emphasizing the importance of closing patients' room doors and using privacy screens. A study conducted in Australia reported that nursing students identified closing doors and using privacy screens as essential measures for preserving patient privacy and dignity [19]. Furthermore, the importance of adequate patient covering during nursing care has also been emphasized in previous studies [18, 20]. However, several factors may hinder consistent protection of patient privacy in clinical practice, including shared hospital rooms, increased workload, insufficient staffing levels, and limited time availability [21]. Multi-bed hospital rooms may allow other patients and healthcare professionals to overhear confidential conversations, which represents a challenge in protecting patient information [22].

In this study, female participants also communicated more frequently with patients and their family members and informed patients about planned procedures, contributing to the preservation of patient dignity and a sense of security. Kim et al. highlighted the importance of protecting confidential information, particularly in the context of verbal communication [23]. Despite technological advances, Rony et al. emphasized the importance of feedback and ensuring that technology complements rather than replaces a patient-centered approach to care [24].

Participants in this study agreed that age, physical appearance, socioeconomic status, and religious affiliation of patients did not influence their behavior with respect to patient privacy. Similarly, the results of a study by Sepehrirad et al. showed that nursing students with higher levels of moral sensitivity demonstrated greater respect for patient privacy [25]. Unlike the findings of this study, where sex was identified as a statistically significant variable, several other studies reported no association between sex and attitudes toward patient privacy protection [26, 27].

Regarding disclosure of patient information outside the hospital environment, male participants reported slightly more frequent sharing of information in informal settings, such as among friends, and reviewing acquaintances' medical records during breaks compared to female participants. These findings contrast with results reported in a study conducted in Ethiopia [28].

Most students in this study reported never searching for patient information on social media, taking photographs with patients, or posting patient photographs online, which is consistent with findings from previous studies [29, 30]. However, international studies also indicate that some nursing students share patient photographs on social media platforms [14, 31]. Wang et al. reported that nursing students frequently exchange patient-related information via social media, while 63.5% of students stated that they had occasionally shared identifiable patient information online [32]. In South Africa, nursing students demonstrated low levels of responsibility when using social media by recording and publishing photographs, audio, and video materials without anonymizing patient identity, directly violating patient privacy and confidentiality [33]. An international survey conducted among health sciences students from eight universities in six countries (China, Canada, the United Kingdom, Australia, Mexico, and Ireland) showed that a considerable proportion of students (20.5%) reported that sharing photographs from clinical practice on social media was inappropriate [34].

A study conducted among Polish nursing students indicated that more than half of participants searched for patient information several times per year, mostly via Facebook, motivated by curiosity and the desire to better understand patients [35]. Increased risk of privacy violations among students who frequently use and update social media accounts may be explained by lower awareness of potential consequences and a greater need for social approval. At the same time, nursing students frequently use social media for academic purposes. O'Connor et al. reported that approximately half of students demonstrated an understanding of digital professionalism and expressed generally positive attitudes toward responsible use of social media, particularly for educational and professional purposes [36]. A high level of professionalism and ethical awareness is essential for personal and professional development as well as for the protection and advancement of the nursing profession. The findings of this study, which indicate a high level of responsibility and awareness regarding patient privacy protection, may reflect the effectiveness of educational programs that continuously emphasize confidentiality, professional responsibility, and respect for patients' rights as fundamental components of quality healthcare.

With regard to the year of study, first-year undergraduate students reported never commenting on patients' appearance, searching for patient information on social media, taking photographs with patients, or posting patient photographs online. Unlike the findings of this study, previous research has shown that senior students demonstrate greater responsibility in protecting patient privacy and using social media appropriately [37, 38]. These findings also differ from those reported by Abuhammad et al., who emphasized that increased knowledge among nurses significantly improves confidentiality-related behaviors [39]. Nursing education plays a key role in developing and maintaining professional values, with students highly valuing human dignity

and justice as core principles of their future professional practice [40]. Research conducted in China indicated that graduate nursing students demonstrated better patient privacy protection behaviors, which was explained by higher levels of moral sensitivity, empathy, and cognitive awareness regarding privacy protection [41].

In this study, second-year graduate students more frequently communicated with patients' family members and consistently informed patients before diagnostic and therapeutic procedures. Previous studies suggest that students with greater clinical experience demonstrate higher levels of awareness and more responsible behavior regarding patient privacy protection. Although differences are not observed across all aspects of behavior, clinical experience plays a crucial role in developing professional engagement and communication with patients' families [22, 42, 43]. Moore et al. reported that nursing students' attitudes toward patient privacy vary according to the year of study, with more mature attitudes observed at higher levels of education, suggesting gradual development of understanding through academic and clinical experience [44]. Even isolated unethical attitudes may significantly influence overall findings, further emphasizing the importance of continuous education in professional ethics and privacy protection.

Limitations and directions for future research

This study has several limitations. The sample included a higher proportion of female participants, which may affect the representativeness of the results. Additionally, the study was conducted at a single higher education institution, limiting the generalizability of the findings to the broader population of nursing students. The use of a self-reported questionnaire may also have resulted in socially desirable responses, potentially affecting the accuracy of reported attitudes regarding patient privacy protection.

Future research should include larger and more diverse samples from multiple higher education institutions. Longitudinal studies could provide insight into the development of nursing students' attitudes toward patient privacy throughout their education and early professional careers. Furthermore, qualitative research could offer deeper insight into students' perceptions, experiences, and challenges related to protecting patient privacy in contemporary healthcare environments.

Implications for clinical practice and education

The results of this study highlight the importance of continuous development of nursing students' awareness regarding respect for patient privacy, particularly in the context of increasing digitalization. In clinical practice, nurses play a key role in protecting the confidentiality and security of patient health data; therefore, it is essential to ensure that students acquire adequate knowledge and competencies related to ethical and legal aspects of privacy protection during their education.

The findings also emphasize the need for additional educational content addressing the appropriate use of electronic health records and protection of personal health data. Integrating topics related to digital security, professional ethics, and patient privacy protection into nursing curricula may contribute to strengthening professional responsibility among future healthcare professionals. In addition to formal education, continuous professional development through workshops, seminars, and professional training is essential to ensure consistent protection of patient privacy in everyday clinical practice.

CONCLUSION

The results of this study indicate a high level of awareness among nursing students regarding the importance of protecting patient privacy and confidentiality in the context of increasing digitalization. Most participants demonstrated professionally and ethically responsible behavior, particularly in the area of data protection and social media use. Despite generally positive attitudes, statistically significant differences were identified in certain aspects of behavior according to sex, age, and year of study, indicating variations in professional awareness and

ethical reasoning. These findings highlight the importance of continuous education of nursing students regarding ethical principles, professional standards, and responsible use of digital technologies in healthcare. Systematic integration of topics related to privacy protection and digital ethics into educational programs may further strengthen professional identity and reduce potentially inappropriate behaviors in clinical practice.

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Declaration of Conflicting Interest

The authors declare no conflict of interest.

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Contribution of Health Literacy and Sociodemographic Factors to Body Mass Index among Croatian Adults

Health Literacy, Sociodemographics, and BMI

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ABSTRACT

Introduction: Obesity is a chronic disease with serious health consequences, including cardiovascular diseases, diabetes, and certain cancers. Identifying factors associated with BMI is essential for prevention and public health planning. This study aimed to examine the contribution of health literacy and sociodemographic factors to BMI among adults in Croatia.

Methods: A cross-sectional study was conducted among 195 adults residing in Croatia. Data were collected in person using paper-based instruments. Participants independently completed the sociodemographic and lifestyle section, whereas the SAHLCA-50 was administered face-to-face by a member of the research team. Spearman's rank correlation and multiple linear regression analyses were used to examine associations with BMI and identify its independent predictors.

Results: The median BMI was 25.1 (IQR 22.4–28.6), with 34.9% of participants overweight and 17.4% obese. Significant correlations were observed between BMI and age ($\rho = 0.372$, $P < 0.001$), sex ($\rho = -0.176$, $P = 0.014$), education ($\rho = -0.193$, $P = 0.007$), and health literacy ($\rho = -0.172$, $P = 0.016$). Regression analysis showed that only age and sex were significant predictors of BMI, explaining 13.1% of the variance (adjusted $R^2 = 0.131$). Health literacy and the remaining sociodemographic variables were not significant predictors of BMI in the multivariable model.

Conclusions: Age and sex were independently associated with BMI, whereas health literacy was not a significant predictor after adjustment for sociodemographic characteristics. Further studies incorporating detailed behavioral, lifestyle, and socioeconomic variables are needed to clarify the relationship between health literacy and BMI.

INTRODUCTION

Obesity is defined as excessive accumulation of adipose tissue and is recognized as a chronic and complex disease that can negatively affect health. It increases the risk of developing type 2 diabetes, cardiovascular diseases, bone and reproductive health problems, as well as certain types of cancer. In addition to its health consequences, obesity can significantly affect quality of life, including difficulties with sleep and mobility [1, 2].

Today, obesity is a global health problem that has been steadily increasing over recent decades. According to data from 2022, one in eight people worldwide lives with obesity, while 43% of adults aged over 18 are overweight, and 16% of them live with obesity. Since 1990, the prevalence of obesity among adults has more than doubled, while in adolescents it has quadrupled [1]. In 2024, an estimated 35 million children under five years of age were overweight. In 2022, more than 390 million children and adolescents aged 5–19 years were overweight, including over 160 million living with obesity [1].

Between 1990 and 2022, the global prevalence of obesity increased substantially, and more than one billion people worldwide were living with obesity by 2022 [2, 3]. The scale and geographic reach of this increase make obesity a global public health challenge. In addition to its clinical burden, obesity is associated with stigma and substantial psychological and social consequences [4]. For this reason, it is important to identify the factors associated with obesity in order to support timely prevention and intervention.

Population-based studies have shown that health literacy is associated with socioeconomic position, health-risk behaviors, and health status [5–7]. Health literacy is a multidimensional construct that encompasses the knowledge, motivation, and competencies required to access, understand, evaluate, and use health information [8]. Studies have reported associations between health literacy and nutrition–exercise behaviors, motivational readiness for physical activity, healthy eating habits, and fast-food consumption [9–12]. These findings suggest that health literacy may be relevant to weight-related behaviors, although they do not establish a mediating or causal effect on BMI.

Body image, eating attitudes, physical activity, and socioeconomic circumstances across the life course are related to weight-related outcomes and health behaviors [13, 14]. Studies in adult populations have also identified sociodemographic and behavioral factors, including age, marital status, education, and dietary intake, as correlates of overweight and obesity [15, 16]. Ethnicity and place-related social context are associated with disparities in obesity [17, 18], while weight-related stigma may differ according to age, sex, and ethnicity [19]. Behavioral and psychological factors, including eating-related behaviors and habitual responding, may also be associated with higher BMI [20, 21]. These findings highlight the complex interplay of biological, behavioral, psychological, and sociodemographic factors associated with BMI. A multidisciplinary approach involving various healthcare professionals is essential for effective obesity prevention and management. According to clinical guidelines, obesity should be managed as a chronic disease through comprehensive, patient-centred care [22]. Nurses can contribute through patient assessment, education, lifestyle counselling, care coordination, and long-term follow-up [23–25]. As nurses and midwives together account for nearly half of the global health workforce, their contribution to obesity prevention and management is of particular importance [26].

This study contributes to the existing literature by providing data on the association of body mass index (BMI) with health literacy, as well as key sociodemographic and behavioral variables among adults in Croatia. The obtained results contribute to a better understanding of the factors associated with obesity in the local context and may serve as a basis for the development of targeted public health interventions and recommendations.

This study aimed to examine the contribution of health literacy and sociodemographic factors to body mass index (BMI). Specifically, it aimed to: a) analyze BMI according to standard classifications; b) investigate differences in BMI according to employment and marital status; and c) examine associations between BMI and sex, age, educational level, self-rated health, meal frequency, place of residence, physical activity, and health literacy.

METHODS

Study design

A cross-sectional study was conducted between March and April 2023 among adults residing in Croatia.

Participants

The study included 195 adults residing in Croatia. The inclusion criteria were age 18 years or older, current residence in Croatia, ability to read and understand the Croatian language, and provision of informed consent to participate in the study. The exclusion criteria were age younger than 18 years, residence outside Croatia, inability to read or independently complete the questionnaire, refusal or withdrawal of informed consent, and questionnaires with missing data that prevented the calculation of BMI or the SAHLCA-50 total score.

An a priori power analysis was performed using G*Power [27] to estimate the required sample size for multiple linear regression (fixed model, R^2 deviation from zero). Assuming a medium effect size ($f^2 = 0.15$), $\alpha = 0.05$, statistical power $(1 - \beta) = 0.95$, and nine predictors, the required sample size was 166 participants. The final sample comprised 195 participants, exceeding the estimated minimum sample size.

Data collection procedure

Data were collected in person between March and April 2023 using paper-based instruments. Participants independently completed the sociodemographic and lifestyle section of the questionnaire. The SAHLCA-50 was administered individually, face-to-face, by a member of the research team, who recorded the participants' pronunciation and word-association responses. The average time required to complete the entire data collection procedure was approximately 10–13 minutes.

Instruments

The questionnaire consisted of two sections. The first section collected sociodemographic data, including sex, age, place of residence, educational level, employment status, and marital status, as well as information on physical activity and the number of meals consumed per day. Body weight and height were self-reported. BMI was calculated as body weight in kilograms divided by height in meters squared (kg/m²). According to World Health Organization criteria, participants were classified as underweight (BMI < 18.5 kg/m²), normal weight (BMI 18.5–24.9 kg/m²), overweight (BMI 25.0–29.9 kg/m²), or obese (BMI ≥ 30.0 kg/m²) [1]. The second section assessed functional health literacy using the Short Assessment of Health Literacy for Croatian Adults (SAHLCA-50). The instrument consists of 50 medical terms. For each item, participants were asked to read the medical term aloud and select the semantically related word from two alternatives; the response option “I do not know” was also available. One point was awarded when both the pronunciation and word association were correct, whereas an incorrect response or the response “I do not know” was scored as 0. The total score ranged from 0 to 50, with higher scores indicating higher functional health literacy. The Croatian validation study demonstrated high internal consistency (Cronbach's $\alpha = 0.91$) [28].

Statistical data analysis

Descriptive statistics were used to summarize the study variables. Continuous variables are presented as medians and interquartile ranges (IQRs). The normality of data distribution was assessed using the Shapiro–Wilk test. Since the data were not normally distributed ($P < 0.05$), non-parametric tests were applied. The Mann–Whitney U test was used to compare two independent groups, and the Kruskal–Wallis test was used to compare multiple independent groups. When the Kruskal–Wallis test indicated a significant difference, pairwise comparisons were performed using Dunn's post hoc test. Associations between variables were assessed using Spearman's rank correlation coefficient. Multiple linear regression analysis was performed to identify predictors of body mass index (BMI). All assumptions for regression analysis, including linearity, normality of re-

siduals, homoscedasticity, and absence of multicollinearity, were verified before analysis. A two-sided P value < 0.05 was considered statistically significant. Statistical analyses were performed using JASP version 0.17.2.1 (Department of Psychological Methods, University of Amsterdam, Amsterdam, The Netherlands) [29].

Ethical considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. The study involved an anonymous, non-interventional survey of adults from the general population and did not include the collection of directly identifiable personal data. Participation was voluntary. Before completing the questionnaire, all participants received written and verbal information about the purpose and procedures of the study and provided written informed consent. Participants were informed that they could withdraw from the study at any time without consequences. Signed informed consent forms were stored separately from the completed questionnaires in sealed envelopes to prevent any link between participants and their responses.

RESULTS

A total of 195 participants were included in the study, of whom 165 (84.6%) were female and 30 (15.4%) were male. The median age was 35 years (IQR, 26–47 years) (Table 1).

Table 1. Distribution of participants' demographic characteristics (N = 195)

Characteristics		n (%)
Sex	Male	30 (15.4)
	Female	165 (84.6)
Marital status	Married	122 (62.6)
	Divorced	9 (4.6)
	Single	57 (29.2)
	Widowed	7 (3.6)
Education level	Elementary school	7 (3.6)
	Secondary education	130 (66.7)
	Higher education	37 (19.0)
	University degree and above	21 (10.8)
Employment	Employed	156 (80.0)
	Unemployed	33 (16.9)
	Retired	6 (3.1)
Place of residence	City	98 (50.3)
	Village	97 (49.7)
Physical activity	No	61 (31.3)
	Several times a year	27 (13.8)
	Several times a week	48 (24.6)
	Several times a month	38 (19.5)
	Daily	21 (10.8)
Number of meals per day	One meal	5 (2.6)
	Two meals	65 (33.3)
	Three meals	95 (48.7)
	Four meals	30 (15.4)
Self-rated health	Very poor	0 (0.0)
	Poor	7 (3.6)
	Moderate	40 (20.5)
	Good	113 (57.9)
	Very good	35 (17.9)
Presence of chronic disease	Yes	42 (21.5)
	No	153 (78.5)

Most participants had normal body weight (88, 45.1%). The median BMI was 25.1 (IQR, 22.4–28.6), and the median health literacy score was 47 (IQR, 44–48) (Table 2).

Table 2. Distribution of BMI categories and descriptive statistics for body mass index and health literacy (N = 195)

Variable		n (%)
BMI category	Underweight	5 (2.6)
	Normal weight	88 (45.1)
	Overweight	68 (34.9)
	Obesity	34 (17.4)
		Median (IQR)
BMI		25.1 (22.4 – 28.6)
Health literacy score		47 (44 – 48)

Note: BMI – body mass index

BMI differed significantly according to marital status (P = 0.015). Post hoc Dunn's test indicated that single participants had significantly lower BMI than married and widowed participants (P < 0.05). BMI also differed significantly according to employment status (P = 0.018). Retired participants had significantly higher BMI than employed and unemployed participants (P < 0.05) (Table 3).

Table 3. BMI by marital and employment status (N = 195)

Variable		BMI	*P-value**
		Median (IQR)	
Marital status	Married	25.76 (23.17– 28.73)	0.015
	Divorced	23.37 (22.13 – 26.53)	
	Single	24.11 (20.55 – 26.71)	
	Widowed	28.68 (23.35 – 35.43)	
Employment	Employed	25.04 (22.65 – 28.53)	0.018
	Unemployed	24.16 (21.65 – 29.24)	
	Retired	30.44 (27.63 – 35.25)	

Note: BMI – body mass index; *Kruskal–Wallis test.

Spearman correlation analysis showed that BMI was significantly negatively correlated with health literacy (ρ = −0.172, P = 0.016), sex (ρ = −0.176, P = 0.014), and educational level (ρ = −0.193, P = 0.007). BMI was also moderately positively correlated with age (ρ = 0.372, P < 0.001), indicating that BMI tended to increase with increasing age (Table 4).

Table 4. Spearman correlations between BMI and selected sociodemographic and health-related variables

Variables		BMI
Age	ρ	0.372
	P-value	<0.001
Sex	ρ	-0.176
	P-value	0.014
Education	ρ	-0.193
	P-value	0.007
Presence of chronic disease	ρ	-0.132
	P-value	0.065
Self-rated health	ρ	0.063
	P-value	0.384
Physical activity	ρ	-0.129
	P-value	0.073
Place of residence	ρ	0.067
	P-value	0.352
Number of meals per day	ρ	0.033
	P-value	0.649
Health literacy score	ρ	-0.172
	P-value	0.016

Note: ρ = Spearman correlation coefficient; *P values* for Spearman correlation analysis

A multiple linear regression analysis was performed to identify predictors of BMI. Variables that were significantly associated with BMI in the bivariate analyses (educational level, age, sex, employment status, marital status, and health literacy) were included in the regression model. The overall model was statistically significant ($F(9, 185) = 4.26$, $P < 0.001$) and explained 13.1% of the variance in BMI (adjusted $R^2 = 0.131$). Age (B = 0.120, β = 0.321, 95% CI for B 0.054–0.185, $P < 0.001$) and sex (B = −2.708, β = −0.201, 95% CI for B −4.608 to −0.807, $P = 0.005$) were significant independent predictors of BMI (Table 5).

Table 5. Multiple linear regression analysis of predictors of body mass index (BMI)

	B	β	t	*P*	95% CI for B		Adjusted R2
					Lower Bound	Upper Bound	
(Constant)	29.546		6.239	<0.001	20.203	38.889	0.131
Education	-0.470	-0.070	-0.951	0.343	-1.443	0.504	
Age	0.120	0.321	3.588	<0.001	0.054	0.185	
Literacy	-0.028	-0.023	-0.287	0.774	-0.215	0.160	
Sex	-2.708	-0.201	-2.810	0.005	-4.608	-0.807	
Employment - retired	-1.363	-0.048	-0.525	0.600	-6.481	3.755	
Employment - employed	-0.682	-0.056	-0.735	0.463	-2.510	1.147	
Marital - single	-0.446	-0.042	-0.525	0.600	-2.123	1.231	
Marital - divorced	-2.379	-0.103	-1.439	0.152	-5.639	0.882	
Marital - widowed	2.004	0.077	1.076	0.283	-1.671	5.678	

Note: B – unstandardized regression coefficient; β – standardized regression coefficient; CI – confidence interval; adjusted R^2 – adjusted coefficient of determination.

DISCUSSION

This study examined the contribution of health literacy and sociodemographic factors to BMI. Although several variables were significantly associated with BMI in the bivariate analyses, only age and sex remained significant independent predictors in the multivariable regression model.

In the present sample, male sex was independently associated with higher BMI. Sex differences in BMI may reflect biological differences in body composition and fat distribution, as well as sociocultural and behavioral factors [30]. Studies among adolescents and university students have also reported sex differences in body-image dissatisfaction, appearance comparisons, and body self-perception [31–35]. However, because these studies predominantly involved younger populations and focused on body image rather than predictors of BMI, they should be interpreted as contextual evidence rather than direct explanations of the association observed in the present study.

Age was positively associated with BMI and remained an independent predictor in the multivariable model. Age-related changes in height, errors in self-reported weight and height, and differences in body composition can affect BMI estimates and their interpretation [36–40]. Studies in older adults have also shown that the use of alternative height measures may materially alter BMI values and nutritional classification [41, 42]. Therefore, the association observed in the present study should be interpreted as a relationship between chronological age and BMI rather than as evidence of a specific metabolic or hormonal mechanism.

Health literacy was negatively correlated with BMI in the bivariate analysis but was not an independent predictor after adjustment for sociodemographic characteristics. The relatively narrow distribution of SAHLCA-50 scores in the present sample, with a median of 47 and an interquartile range of 44–48, may have reduced the ability to identify an independent association.

Evidence regarding the relationship between health literacy and BMI is inconsistent. A Croatian study using the SAHLCA-50 found no statistically significant differences in health literacy according to BMI categories [43]. In contrast, a population-based study among Albanian adults found that inadequate health literacy was independently associated with higher odds of overweight and obesity [44]. Studies among Taiwanese schoolchildren and Portuguese adults also reported associations between health literacy and weight-related outcomes [45, 46], whereas a study among Iranian high school students found no statistically significant correlation between health literacy and BMI [47].

Taken together, these findings suggest that the relationship between health literacy and BMI may vary according to age, population characteristics, the instrument used to assess health literacy, and the behavioral and socioeconomic variables included in the analysis. Health literacy may support healthier decision-making, but it should not be interpreted as a sufficient or direct determinant of body weight.

Overall, the variables included in the regression model explained a relatively small proportion of BMI variance (adjusted R^2 = 0.131). This result indicates that a substantial proportion of BMI variance remains unexplained and may be attributable to biological, psychological, behavioral, social, and environmental factors that were not included in the model. Therefore, these findings emphasize the need for future research that would encompass a wider spectrum of variables and consider possible interactions between individual characteristics, lifestyle, and socioeconomic circumstances.

In this sample, 68 participants (34.9%) were overweight and 34 participants (17.4%) were obese, indicating that excess body weight was common among the participants. These findings are consistent with current global estimates reported by the World Health Organization, indicating that overweight and obesity remain major public health challenges worldwide [1]. Such data confirm that obesity remains a serious public health problem and emphasize the need for preventive and intervention measures in different age groups.

The results indicate the need for a personalized and age-sensitive approach to the prevention and treatment of obesity. Older adults should be included in programs that promote physical activity and support metabolic health, while the development of sex-specific educational strategies is also recommended, given the differences between men and women in body perception, motivation, and approaches to weight management. Nurses, as key members of multidisciplinary teams, play an important role in implementing such interventions by identifying at-risk groups, providing individualized counseling, and encouraging long-term behavioral change. The relatively high proportion of participants with overweight or obesity highlights the importance of early prevention, particularly among younger adults. Programs that promote healthy eating habits, regular physical activity, and reduced sedentary behavior should be an integral part of primary healthcare, educational curricula, and public health initiatives.

Future research should include participants across a broader age range to improve the generalizability of the findings. It is also recommended to include a larger sample and apply a longitudinal study design to better examine the causal relationship between health literacy and changes in nutritional status over time. Furthermore, incorporating objective measures of physical activity, dietary habits, and psychological factors may provide a more comprehensive understanding of their potential mediating or moderating role in the relationship between health literacy and BMI.

Study Limitations

Despite the contribution of this study, several limitations should be considered when interpreting the findings. The study relied on self-reported data, which may have resulted in inaccuracies in reporting body weight, height, and dietary habits. In addition, the sample was relatively small and not fully representative of the Croatian adult population, owing to the predominance of younger participants and women. Furthermore, the cross-sectional design precludes conclusions about causal relationships between health literacy and BMI. Finally, several potentially important variables, including detailed measures of physical activity, stress, socioeconomic status, and genetic predisposition, were not assessed and may have contributed to the unexplained variation in BMI.

CONCLUSION

The results of this study highlight the multifactorial nature of body mass index (BMI), with age and sex emerging as significant independent predictors, whereas health literacy was not a significant predictor in the multivariable model. Nevertheless, health literacy remains an important component of health promotion, as it may support healthier decisions and behaviors that influence nutritional status over time. These findings underscore the importance of adopting a comprehensive approach to obesity prevention and management that considers biological, psychological, and social determinants of body weight.

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Author Contributions

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Declaration of Conflicting Interest

The authors declare no conflicts of interest.

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Patients' Knowledge of Dental Implants: Differences According to Sex, Age, and Educational Level

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ABSTRACT

Introduction: Dental implants are considered a reliable and effective treatment option for the replacement of missing teeth; however, adequate patient knowledge regarding implant therapy, maintenance, oral hygiene, and long-term care is essential for informed decision-making and successful treatment outcomes. This study aimed to assess patients' knowledge of dental implants and to determine whether patients' knowledge differs according to sex, age, and educational level.

Methods: A cross-sectional study included 100 participants. Data were collected using a structured questionnaire designed for this study, which included demographic characteristics and questions assessing the level of knowledge about dental implants, including indications, materials, duration, complications, and maintenance. Data were analyzed using descriptive and inferential statistical methods.

Results: Most participants (98%) correctly defined the term dental implant, and the median number of correct answers was 11 out of a possible 17. There were no significant differences in the level of knowledge according to sex (P = 0.85), while significant differences in overall knowledge were observed across educational levels (P = 0.04). Men significantly more often recognized smoking as a contraindication than women (47.8% vs. 24.1%, P = 0.02). The highest percentage of correct answers was related to the purpose and longevity of dental implants, whereas the lowest scores were observed for surgical and technical aspects.

Conclusion: The participants demonstrated a moderate level of knowledge regarding dental implants, with no significant differences observed according to sex or age, while a higher educational level was significantly associated with greater overall knowledge. The findings indicate the need for additional patient education focused on the surgical and biomechanical aspects of implant therapy, as well as on the importance of proper maintenance and regular oral hygiene for long-term implant success.

INTRODUCTION

Tooth loss represents one of the major public health problems in the field of oral health and significantly affects masticatory function, speech, aesthetics, and quality of life, particularly in the elderly population. In Croatia, a high prevalence of tooth loss is still observed despite advances in preventive and therapeutic dental procedures. According to data from the World Health Organization (WHO), the prevalence of complete edentulism among the adult population in Croatia is among the highest in Europe, especially in individuals older than 65 years [1]. Studies conducted in Croatia confirm a high prevalence of edentulism and poor oral health status among the adult population, together with a pronounced need for prosthetic rehabilitation [2, 3]. Data from the Croatian Institute of Public Health further indicate the extent of the problem, as more than 400,000 tooth extractions are performed annually [4].

Due to the high prevalence of tooth loss, an increasing number of patients are opting for modern prosthetic rehabilitation methods such as dental implants. A dental implant is defined as an artificial replacement structure that substitutes the root of a missing tooth and serves as a support for a prosthetic restoration [5, 6]. Implants are most commonly made of titanium and its alloys because of their biocompatibility and ability to achieve stable osseointegration [7]. The most common indications for implant therapy include the replacement of one or more missing teeth, stabilization of dentures, and preservation of adjacent healthy teeth without the need for tooth preparation [8, 9].

Dental implants are currently considered one of the most effective treatment options for replacing missing teeth because they enable preservation of masticatory function, improvement of aesthetics and speech, and significantly contribute to patients' quality of life [4, 10]. Their main advantages include high stability, preservation of alveolar bone, and long-term treatment success, which, according to studies, exceeds 95% [11, 12]. The success of implant therapy is based on the process of osseointegration, defined as a stable connection between the implant and bone without signs of inflammation or mobility [12, 13].

Despite the numerous advantages of implant therapy, its acceptance among patients is still not universal. Insufficient information, financial constraints, fear of surgical procedures, and limited access to reliable information sources may influence treatment decisions [14, 15]. Previous studies indicate that patients' level of knowledge about dental implants differs according to age, sex, education, and previous experience with prosthetic therapy [16–18]. Furthermore, studies have shown that women more frequently express greater interest in the aesthetic aspects of therapy, whereas men more often emphasize functionality as the main motivation for implant placement [19]. Younger age groups demonstrate better knowledge and more positive attitudes toward implant procedures, which is associated with greater exposure to information through digital media [20]. Patient education regarding dental implants is essential for making informed treatment decisions. Dentists are considered the most important and reliable source of information about implant therapy [21, 22].

Successful implant placement requires an adequate quantity and quality of alveolar bone as well as good oral hygiene, whereas contraindications include active infections, uncontrolled diabetes, severe systemic diseases, and smoking as an important risk factor for complications and peri-implantitis [23, 24]. Previous studies conducted in Croatia on patients' knowledge and attitudes toward dental implants are relatively limited. Kranjčić et al. investigated the awareness of older adults regarding dental implants and found that the level of knowledge about implant therapy differed significantly according to age and educational level [25]. More recent Croatian studies have also confirmed the presence of financial and informational barriers to the acceptance of implant treatment [26]. However, available data remain limited, particularly regarding contemporary patterns of patient information-seeking and possible changes in the level of knowledge during the past decade, marked by increasing availability of digital information sources and advances in implant therapy. Therefore, there is a need for more recent data that would provide better insight into the current level of patient awareness and the factors associated with knowledge about implant therapy. This study aimed to assess patients' knowledge of dental implants and to determine whether knowledge differs according to sex, age, and educational level.

METHODS

Study design

This cross-sectional study was conducted from March to September 2025 in a dental clinic in Osijek.

Setting and samples

The study included 100 adult patients (46 men and 54 women) attending a dental clinic in Osijek who voluntarily agreed to participate in the survey. Inclusion criteria were age ≥18 years and willingness to participate in the study. Participants were categorized into four age groups: younger than 30 years, 30–49 years, 50–69 years, and 70 years or older.

Measurements/instruments

Data were collected using an anonymous questionnaire specifically designed for this study based on available literature related to dental implants and patients' knowledge and attitudes toward implant therapy [10, 16–22, 27, 28]. The questionnaire consisted of two sections. The first section included demographic data (sex, age, and educational level), while the second section contained 17 closed-ended questions assessing knowledge about dental implants. The questions covered several thematic areas, including basic information about implants (definition, materials, components, and purpose), implant placement procedure and duration, osseointegration, complications and contraindications, and radiological and surgical procedures in implantology. The questionnaire consisted of 17 knowledge questions, some of which included multiple correct answers. Each question was scored as either correct (1 point) or incorrect (0 points). For questions with multiple correct answers, one point was awarded only when all correct answer options were selected. Partially correct responses were scored as incorrect. The total knowledge score was obtained by summing the scores across all questions, with higher scores indicating greater knowledge about dental implants.

Data collection/procedure

The study was conducted from March to September 2025. The questionnaire was distributed online using Google Forms. Participants completed the questionnaire using their own mobile devices while waiting for their scheduled appointment in the clinic waiting area. The average time required to complete the questionnaire was approximately 10 minutes. Data were collected anonymously, and no personally identifiable information was obtained from participants. Initially, 102 questionnaires were collected. Two incomplete questionnaires were excluded, resulting in a final sample of 100 participants.

Ethical considerations

Participation in the study was voluntary and anonymous. Before accessing the online questionnaire, all participants were provided with information about the purpose, procedures, and voluntary nature of the study. Participants were required to indicate their informed consent by selecting the designated consent checkbox before they could proceed to the questionnaire. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki for biomedical research.

Statistical data analysis

Categorical variables were presented as absolute and relative frequencies. Differences between categorical variables were analyzed using Fisher's exact test. The normality of distribution for continuous variables was assessed using the Shapiro–Wilk test. Continuous variables were described using median and interquartile range values. Differences in continuous variables according to sex were analyzed using the Mann–Whitney U test, together with the Hodges–Lehmann estimate of median difference and corresponding 95% confidence intervals [30]. All P values were two-sided, and the level of statistical significance was set at $\alpha = 0.05$. Statistical analyses were performed using MedCalc® Statistical Software version 23.3.7 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2025).

RESULTS

The study included 100 participants (46 men and 54 women). The largest proportion of participants, 49 (49%), were aged ≤30 years, whereas 9 (9%) were aged 70 years or older. Most participants had completed secondary education (55; 55%), while 28 (28%) had attained a university degree or higher level of education (Table 1).

Table 1. General characteristics of the participants (N = 100)

Characteristic		n (%)
Sex		
	Man	46 (46)
	Women	54 (54)
Age groups		
	< 30 years	49 (49)
	30–49 years	23 (23)
	50–69 years	19 (19)
	≥ 70 years	9 (9)
Educational level		
	Secondary education	55 (55)
	College education	17 (17)
	University degree or higher education	28 (28)

Overall, 98% of participants correctly identified dental implants as artificial replacements inserted into the jawbone to replace a missing tooth, while 64% reported that titanium is the most commonly used material for dental implants. The duration of the implant placement process was correctly identified as approximately 3–6 months by 47% of participants, and 70% indicated that the minimum age for implant placement is 18 years. Sufficient bone quantity and density were identified as the primary prerequisite for dental implant placement by 88% of participants, with significantly more men than women providing the correct answer ($P = 0.02$). Replacement of a missing tooth was identified as the primary purpose of dental implants by 95% of participants. A lifespan of 10 years or longer was reported by 74% of participants, while between 80% and 85% indicated that implant longevity depends on maintaining good oral hygiene, regular dental visits, lifestyle habits, and oral health status (Table 2).

Table 2. Assessment of knowledge about dental implants according to sex

Question / Item	Men n (%)	Women n (%)	Total n (%)	$P^{\dagger}$
What are dental implants?				
Filling for a tooth damaged by caries	0 (0.0)	1 (1.9)	1 (1)	0.71
Temporary denture	1 (2.2)	0 (0.0)	1 (1)	
Artificial substitutes implanted into the jawbone to replace a missing tooth*	45 (97.8)	53 (98.1)	98 (98)	
What material are dental implants most commonly made of?				
Acrylic	9 (19.6)	10 (18.5)	19 (19)	0.91
Composite	7 (15.2)	9 (16.7)	16 (16)	
Titanium*	29 (63)	35 (64.8)	64 (64)	
Gold	1 (2.2)	0 (0.0)	1 (1)	
What is the average duration of the implant placement process (from start to finish)?				
One week	4 (8.7)	5 (9.3)	9 (9)	0.63
1–3 months	18 (39.1)	26 (48.1)	44 (44)	
3–6 months*	24 (52.2)	23 (42.6)	47 (47)	

Question / Item	Men n (%)	Women n (%)	Total n (%)	P†
What is the minimum age requirement for dental implant placement?				
No minimum age limit	10 (21.7)	7 (13)	17 (17)	0.28
10 years	5 (10.9)	2 (3.7)	7 (7)	
18 years*	29 (63)	41 (75.9)	70 (70)	
24 years	2 (4.3)	4 (7.4)	6 (6)	
What is the main prerequisite for dental implant placement?				
Sufficient amount and density of bone*	43 (93.5)	45 (83.3)	88 (88)	0.02
Sufficient healthy teeth	1 (2.2)	8 (14.8)	9 (9)	
Younger age	2 (4.3)	0 (0.0)	2 (2)	
Healthy diet	0 (0.0)	1 (1.9)	1 (1)	
What are the parts of a dental implant?				
Implant body*	44 (95.7)	50 (92.6)	94 (94)	0.68
Implant neck*	42 (91.3)	50 (92.6)	92 (92)	> 0.99
Abutment*	15 (32.6)	21 (38.9)	36 (36)	0.54
Prosthetic restoration*	23 (50)	35 (64.8)	58 (58)	0.16
Dental calculus	1 (2.2)	0 (0.0)	1 (1)	0.46
What is the main purpose of dental implants?				
Replacement of a missing tooth*	43 (93.5)	52 (96.3)	95 (95)	0.80
Reducing the need for oral hygiene	1 (2.2)	0 (0.0)	1 (1)	
Improving smile aesthetics	2 (4.3)	2 (3.7)	4 (4)	
How long do implants last?				
Up to 1 year	1 (2.2)	1 (1.9)	2 (2)	0.45
2–4 years	0 (0.0)	3 (5.6)	3 (3)	
5–10 years	9 (19.6)	12 (22.2)	21 (21)	
10 years and more*	36 (78.3)	38 (70.4)	74 (74)	
What does implant longevity depend on?				
Oral hygiene maintenance*	36 (78.3)	49 (90.7)	85 (85)	0.09
Regular dental check-ups*	38 (82.6)	44 (81.5)	82 (82)	> 0.99
Lifestyle habits (smoking, alcohol)*	35 (76.1)	45 (83.3)	80 (80)	0.45
Oral health status*	35 (76.1)	45 (83.3)	80 (80)	0.45

*Correct answers; †Fisher's exact test

Most participants correctly identified the most common complications of implant placement, including infection (79%) and implant failure/rejection (83%). Uncontrolled diabetes mellitus was identified by 77% of participants as the most important contraindication to implant placement, while men significantly more often recognized smoking as a contraindication than women (47.8% vs. 24.1%, $P = 0.02$). Regarding the perceived advantages of implants over fixed dental bridges, the most common response was that implants do not require preparation (grinding) of adjacent teeth (52%), with this answer being significantly more frequently provided by women than men ($P = 0.04$). Men also significantly more often correctly identified bone augmentation as the surgical procedure used to compensate for insufficient bone before implant placement (56.5% vs. 40.7%, $P = 0.01$). The vast majority of participants were aware that implants can be used to replace multiple missing teeth (93%) (Table 3).

Table 3. Assessment of knowledge about dental implants according to sex

Question / Item	Men n (%)	Women n (%)	Total n (%)	*P*†
What are the possible complications of implant placement?				
Infection*	34 (73.9)	45 (83.3)	79 (79)	0.33
Damage to anatomical structures during implant placement*	28 (60.9)	31 (57.4)	59 (59)	0.84
Implant failure/rejection*	37 (80.4)	46 (85.2)	83 (83)	0.60
Gingivitis	16 (34.8)	23 (42.6)	39 (39)	0.54
Implant fracture*	31 (67.4)	31 (57.4)	62 (62)	0.41
Fracture of the prosthetic restoration*	24 (52.2)	28 (51.9)	52 (52)	>0.99
What are the contraindications for implant placement?				
Uncontrolled diabetes mellitus*	37 (80.4)	40 (74.1)	77 (77)	0.49
Gingivitis	30 (65.2)	31 (57.4)	61 (61)	0.54
Head and neck radiation therapy*	23 (50.0)	26 (48.1)	49 (49)	>0.99
Older age	14 (30.4)	11 (20.4)	25 (25)	0.26
Smoking*	22 (47.8)	13 (24.1)	35 (35)	0.02
What is the process of implant integration with bone called?				
Osseointegration*	36 (78.3)	43 (79.6)	79 (79)	0.97
Osteomyelitis	2 (4.3)	3 (5.6)	5 (5)	
Osteonecrosis	7 (15.2)	6 (11.1)	13 (13)	
Osteopenia	1 (2.2)	2 (3.7)	3 (3)	
What is the main advantage of dental implants compared with bridges?				
Cost	0 (0.0)	3 (5.6)	3 (3)	0.04
Durability	26 (56.5)	19 (35.2)	45 (45)	
No preparation of adjacent teeth is required*	20 (43.5)	32 (59.3)	52 (52)	
Can dental implants be used to replace multiple teeth?				
No	2 (4.3)	2 (3.7)	4 (4)	>0.99
Yes*	43 (93.5)	50 (92.6)	93 (93)	
Only in the mandible	0 (0.0)	1 (1.9)	1 (1)	
Only in the maxilla	1 (2.2)	1 (1.9)	2 (2)	
Which radiographic method is most commonly used to assess bone before implant therapy?				
CBCT (Cone Beam Computed Tomography)*	29 (63.0)	36 (66.7)	65 (65)	0.37
MRI (Magnetic Resonance Imaging)	9 (19.6)	5 (9.3)	14 (14)	
Periapical radiograph	7 (15.2)	9 (16.7)	16 (16)	
Ultrasound	1 (2.2)	4 (7.4)	5 (5)	
What is the surgical procedure used to compensate for insufficient bone before implant placement called?				
Bone augmentation*	26 (56.5)	22 (40.7)	48 (48)	0.01
Endodontics	13 (28.3)	20 (37.0)	33 (33)	
Enucleation	0 (0.0)	8 (14.8)	8 (8)	
Gingivectomy	7 (15.2)	4 (7.4)	11 (11)	

Question / Item	Men n (%)	Women n (%)	Total n (%)	P†
What is peri-implantitis?				
Allergic reaction to a dental implant	6 (13.0)	8 (14.8)	14 (14)	0.82
Disintegration of a dental implant	2 (4.3)	5 (9.3)	7 (7)	
Inflammation of the soft and hard tissues surrounding the implant*	36 (78.3)	39 (72.2)	75 (75)	
Inflammation of the tooth root	2 (4.3)	2 (3.7)	4 (4)	

*Correct answers; †Fisher's exact test

The possible score ranged from 0 to 17 correct answers, with higher scores indicating a greater level of knowledge. The median score was 11 (interquartile range, 8–13), with observed scores ranging from 3 to 16 correct answers. The distribution of participants according to the number of correct answers is shown in Figure 1.

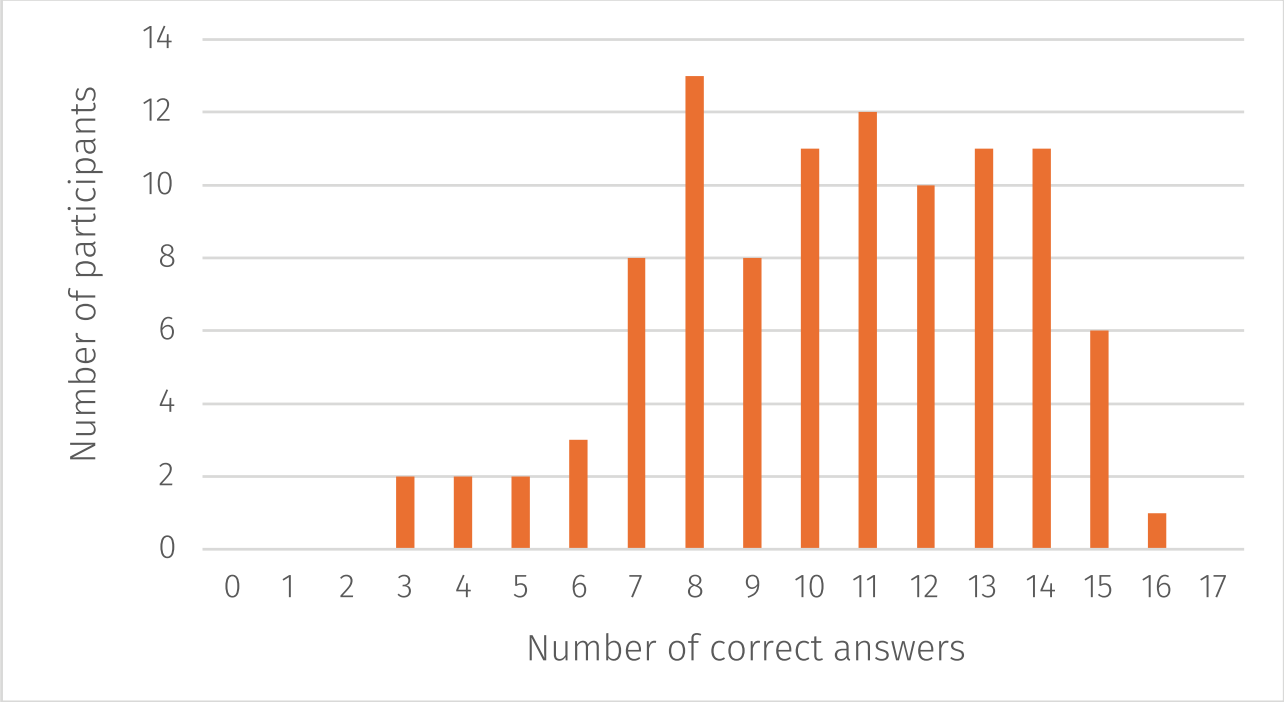

Figure 1. Distribution of participants according to the number of correct answers.

There was no significant difference in the overall knowledge score according to participants' sex (Table 4).

Table 4. Differences in overall knowledge scores according to sex

	Possible range	Median (Interquartile range)		Difference	95% Confidence Interval	*P**
		Men	Women			
Overall knowledge score	0 – 17	10 (8 – 13)	11 (8 – 13)	0	-1 to 1	0.85

* Mann–Whitney U test (Hodges–Lehmann estimate of median difference)

No statistically significant differences in overall knowledge scores were observed across age groups, although participants aged 30–49 years achieved the highest median number of correct answers. In contrast, overall knowledge scores differed significantly according to educational level (P = 0.04). Post hoc analysis showed that participants with a university degree or higher education achieved a higher median number of correct answers than those with secondary education (median 12 vs. 10 correct answers) (Table 5).

Table 5. Differences in overall knowledge according to age groups and level of education

Characteristic		Median (Interquartile range)	*P**
Age groups			
	< 30 years	10 (8 – 12)	0.35
	30–49 years	12 (8 – 14)	
	50–69 years	11 (9 – 13)	
	≥ 70 years	10 (8 – 12)	
Educational level			
	Secondary education	10 (8 – 12)	0.04†
	College education	10 (8 – 13)	
	University degree or higher education	12 (10 – 14)	

* Kruskal–Wallis test (Conover post hoc test).

† Significant difference at $P < 0.05$ between participants with secondary education and those with a university degree or higher education

DISCUSSION

The findings of this study indicate that participants' knowledge regarding dental implants was moderate, while a higher educational level was significantly associated with greater overall knowledge. No statistically significant differences in knowledge were observed with respect to participants' sex or age, although the highest median number of correct answers was recorded in the 30–49 age group compared with other age groups. Previous studies have reported that younger individuals are more likely to use digital sources of information and therefore have greater access to implant-related content, whereas older adults, despite often having a greater need for prosthetic rehabilitation, tend to possess less accurate knowledge regarding implant therapy [15–18, 21, 22]. This may be due to limited internet use, reliance on information obtained through personal communication within their social environment, or a lack of systematic educational interventions targeted at this population.

In this study, no statistically significant difference in overall knowledge was observed between men and women. However, certain questionnaire items revealed significant sex-related differences. Men were significantly more likely to recognize adequate bone quantity and density as a key prerequisite for implant placement, as well as smoking as an important contraindication, whereas women more frequently identified the fact that dental implants do not require the preparation (grinding) of adjacent teeth. Men were also significantly more likely to correctly identify bone augmentation as the surgical procedure used to compensate for insufficient bone before implant placement. This pattern is partly consistent with the findings of Alomran et al., who reported

that women generally demonstrated greater interest in the aesthetic aspects of treatment, whereas men more frequently emphasized its functional benefits [20]. Furthermore, men tend to express greater confidence in their knowledge and treatment-related decision-making regardless of their actual level of information [19, 20, 27, 28].

Educational level was significantly associated with participants' knowledge of dental implants. Participants with a university degree achieved a higher median number of correct answers compared with those with secondary education. This finding is consistent with previous studies [18, 20, 29], which have shown that a higher level of education contributes to a better understanding of dental concepts and greater confidence in modern therapeutic procedures [18, 22].

It is particularly important to emphasize the role of dentists as the primary source of information. Most participants reported receiving key information about dental implants directly from their dentist, which is consistent with studies identifying dental professionals as the primary and most reliable source of information regarding implant therapy [15, 16, 21, 22]. At the same time, some participants obtain information from the internet, social media, or the experiences of other patients, highlighting the need for high-quality, evidence-based educational content that is readily accessible to the general public [15–18]. Incorrect or incomplete information available online may lead to misunderstandings of the procedure, unrealistic expectations, overestimation of treatment possibilities, or unjustified concerns regarding complications. Rustemeyer and Bremerich reported that patients' level of knowledge and expectations regarding dental implants significantly influence the acceptance of implant therapy, with insufficient information representing one of the key barriers to treatment acceptance [30].

The present findings suggest that patient education represents an essential component of successful implant therapy. Patients who have a better understanding of the purpose and course of treatment are more likely to adhere to professional recommendations, develop realistic expectations, and maintain oral hygiene more responsibly, which may contribute to the long-term success of implants and greater treatment satisfaction [8, 9, 18, 28]. These findings emphasize the importance of providing individually tailored counselling in clinical practice, particularly for groups with lower levels of knowledge.

Overall, participants demonstrated a moderate level of knowledge regarding dental implants, with a median of 11 correct answers out of a possible 17. Most participants correctly identified a dental implant as an artificial substitute placed in the jawbone, indicating a high level of basic understanding of the concept. A similar moderate level of knowledge in comparable populations was reported by Pommer et al. and Suprakash et al., confirming that basic awareness of implant therapy is now widely distributed [15, 18].

The highest percentage of correct responses related to the basic purpose of dental implants and their longevity. Most participants were aware that the lifespan of implants depends on oral hygiene, regular dental check-ups, and lifestyle habits, indicating a high level of awareness of the patient's role in the long-term success of implant therapy [15, 18]. In contrast, the lowest proportion of correct answers was observed for questions related to implant abutments and bone augmentation, suggesting limited knowledge regarding the technical and surgical aspects of implant therapy. Overall, the level of knowledge observed in this study is comparable with findings reported from Austria [15], the United Kingdom [16], and India [17]. These studies consistently demonstrate that most patients possess a basic understanding of dental implants but have limited knowledge regarding the surgical and biomechanical aspects of treatment [15–17]. Similarly, Ho et al., in a cross-sectional study conducted in Japan, found that despite generally positive perceptions of dental implants, patients often lack knowledge regarding treatment procedures, indications, and potential complications [31]. The authors emphasized that information regarding additional procedures, such as bone augmentation, and safety-related aspects of treatment remains limited, while professional sources are not always used as the primary source of information [31].

By comparing the results of this study with previous Croatian research, a gradual improvement in patients' awareness of dental implants can be observed. A Croatian study conducted in 2015 reported limited knowledge among older participants and

identified age and educational level as significant factors associated with awareness and knowledge of implant therapy [25]. In contrast, a study conducted in 2021 demonstrated greater familiarity with dental implants and more positive attitudes toward implant treatment, with education and access to information playing important roles, while financial barriers to treatment acceptance were also identified [26].

The findings of the present study indicate that most participants correctly recognize the fundamental characteristics of implant therapy, whereas age was not significantly associated with the overall level of knowledge. This may be related to the increasing availability of information regarding dental implants in recent years, while educational level continues to be an important factor associated with better knowledge of implant therapy. The findings of previous Croatian studies, together with those of the present research, underscore the need for systematic and structured patient education regarding dental implants. Improving patients' understanding of implant therapy may facilitate informed decision-making, promote realistic treatment expectations, and contribute to better long-term treatment outcomes.

Limitations

This study has several limitations that should be acknowledged. First, it was conducted in a single dental clinic and included a relatively small sample, which may limit the generalizability of the findings to the broader population. In addition, certain age groups, particularly participants older than 70 years, were underrepresented. The cross-sectional study design precludes conclusions regarding causal relationships between the examined variables. Furthermore, the use of an online questionnaire may have introduced selection bias, as participation was limited to individuals with internet access and sufficient digital literacy. Despite these limitations, the study provides valuable insight into patients' knowledge of dental implants and may serve as a foundation for future multicenter investigations involving larger and more representative samples.

Recommendations for Future Research

Future research should include larger and more diverse populations from different geographical regions to improve the generalizability of the findings. Longitudinal and multicenter studies may provide a more comprehensive understanding of changes in patients' knowledge and attitudes toward dental implants over time. In addition, future studies should explore the influence of socioeconomic status, previous dental experiences, access to dental care, and digital sources of information on patients' awareness, perceptions, and acceptance of implant therapy. The development and validation of standardized instruments for assessing knowledge of dental implants would further enhance comparability across studies and contribute to the advancement of research in this field.

Implications for Clinical Practice and Education

The findings of this study highlight the important role of patient education in improving awareness and understanding of dental implant therapy. Dental professionals should provide clear, evidence-based, and individualized information regarding implant indications, benefits, potential risks, and maintenance requirements. Particular attention should be directed toward patients with lower educational levels, who may benefit from additional educational support. Furthermore, the implementation of educational strategies incorporating digital media, printed materials, and chairside counselling may enhance patient knowledge and facilitate informed decision-making regarding implant treatment.

CONCLUSIONS

The findings of this study indicate that participants demonstrated a moderate level of knowledge regarding dental implants. Educational level emerged as the factor most strongly associated with overall knowledge, whereas sex and age were not significant-

ly associated with knowledge scores. Participants with higher educational attainment achieved better overall knowledge scores, suggesting that education plays an important role in patients' awareness and understanding of implant therapy. These findings underscore the importance of continuous patient education and highlight the crucial role of dental professionals in providing accurate, evidence-based information regarding implant treatment. Strengthening patient education may contribute to more informed treatment decisions, more realistic treatment expectations, and better patient engagement throughout implant therapy.

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Conceptualization, V.G. and L.I.G.; Methodology, L.I.G., Ž.U. and V.G.; Software, A.LJ., L.I.G. and Z.G.; Validation, A.LJ., L.I.G. and Ž.U.; Formal Analysis, A.LJ., Ž.U. and Z.G.; Investigation, V.G., L.I.G.; Resources, V.G. and L.I.G.; Data Curation, V.G., L.I.G.; Writing – Original Draft Preparation, V.G.; Writing – Review & Editing, V.G., L.I.G., Z.G., A.LJ. and Ž.U.; Visualization, A.LJ., Ž.U. and Z.G.; Supervision, Ž.U.; Project Administration, V.G., L.I.G. and Z.G.

Declaration of Conflicting Interest:

The authors declares no conflict of interest.

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Mandatory Childhood Vaccination in Croatia: Positive Attitudes and Areas of Uncertainty Among Nursing Students

Nursing Students' Attitudes Toward Mandatory Childhood Vaccination

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ABSTRACT

Introduction: Childhood vaccination is one of the most effective public health measures for preventing and controlling infectious diseases, and nurses play an important role in its implementation and promotion. The study aimed to examine nursing students' attitudes toward mandatory childhood vaccination according to the vaccination schedule of the Republic of Croatia and to determine whether these attitudes differed with regard to sociodemographic variables.

Methods: A cross-sectional study was conducted among 119 undergraduate and graduate nursing students at a higher education institution in the Republic of Croatia. Data were collected using an anonymous questionnaire that assessed attitudes using a Likert scale. Data were analyzed using Microsoft Excel and JASP.

Results: Statistically significant differences in attitudes were found according to age ($P < 0.001$) and employment in the nursing profession ($P = 0.0014$). Participants not employed in nursing had higher attitude scores than those employed in nursing. No statistically significant differences were found according to year of study ($P = 0.547$).

Conclusion: The findings indicate the need for additional education and guidance for nursing students during their studies to strengthen positive attitudes toward vaccination. This may enhance their future role in public health interventions and community health protection.

INTRODUCTION

Childhood vaccination is one of the most effective public health measures for preventing and controlling infectious diseases. Vaccines protect children from potentially severe and fatal infections and contribute to herd immunity, thereby reducing disease transmission within the community. Timely vaccination according to the national vaccination schedule is essential for protecting the most vulnerable groups, including newborns, immunocompromised individuals, and older adults [1, 2].

Nurses play an essential role in the implementation of vaccination programs. In addition to participating in the vaccination process itself, they are often the first point of contact for parents and children within the healthcare system. Their role includes informing, counseling, and educating parents about the importance, safety, and effectiveness of vaccines. In the context of increasingly widespread misinformation and distrust of medical recommendations, nurses' expertise, accessibility, and communication skills are particularly important [3]. Their central role in community vaccination programs makes them essential sources of information and education for the public [2]. However, in their daily work, nurses and other healthcare professionals face numerous challenges, including the negative influence of the media on the implementation of public health interventions [4]. Misinformation and conspiracy theories about vaccines are increasingly present in the public sphere, particularly on social media, and significantly affect individuals' attitudes toward vaccination [5]. The rapid spread of inaccurate information, known as an infodemic, can have serious consequences for population health by undermining trust in the healthcare system and evidence-based recommendations [6].

In this context, it is particularly important to foster positive attitudes toward vaccination among nursing students during their education. As future healthcare professionals, they will play an important role in educating patients and parents and promoting vaccination as a key measure for protecting community health. Their attitudes can significantly influence vaccination decision-making, particularly when patients are exposed to conflicting information from different sources.

Educational programs play an important role in shaping students' attitudes by providing them with the knowledge and skills needed to understand the importance of vaccination and its role in disease prevention [7, 8]. In addition, the use of different information sources, including the media and direct communication with experts, can help clarify uncertainties and reduce vaccination-related fears [9]. Raising awareness of responsibility for community health may contribute to the development of positive attitudes and a professional approach to this public health measure [9, 11]. Evidence from multiple countries indicates that vaccination may be delayed or refused because of doubts about the importance, safety, and effectiveness of vaccines, while barriers to vaccine access also persist [10]. This highlights the need to strengthen vaccination-related education and competencies among healthcare professionals, particularly those still in training. Assessing nursing students' attitudes is therefore essential for improving educational programs and developing strategies aimed at promoting vaccination.

The aim of this study was to examine nursing students' attitudes toward mandatory childhood vaccination according to the vaccination schedule of the Republic of Croatia and to determine whether these attitudes differed with regard to sociodemographic variables.

METHODS

Study design

A cross-sectional study was conducted [12].

Setting and samples

The study included a convenience sample of 119 participants who met the following inclusion criteria: enrollment in a full-time undergraduate nursing program or a full-time or part-time graduate nursing program at a higher education institution in the Republic of Croatia, voluntary consent to participate in the study, and attendance in class on the day the study was conducted.

Measurements/instruments

A survey questionnaire specifically designed for this study was used. The questionnaire consisted of two sections. The first section covered the participants' general characteristics, including age, gender, year of study, type of secondary school completed, employment in the nursing profession, and vaccination status. The second section contained questions assessing their attitudes.

The questionnaire was developed based on relevant literature and guidelines and recommendations on vaccination issued by the Croatian Institute of Public

Health and the World Health Organization [13–17]. A total of 27 items were developed to assess the attitudes of undergraduate and graduate nursing students and were grouped into six thematic domains: (1) attitudes toward the effectiveness and safety of vaccination (7 items), (2) mandatory vaccination and the right to make decisions (6 items), (3) sources of information and the media (5 items), (4) vaccination education (4 items), (5) attitudes toward healthcare professionals (3 items), and (6) personal attitudes toward vaccination (2 items).

Participants rated their level of agreement with each statement on a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). To facilitate interpretation of the results, the responses "agree" and "strongly agree" were combined into the category of positive attitudes, while "disagree" and "strongly disagree" were classified as negative attitudes.

Data collection/procedure

Data were collected using a structured paper-and-pencil questionnaire administered to nursing students at a higher education institution.

Ethical considerations

The study was conducted in accordance with applicable ethical and legal guidelines for the protection of participants, including the principles of Good Clinical Practice, the Declaration of Helsinki, the Health Care Act of the Republic of Croatia, and the Act on the Protection of Patients' Rights of the Republic of Croatia. Participant anonymity and confidentiality were strictly maintained throughout data collection and processing.

Before inclusion in the study, participants received written information containing all relevant details, after which they provided informed consent to participate. To further protect their identities, signed consent forms were stored separately from completed questionnaires, thereby preventing responses from being linked to individual participants. Participants were also provided with an email address they could use to ask questions or seek clarification about the study.

Statistical data analysis

Descriptive statistics included the mean, standard deviation, variance, minimum and maximum values, and frequencies.

Group differences were examined using the parametric analysis of variance (ANOVA) and the nonparametric Kruskal–Wallis and Mann–Whitney U tests. Statistical analyses were performed using Microsoft Excel and JASP version 0.19.3 (Department of Psychological Methods, University of Amsterdam, Amsterdam, the Netherlands), with statistical significance set at $P < 0.05$.

RESULTS

A total of 119 participants took part in the study, of whom 105 (88.24%) were women. Most participants were aged 20–29 years, and the mean age was 26.97 years (range 20–56). A total of 96 (80.67%) participants had completed secondary medical school. The largest group comprised 44 first-year graduate nursing students (36.97%), whereas the smallest group consisted of first-year undergraduate nursing students, 9 (7.56%). Most participants were employed in the nursing profession, 63 (52.94%). All 119 participants (100%) had been vaccinated during childhood according to the mandatory vaccination schedule. Twenty-five participants (21.01%) had children, and all 25 (100%) reported that their children had also been vaccinated according to the mandatory vaccination schedule (Table 1).

Table 1. Sociodemographic Characteristics of Participants (N=119)

Sociodemographic variable	Category	n (%)
Gender	Male	14 (11.76)
	Female	105 (88.24)
Age group (years)	20 – 29	92 (77.32)
	30 – 39	9 (7.56)
	40 – 49	16 (13.44)
	50 – 59	2 (1.68)
Secondary school completed	Secondary medical school	96 (80.67)
	General secondary school	19 (15.97)
	Vocational secondary school	4 (3.36)
Year of study	First year of undergraduate study	9 (7.56)
	Second year of undergraduate study	18 (15.13)
	Third year of undergraduate study	23 (19.33)
	First year of graduate study	44 (36.97)
	Second year of graduate study	25 (21.01)
Employment in the nursing profession	Yes	63 (52.94)
	No	56 (47.06)
Personal vaccination status	Yes	119 (100)
	No	0 (0.0)
Vaccination status of participants' children[1]	Yes	25 (100)
	No	0 (0.0)

[1] Calculated among participants who had children (n=25).

Table 2 presents the distribution of positive, neutral, and negative response categories across the six thematic domains. In the domain of attitudes toward the effectiveness and safety of vaccination, most responses (69.63%) were classified in the positive response category (agree or strongly agree). Analysis of individual items showed that 113 (94.96%) participants agreed or strongly agreed that *vaccination provides the best protection for children against infectious diseases*, while 104 (87.40%) agreed or strongly agreed that the benefits of *vaccination outweigh its potential harms*. A neutral response was selected by 34 (28.57%) participants for the item concerning whether vaccines had been *sufficiently researched before administration* and by 39 (32.77%) for the item concerning the *association of vaccination with autoimmune diseases and autism*.

In the thematic domain of mandatory vaccination and the right to make vaccination decisions, 101 (84.87%) participants agreed or strongly agreed that vaccination should be *mandatory for every child in the Republic of Croatia* and were therefore classified in the positive response category. For the item concerning *parental autonomy in vaccination decision-making*, 54 (45.38%) participants were classified in the negative response category, 26 (21.85%) in the neutral response category, and 39 (32.77%) in the positive response category. For the item concerning *financial penalties as an incentive for childhood vaccination*, 42 (35.29%) participants were classified in the positive response category, 41 (34.45%) in the negative response category, and 36 (30.25%) in the neutral response category. For the item concerning societal pressure on parents, 66 (55.46%) participants agreed or strongly agreed that *society places pressure on parents, making it more difficult for them to make decisions about childhood vaccination*.

In the thematic domain of sources of information and the media, the largest proportion of responses (40.50%) was classified in the negative response category. For the item concerning *social media as a source of information for parents*, 102 (85.71%) participants agreed or strongly agreed. A total of 104 (87.39%) participants agreed or strongly agreed that the *Internet is an unreliable source of information*, while 65 (54.62%) agreed or strongly agreed that *social media facilitate the spread of the anti-vaccination movement*.

In the thematic domain of vaccination education, the largest proportion of responses (38.24%) was

classified in the negative response category. For the item concerning *parents' lack of knowledge as the main reason for vaccination refusal*, 102 (85.71%) participants agreed or strongly agreed. For the item concerning the *adequacy of education provided by healthcare professionals*, 60 (50.42%) participants were classified in the negative response category, while 44 (36.97%) selected a neutral response. For the item concerning the *sufficiency of vaccination-related information acquired during their education*, 54 (45.38%) participants were classified in the positive response category, 34 (28.57%) in the neutral response category, and 31 (26.05%) in the negative response category.

The thematic domain of attitudes toward healthcare professionals comprised three items, with 57.14% of responses classified in the positive response category and 30.53% in the neutral response category. For the item concerning *healthcare professionals' activities in promoting childhood vaccination*, 49 (41.18%) participants were classified in the positive response category, while 46 (38.66%) selected a neutral response. For the item concerning *healthcare professionals' positive attitudes toward vaccination*, 68 (57.14%) participants agreed or strongly agreed, while 41 (34.45%) selected a neutral response.

In the thematic domain of personal attitudes toward vaccination, 91.17% of responses were classified in the positive response category. A total of 110 (92.44%) participants reported that they would *vaccinate their own child according to the vaccination schedule of the Republic of Croatia*, while 107 (89.92%) reported that they would *advise parents to vaccinate their children*.

Table 2. Distribution of Response Categories Across Thematic Domains

Thematic domain	Positive attitude*	Neutral attitude	Negative attitude**
	%		
Attitudes toward the effectiveness and safety of vaccination	69.63	17.88	12.46
Mandatory vaccination and the right to make vaccination decisions	49.58	23.11	27.31
Sources of information and the media	37.47	22.02	40.50
Vaccination education	36.77	25.00	38.24
Attitudes toward healthcare professionals	57.14	30.53	12.32
Personal attitudes toward vaccination	91.17	7.98	0.84

*Agree or strongly agree. **Disagree or strongly disagree.

Table 3 presents nursing students' attitudes toward mandatory childhood vaccination by age group. Mean attitude scores ranged from 3.18 to 3.48. The highest mean score was recorded among participants aged 50–59 years (M = 3.48), while the lowest mean score was recorded among those aged 40–49 years (M = 3.18). The Kruskal–Wallis test indicated a statistically significant difference in attitude scores across age groups (χ^2 = 19.446; df = 3; P < 0.001).

Table 3. Nursing students' attitudes toward mandatory childhood vaccination by age group

Age group (years)	n	Mean attitude score	χ^2	df	*P**
20-29	92	3.32	19.446	3	<0.001
30-39	9	3.41			
40-49	16	3.18			
50-59	2	3.48			

*Kruskal-Wallis test

Table 4 presents nursing students' attitudes toward mandatory childhood vaccination by year of study. Mean attitude scores ranged from 3.26 to 3.49. The highest mean score was recorded among first-year undergraduate students (n = 9; M = 3.49), while the lowest was recorded among first-year graduate students (n = 44; M = 3.26). The Kruskal–Wallis test indicated no statistically significant difference in attitude scores across years of study (χ^2 = 3.065; df = 4; *P* = 0.547).

Table 4. Differences in Attitudes Toward Mandatory Childhood Vaccination by Year of Study

Year of study	n	Mean attitude score	χ^2	df	*P**
First-year undergraduate	9	3.49	3.065	4	0.547
Second-year undergraduate	18	3.45			
Third-year undergraduate	23	3.46			
First-year graduate	44	3.26			
Second-year graduate	25	3.34			

Note: Higher scores indicate more positive attitudes toward vaccination. *Kruskal–Wallis test

Table 5 presents nursing students' attitudes toward mandatory childhood vaccination according to employment in the nursing profession. Participants who were not employed in the nursing profession had higher mean attitude scores than those who were employed (3.453 vs. 3.278). The Mann–Whitney U test indicated a statistically significant difference in attitude scores between the two groups (U = 1166.0; P = 0.0014).

Table 5. Differences in Attitudes by Employment Status in the Nursing Profession

Employed in the nursing profession	Mean attitude score	Me	n	SD	U	*P**
Yes	3.278	3.30	63	0.25	1166.0	0.0014
No	3.453	3.42	56	0.29		

Note: Higher scores indicate more positive attitudes toward vaccination. *Mann-Whitney U test

DISCUSSION

Nurses serve as an important link between the healthcare system and patients. Through their knowledge, attitudes, and communication, they can influence parents' understanding and vaccination decisions, as well as attitudes within the wider community [3, 18]. Their role extends beyond the technical administration of vaccines and includes education, counseling, and advocacy, further emphasizing the need for high-quality vaccination education within nursing curricula [18]. Examining nursing students' attitudes toward mandatory childhood vaccination provides insight into how future healthcare professionals perceive and evaluate this public health measure.

The findings showed that nursing students generally had positive attitudes toward childhood vaccination, particularly regarding its effectiveness and safety. A high proportion of participants agreed that vaccination provides the best protection against infectious diseases and that its benefits outweigh its potential harms. Most participants also disagreed with statements suggesting that vaccination against eradicated diseases is unnecessary or that vaccines cause autism and autoimmune diseases. Nevertheless, the proportion of neutral responses to items concerning vaccine research and potential adverse outcomes indicates that some uncertainty remains. These findings are consistent with previous studies reporting generally positive attitudes toward vaccination among students in health-related fields [19–21]. Such attitudes may provide an important foundation for future professional practice, given the influence healthcare professionals can have on parents' vaccination decisions [18, 32, 33].

Despite the generally positive attitudes, the responses indicated some uncertainty regarding mandatory vaccination, parental autonomy, and the use of sanctions. Most participants supported manda-

tory vaccination, but responses were divided concerning parents' right to make vaccination decisions independently. A similar distribution was observed for items concerning restrictions on the enrollment of unvaccinated children in educational institutions and financial penalties for parents. These findings illustrate that vaccination extends beyond medical considerations and involves ethical, legal, and social dimensions, as also reported in previous studies [19, 22]. Responses concerning the potential stigmatization of unvaccinated children and their families may also reflect students' awareness of the broader social consequences of vaccination policies.

In the domain of sources of information and the media, participants' responses indicated a critical assessment of online information. Although students recognized social media as a common source of information for parents, most did not consider it a reliable source and acknowledged its role in spreading anti-vaccination attitudes. These findings are consistent with numerous international studies emphasizing the influence of digital platforms on the spread of misinformation and declining confidence in vaccines [23–27]. Of particular concern is the phenomenon of so-called "echo chambers," in which users encounter only information that confirms their existing views, making it more difficult to obtain objective information and make evidence-based decisions [27].

Vaccination education emerged as one of the key areas of weakness. Although students largely recognized parents' lack of knowledge as an important reason for vaccination refusal, a substantial proportion of participants considered the education provided by healthcare professionals to be insufficient. The findings also indicate uncertainty among students regarding their own knowledge, with many considering the information acquired during their education not fully sufficient for future professional practice. These findings are consistent with studies pointing to shortcomings in the education of health professions students, particularly in the practical application of knowledge and communication with patients [28, 29]. Previous research has also emphasized the value of targeted educational interventions and appropriately designed communication strategies for parents [30, 31].

Attitudes toward healthcare professionals were generally positive, although a considerable proportion of participants selected neutral responses, particularly when assessing healthcare professionals' engagement in promoting childhood vaccination. This finding may indicate insufficient visibility of educational activities undertaken by healthcare professionals or inconsistent quality of communication with parents. Given that healthcare professionals are among the most important sources of vaccination information, their expertise, communication skills, and personal attitudes play an important role in building public confidence [32, 33].

The most positive responses were recorded in the domain of personal attitudes toward vaccination. Almost all participants reported that they would vaccinate their own child according to the vaccination schedule of the Republic of Croatia, and a similarly high proportion would advise parents to vaccinate their children. These findings indicate that the generally positive evaluation of vaccination was also reflected in participants' intended personal and professional behavior. This is particularly important because nurses are expected to provide evidence-based information and support parents in making vaccination decisions [18].

Attitude scores differed significantly according to age and employment status in the nursing profession. Participants who were not employed in the nursing profession had higher attitude scores than those who were employed. This employment-related finding is consistent with a large study among Spanish university students, in which students in paid employment expressed less favorable attitudes toward vaccination [34]. However, that study included students from different academic disciplines and did not specifically examine employment in the nursing profession. In contrast, a study among Turkish nursing students found no significant differences in attitudes toward COVID-19 vaccination according to employment in a healthcare facility or age [35]. These differences may be related to the specific vaccines examined, the instruments used, and the characteristics of the samples. In the present study, employment status may also have been associated with age, level of study, or recent exposure to educational content; therefore, the difference cannot be attributed to professional experience alone. Differences among age groups should also be interpreted

cautiously because the groups were unequal in size, the pattern was not linear, and only two participants were aged 50–59 years.

No statistically significant differences in attitude scores were found according to year of study. Previous studies have reported inconsistent patterns regarding academic progression. Among Spanish nursing students, those in more advanced years had more favorable attitudes, whereas among Portuguese students, more positive attitudes were observed in earlier years of study [19]. Similarly, a Bulgarian study found that students in advanced years expressed greater confidence in vaccine effectiveness and were less likely to endorse the misconception that the measles vaccine causes autism [21]. Research conducted among health professions students in Mostar also highlighted the importance of academic activities in shaping vaccination-related attitudes [20]. Although these findings cannot be directly compared because of differences in student populations and measurement instruments, they suggest that the relationship between academic progression and vaccination attitudes may depend on curricular and sociocultural context.

Study Limitations and Future Research Directions

Despite its valuable findings, this study has several limitations. The relatively small convenience sample limits the generalizability of the findings to the wider population of nursing students in the Republic of Croatia. Participants may also have responded in accordance with socially desirable patterns. In addition, the questionnaire used in the study was not validated, and the absence of open-ended questions limited a deeper understanding of the reasons underlying individual attitudes.

Future research should include larger and more representative samples and combine quantitative and qualitative methods to provide a more comprehensive understanding of students' attitudes and knowledge. Longitudinal studies could provide insight into changes during education and professional development. Including practicing healthcare professionals would also enable comparisons between theoretical knowledge and actual clinical practice.

Implications for Clinical Practice and Education

The findings support the need to strengthen vaccination-related education in nursing programs. This should include not only broader theoretical content but also the development of practical competencies and communication skills and preparation for recognizing and addressing misinformation. Based on previous evidence supporting targeted educational and communication strategies [28–31], nursing programs could also incorporate interdisciplinary learning, the involvement of practicing professionals, and simulation-based exercises to better prepare students for vaccination-related challenges in clinical practice.

CONCLUSIONS

The findings of this study indicate that nursing students largely express positive attitudes toward mandatory childhood vaccination, particularly regarding its effectiveness and safety as fundamental aspects of this public health measure. These findings indicate a high level of acceptance of vaccination as a key tool in the prevention of infectious diseases. However, despite the generally positive attitudes, a certain degree of ambivalence was observed, particularly regarding parental autonomy, sanctions related to non-vaccination, and the broader social implications of vaccination. This division in attitudes suggests that students do not view vaccination exclusively from a medical perspective but also recognize its ethical, legal, and social dimensions. This further confirms the complexity and multidimensional nature of mandatory vaccination.

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Conflicts of interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, M.E. and J.V.; Methodology, M.E.; Software, M.E. and T.M.; Validation, M.E., J.V. and T.M.; Formal Analysis, M.E. and J.V.; Investigation, M.E.; Resources, M.E. and M.B.; Data Curation, M.E. and T.M.; Writing – Original Draft Preparation, M.E.; Writing – Review & Editing, M.E., T.M., J.V. and M.B.; Visualization, M.E. and T.M.; Supervision, J.V. and M.B.; Project Administration, M.E. and J.V..

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Dimensions of Spiritual Needs Among Older Adults Receiving Community Nursing Care: A Cross-Sectional Study

Older Adults' Spiritual Needs and Alderfer's ERG Model

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Keywords: Generativity; Older Adults; Spiritual Needs.

ABSTRACT

Introduction: With population ageing, there is an increasing need for a holistic approach to healthcare for older adults, with spiritual needs representing an important but often under-researched aspect. Therefore, this study aimed to examine the level of spiritual needs among older adults receiving community nursing care in Osijek-Baranja County.

Methods: A cross-sectional study was conducted with a convenience sample of 175 people aged 65 years and older who used the services of the Community Nursing Service of the Health Center of Osijek-Baranja County. Data were collected using a paper-and-pencil survey comprising the standardized Spiritual Needs Questionnaire and a sociodemographic questionnaire.

Results: The most pronounced spiritual needs among the respondents were the needs for giving and inner peace, while existential needs were the least pronounced ($P < 0.001$). Women reported higher Inner Peace ($P = 0.010$), Existential ($P = 0.030$), and Religious Needs ($P = 0.001$). Participants belonging to a religious community reported higher Inner Peace ($P = 0.030$), Giving/Generativity ($P = 0.008$), and Religious Needs ($P < 0.001$). Age was negatively associated with Inner Peace ($P = 0.010$) and Giving/Generativity Needs ($P = 0.010$), whereas self-rated religiosity was positively associated with all dimensions ($P \leq 0.008$), particularly Religious Needs ($P < 0.001$).

Conclusion: Older adults receiving community nursing care demonstrated substantial spiritual needs, especially those related to generativity and inner peace. These findings emphasize the importance of incorporating spiritual care into nursing practice and the broader healthcare of older adults.

INTRODUCTION

Ageing is a natural and continuous process that includes biological, psychological and social changes in an individual [1]. Contemporary society is faced with demographic ageing due to increased life expectancy and the growing proportion of older adults. due to the extension of life expectancy and the increase in the proportion of the older adult population. This demographic phenomenon brings economic, social and health challenges [2]. The ageing process does not depend solely on chronological age, but also on the biological and psychological characteristics of the individual [3]. Ageing affects all major organ systems and is associated with a progressive reduction in physiological reserve [4]. Despite these changes, organ function may remain adequate under normal conditions, while reduced reserve becomes more evident during physiological stress [4].

Knowledge of the ageing process enables the development of geroprotective interventions that contribute to better ageing outcomes [3]. Contemporary geriatric research increasingly emphasizes the concept of ageing well, which goes beyond the traditional biomedical approach focused solely on the absence of disease and the preservation of physical health [5]. Ageing well implies the preservation of physical and cognitive health, as well life as satisfaction, good social relationships, psychological resilience and a sense of purpose, thereby extending the focus beyond the physical and functional aspects of ageing [5-6]. Limitations and health problems are not viewed as obstacles but as part of the life experience to which an individual adapts with the help of psychological and social resources. The ability to adapt, accept change and maintain a sense of meaning plays an important role in the lives of older adults [5].

Within this broader understanding of ageing well, it is important to acknowledge that every individual goes through periods of stability and transition throughout life. Retirement is one of the transitions that may influence an individual's sense of identity and meaning in later life which is also closely related to the last psychosocial development stage [7]. These themes are also reflected in Erikson's theory, in which older adulthood represents the final stage of psychosocial development, marked by the conflict between ego integrity and despair [8]. People who evaluate their life decisions and achievements positively are more likely to accept ageing and maintain a sense of self-worth, whereas dissatisfaction with their life experiences can lead to feelings of frustration and despair [8]. Satisfaction with retirement is associated with physical and mental health, financial security, social integration, and relationships with family and the wider community [9]. Ageing often involves losses such as reduced income, loss of a partner or friend, and changes in family relationships, which requires effective adaptation strategies [8]. In such circumstances, support from family, friends, and other sources can foster a sense of belonging and social connectedness. Social connection is a fundamental human need and one of the strongest predictors of survival across the life course, contributing to well-being, resilience, and longevity through behavioral and biological mechanisms [10]. The ability to adapt to life changes and find meaning may therefore be particularly important in later life.

According to Viktor Frankl, the search for meaning is a fundamental human motivation, and finding purpose contributes to resilience and a sense of fulfilment even in difficult circumstances [11]. Meaning in life is associated with personal growth, a better understanding of one's own needs and a different perspective on the world [12]. Through personal beliefs, individuals may experience a connection with something beyond material reality, which can represent an important source of inner strength and stability [13].

Contemporary approaches to ageing emphasize the importance of maintaining health and psychological resilience, as well as achieving life satisfaction and a sense of purpose. In this context, Alderfer's Existence, Relatedness and Growth (ERG) model provides a relevant theoretical framework. Developed as a modification of Maslow's hierarchy of needs, the model distinguishes between existence, relatedness and growth needs [14]. Existence needs relate to basic living conditions and security, relatedness needs concern interpersonal relationships and social inclusion, while growth needs relate to personal development, a sense of competence and the fulfilment of one's potential [15]. Unlike Maslow's

hierarchy, Alderfer proposed that needs are not arranged in a strict hierarchy and that individuals may simultaneously pursue needs at different levels [14, 15]. Needs are interconnected and changeable, and their fulfilment depends on individual circumstances and motivation [16]. Because of its flexibility, the ERG model may provide a useful framework for examining spiritual and psychological needs. These broader categories can also be recognized in the Spiritual Needs Questionnaire developed by Arndt Büssing, which examines religious needs, existential needs, inner peace needs and giving/generativity needs [17]. Spiritual needs can therefore be viewed as a combination of the existential, relational and developmental aspects of an individual. Alderfer's model allows individual needs to be understood regardless of an older person's physical or material circumstances, making it suitable for research on the ageing process. This approach may contribute to a better understanding of adaptation to ageing while emphasizing the uniqueness of each individual's experience.

The aim of this study was to assess the level of spiritual needs among older adults receiving community nursing care from the Community Nursing Service of the Health Center of Osijek-Baranja County. Specifically, the study examined spiritual needs across the dimensions of inner peace, existential needs, generativity/giving, and religious needs, as well as within the framework of Alderfer's ERG model. Furthermore, differences in spiritual needs were analysed with respect to selected sociodemographic and personal characteristics, while associations between spiritual needs and age, number of children, perceived financial status and self-rated religiosity were examined.

METHODS

Study design

The research was designed as a cross-sectional study [18].

Setting and sample

The study initially included a convenience sample of 185 participants. Owing to incomplete questionnaires, 175 participants were included in the final quantitative analysis. The target population consisted of people aged 65 years and older who received care from the Community Nursing Service of the Health Center of Osijek-Baranja County. The inclusion criteria were being aged 65 years or older, receiving community nursing care, having sufficient cognitive ability to understand and respond to the questionnaire and providing written informed consent to participate in the study. The study was conducted between April and July 2025.

Measurements/instruments

The anonymous structured questionnaire consisted of three sections: the Spiritual Needs Questionnaire, sociodemographic data and general data. The Spiritual Needs Questionnaire is a standardized instrument developed in 2009 to assess individuals' spiritual needs and is frequently used with older adults [17]. The main purpose of the questionnaire is to identify the intensity of different dimensions of spiritual needs to support the provision of appropriate spiritual care.

The questionnaire examines four dimensions: inner peace needs, existential needs, giving/generativity needs and religious needs. Items within the inner peace dimension address seeking inner peace, staying in peaceful places, appreciating the beauty of nature and discussing problems and fears with others. The existential needs dimension includes reflecting on the meaning of life and life after death, forgiveness and resolving unsettled issues. The giving/generativity dimension includes giving gifts, comfort and love to others, sharing knowledge and life experiences and reflecting on the value of one's life. The religious needs dimension includes reading religious texts, participating in religious rituals, praying alone or with others and establishing a connection with something greater than oneself [17]. In the present study, the Spiritual Needs Questionnaire demonstrated acceptable internal consistency, with a Cronbach's alpha of 0.72.

Sociodemographic data included age, gender, marital status, number of children, level of education, place of residence and perceived financial status. General data included the presence of chronic illnesses, membership in a religious community and self-rated religiosity on an 11-point scale ranging from 0 to 10.

Data collection/procedure

The topic and purpose of the study, the study procedures, participant anonymity and the right to withdraw at any time were explained to the participants verbally and in writing through the participant information sheet. Before taking part in the study, all participants signed an informed consent form. Data were collected using a paper-and-pencil questionnaire. All participants had sufficient cognitive ability to understand and respond to the questionnaire. For participants who were unable to complete the questionnaire independently because of physical limitations, the questionnaire was administered by the researcher, who read the questions aloud in a neutral tone without providing guidance or influencing their responses. The questionnaires were completed in the participants' homes, with completion taking approximately 12–17 minutes.

Ethical considerations

The study was approved by the Ethics Committee of the Faculty of Dental Medicine and Health Osijek (approval number: 2158/97-97-10-25-31) and the Ethics Committee of the Health Center of Osijek-Baranja County (approval number: 03-844-3/25).

Statistical data analysis

Categorical variables were summarized using frequencies and percentages. Numerical variables were summarized using medians and interquartile range (IQR). The normality of numerical variables was assessed using the Shapiro–Wilk test. The internal consistency of the Spiritual Needs Questionnaire was assessed using Cronbach's alpha. Differences among the Spiritual Needs Questionnaire domain scores were assessed using the Friedman test, followed by Conover post hoc comparisons with Bonferroni correction. The Mann–Whitney U test was used to compare two independent groups, while the Kruskal–Wallis test was used to compare three or more independent groups. Spearman's rank correlation coefficient was used to examine associations between variables. Statistical significance was set at $P < 0.05$. Statistical analyses were performed using JASP, version 0.19.3 (JASP Team, Amsterdam, the Netherlands).

RESULTS

The study included 175 participants, of whom 125 (71.4%) were women and 82 (47.1%) were widowed. The median age was 76 years. A total of 137 (79.7%) participants had a diagnosed chronic illness. Furthermore, 128 (74.0%) participants reported belonging to a religious community, while Catholicism was the most commonly reported religious affiliation (101; 57.7%). The median self-rated religiosity score was 7 (Table 1).

Table 1. Characteristics of participants (N = 175)

Characteristic		n (%)*
Gender	Male	50 (28.6)
	Female	125 (71.4)
Marital status	Married	73 (42.0)
	Divorced	9 (5.2)
	Widowed	82 (47.1)
	Single	9 (5.2)
	Living with a partner	1 (0.6)

Characteristic		n (%)*
Number of children	0	18 (10.5)
	1	39 (22.8)
	2	90 (52.6)
	3	22 (12.9)
	4	2 (1.2)
Place of residence	Suburban area	15 (8.6)
	City	122 (69.7)
	Village	38 (21.7)
Chronic disease	Yes	137 (79.7)
	No	35 (20.3)
Belonging to a religious community	Yes	128 (74.0)
	No	36 (20.8)
	Prefer not to answer	9 (5.2)
Religious community	I do not want to declare	47 (26.9)
	Catholicism	101 (57.7)
	Orthodoxism	18 (10.3)
	Other (adventists. Jehovah's witnesses. Protestants. Hungarian reformists)	9 (5.1)
		Mdn (IQR)
Religiosity (0-10)		7 (4-8.75)
Age		76 (71-83)

*Percentages were calculated based on valid responses. Data were missing for marital status (n = 1), number of children (n = 4), chronic disease (n = 3) and belonging to a religious community (n = 2).

Within the Inner Peace Needs dimension, the highest median score was recorded for the item "To plunge into beauty of nature?" (Mdn = 2; Q1–Q3 = 0.50–3), whereas the lowest median score was recorded for the item "To talk with others about your fears and worries?" (Mdn = 1; Q1–Q3 = 0–2) (Table 2).

Table 2. Distribution of responses to SpNQ items by spiritual needs dimension

	SpNQ item During the last time, did you have had the needs ...	0	1	2	3	Mdn (IQR)
		n (%)				
Inner Peace Needs	To talk with others about your fears and worries?	68 (38.9)	27 (15.4)	45 (25.7)	35 (20.0)	1 (0-2)
	To plunge into the beauty of nature?	43 (24.9)	27 (15.6)	54 (31.2)	49 (28.3)	2 (0.50-3)
Existential Needs	To reflect back on your life?	32 (18.3)	35 (20.0)	54 (30.9)	54 (30.9)	2 (1-3)
	To talk with someone about the possibility of life after death?	110 (63.2)	23 (13.2)	22 (12.6)	19 (10.9)	0 (0-1)

	SpNQ item During the last time, did you have had the needs ...	0	1	2	3	Mdn (IQR)
		n (%)				
Giving/generativity Needs	To turn to someone in a loving attitude?	34 (19.4)	27 (15.4)	55 (31.4)	59 (33.7)	2 (1-3)
	To give away something from yourself?	27 (15.4)	22 (12.6)	61 (34.9)	65 (37.1)	2 (1-3)
	To be assured that your life was meaningful and of value?	28 (16.3)	27 (15.7)	52 (30.2)	65 (37.8)	2 (1-3)
	To be re-involved by your family in their life concerns?	71 (40.8)	23 (13.2)	44 (25.3)	36 (20.7)	1 (0-2)
Religious Needs	To pray with someone?	102 (59.3)	28 (16.3)	32 (18.6)	10 (5.8)	0 (0-1)
	To pray for yourself?	38 (21.8)	27 (15.5)	55 (31.6)	54 (31.0)	2 (1-3)
	To turn to a higher presence (i.e., God, Allah)?	30 (17.2)	31 (17.8)	51 (29.3)	62 (35.6)	2 (1-3)

Note: 0 – no; 1 – somewhat; 2 – strong; 3 – very strong

There was a significant difference among the scores of the Spiritual Needs Questionnaire domains ($P < 0.001$). Scores for Giving/Generativity Needs were significantly higher than those for Inner Peace Needs, Religious Needs and Existential Needs (Conover post hoc test with Bonferroni correction, $P < 0.05$). Scores for Inner Peace Needs were also significantly higher than those for Existential Needs (Conover post hoc test with Bonferroni correction, $P < 0.05$) (Table 3).

Table 3. Descriptive statistics of the domains of the Spiritual Needs Questionnaire

Spiritual Needs Questionnaire Domains	Mdn (IQR)	P*
Inner Peace Needs	1.50 (0.75 – 2)	<0.001
Existential Needs	1 (0.57 – 1.60)	
Giving/generativity Needs	1.93 (1 – 2.33)	
Religious Needs	1.33 (0.50 – 1.95)	

* Friedman test

The results showed that age is weakly negatively correlated with inner peace ($P = 0.01$) and the need for giving ($P = 0.01$). There is also a weak positive correlation between the feeling of religiosity and the need for inner peace ($P = 0.008$), existential needs ($P = 0.006$) and the need for giving ($P = 0.003$), while there is a moderate positive correlation between the feeling of religiosity and religious needs ($P < 0.001$) (Table 4).

Table 4. Correlations between Spiritual Needs Questionnaire domains and selected variables

Spiritual Needs Questionnaire domain	Age	Number of children	Self-rated financial status	Self-rated religiosity
	ρ (P*)			
Inner Peace Needs	-0.186 (0.01)	0.130 (0.09)	0.088 (0.25)	0.203 (0.008)
Existential Needs	-0.047 (0.54)	0.062 (0.43)	0.062 (0.42)	0.215 (0.006)
Giving/generativity Needs	-0.190 (0.01)	0.143 (0.06)	0.128 (0.09)	0.226 (0.003)
Religious Needs	-0.017 (0.827)	0.101 (0.196)	0.062 (0.427)	0.599 (<0.001)

*Spearman's rank correlation test.

Women had significantly higher scores for Inner Peace Needs (P = 0.010), Existential Needs (P = 0.030) and Religious Needs (P = 0.001) than men. Giving/Generativity Needs did not differ significantly by gender (P = 0.590). Participants who reported belonging to a religious community had significantly higher scores for Inner Peace Needs (P = 0.030), Giving/Generativity Needs (P = 0.008) and Religious Needs (P < 0.001) than those who did not. No significant difference was observed for Existential Needs (P = 0.10) (Table 5).

Table 5. Comparison of Spiritual Needs Questionnaire domain scores by gender and religious community membership

	Gender			Religious belonging		
	Male	Female	P^*	Yes	No	P^*
	Mdn (IQR)			Mdn (IQR)		
Inner Peace Needs	1.25 (0.5-1.75)	1.5 (0.75-2.25)	0.01	1.5 (0.75-2)	1 (0.5-1.56)	0.03
Existential Needs	0.86 (0.29-1.43)	1.14 (0.57-1.71)	0.03	1 (0.57-1.71)	0.86 (0.29-1.43)	0.10
Giving/ Generativity Needs	1.75 (1.04-2.29)	1.83 (1-2.33)	0.59	1.83 (1.71-2.33)	1.42 (0.79-1.88)	0.008
Religious Needs	0.58 (0.17-1.79)	1.42 (0.83-2)	0.001	1.5 (0.83-2)	0.5 (0-1.08)	<0.001

* Mann-Whitney U test

DISCUSSION

The main findings of this study were the prominence of Giving/Generativity Needs and Inner Peace Needs, despite most participants belonging to a religious community. Self-rated religiosity was positively associated with all dimensions of spiritual needs, particularly Religious Needs. Women and participants belonging to a religious community expressed higher needs in several domains, while older age was weakly associated with lower Inner Peace and Giving/Generativity Needs. Overall, these findings indicate that spiritual needs among older adults receiving community nursing care are multidimensional and shaped by both personal and religious factors.

The prominence of Inner Peace Needs was one of the key findings, consistent with previous studies using the Spiritual Needs Questionnaire [19, 20]. Participants reported a greater need to experience the beauty of nature than to talk with others about their fears and worries. Previous research has similarly indicated that reflection and time spent in nature may support psychological well-being, reduce stress and facilitate emotional regulation in later life [21]. The importance of inner peace suggests that spiritual needs in later life extend beyond formal religious beliefs and practices. When planning individualized care for older adults, healthcare professionals should therefore recognize non-religious sources of spirituality, including relationships, nature, reflection and personal values.

The need to reflect on one's life was among the most strongly expressed existential needs, supporting findings from previous research [22]. This type of reflection may become particularly important when older adults experience widowhood, declining health or reduced social engagement. Rather than being solely a response to adversity, life review may promote psychological well-being, strengthen personal identity and support adaptation [23]. The positive association between self-rated religiosity and Existential Needs further supports the potential role of spirituality in helping older adults find meaning, hope and a sense of security when facing age-related challenges [24]. Existential concerns therefore represent an important aspect of later life. Encouraging reflection on life experiences and purpose may support resilience and adaptation to age-related changes.

Giving/Generativity Needs, particularly the needs to show love, help others and feel that one's life has meaning and value, were also strongly expressed. These findings support theoretical frameworks that describe generativity as an important developmen-

tal task in later life that contributes to emotional well-being, identity and purpose [25, 26]. Opportunities to help others, share knowledge and pass on life experiences may provide an important source of social connection and dignity. Generativity may also help reduce social isolation and loneliness. Providing opportunities to share knowledge, experience and skills may strengthen older adults' sense of worth and contribution despite health or functional limitations.

Although most participants reported belonging to a religious community, Religious Needs were not as strongly expressed as Giving/Generativity Needs. Individual prayer was reported more frequently than praying with another person, suggesting that religious practice may be experienced as a private and personal activity by some older adults. This finding is consistent with previous research showing diverse forms of religious expression and an increasing individualization of religious practice in later life [27, 28]. Spiritual care should therefore be based on an individual assessment of needs rather than assumptions based solely on religious affiliation or community membership.

Study Limitations and Future Research Directions

Several limitations should be considered. Convenience sampling, recruitment from a single county and the inclusion of only recipients of community nursing care limit the generalizability of the findings. Women were also overrepresented in the sample. The cross-sectional design does not allow causal or temporal conclusions, while the use of self-report measures may have introduced recall or social desirability bias. Furthermore, the quantitative approach could not fully capture the complexity of each participant's spiritual experience.

Future studies should include larger and more representative samples of older adults from different regions of Croatia. Longitudinal research could provide insight into how spiritual needs change over time. A mixed-methods approach may offer a more comprehensive understanding of spiritual needs and adaptation to ageing, while comparisons between community-dwelling and institutionalized older adults could further clarify differences in spiritual needs across living arrangements and social contexts.

Implications for Clinical Practice and Education

The findings highlight the importance of assessing spiritual needs as part of holistic community nursing care. Such assessment should address not only religious needs but also inner peace, meaning, relationships and generativity. Nursing education and continuing professional development should therefore include spiritual assessment, communication skills and appropriate referral when identified needs exceed nurses' scope of practice. This may support more individualized care for older adults.

CONCLUSIONS

Spiritual needs were prominent among older adults receiving community nursing care, particularly Giving/Generativity Needs and Inner Peace Needs. Spiritual needs differed according to gender and religious community membership and were associated with age and self-rated religiosity. These findings highlight the importance of recognizing spiritual needs as part of holistic community nursing care for older adults.

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Conflicts of interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, M.L. and Ž.M.; Methodology, M.L., M.K., A.-M.K. and Ž.M.; Software, M.L. and G.K.; Validation, M.L., M.K., A.-M.K., G.K., J.P. and Ž.M.; Formal Analysis, M.L., A.-M.K. and Ž.M.; Investigation, M.L.; Resources, M.L. and J.P.; Data Curation, M.L. and J.P.; Writing – Original Draft Preparation, M.L., M.K., A.-M.K. and Ž.M.; Writing – Review & Editing, M.L., M.K., A.-M.K., G.K., J.P. and Ž.M.; Visualization, M.L., M.K., A.-M.K. and Ž.M.; Supervision, M.L., M.K., A.-M.K., J.P. and Ž.M.; Project Administration, M.L., M.K. and Ž.M.; Funding Acquisition, M.L.

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Original scientific article

Post-traumatic stress disorder after prolonged hospitalization and intensive care: A systematic review

PTSD After Intensive Care

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ABSTRACT

Introduction: Post-traumatic stress disorder (PTSD) is increasingly recognized as a significant component of the psychological consequences following prolonged hospitalization and treatment in the intensive care unit (ICU). This systematic review aimed to describe the prevalence of PTSD among adult ICU survivors; identify the most common risk factors and associated psychological outcomes; and examine interventions relevant to clinical practice.

Methods: A systematic literature search was conducted in January 2026 in the PubMed and Scopus databases in accordance with the PRISMA 2020 guidelines. Studies published between 2021 and 2026; available in English; with access to an abstract and full-text were included. Clinical and observational studies conducted in adult populations after ICU stay were analyzed. Studies focusing on pediatric populations, family members, and caregivers (PICS-F); healthcare professionals; as well as qualitative studies; study protocols; and single case reports were excluded.

Results: A total of 175 records were identified; 149 articles were screened after duplicate removal, and 26 studies were included in the final synthesis. The prevalence of PTSD ranged from 13% to 60%, depending on population characteristics, follow-up duration, and the assessment instruments used. The factors most frequently associated with post-traumatic stress disorder symptoms included delirium, hallucinations and delusional memories, deep sedation, prolonged mechanical ventilation, and dyspnea, while lower levels of social support were associated with poorer psychological outcomes after intensive care.

Conclusion: PTSD is a common and long-term psychological consequence of intensive care. The findings highlight the need for systematic psychological screening, early identification of high-risk patients, and the integration of psychological care into standard post-ICU follow-up and rehabilitation pathways.

INTRODUCTION

Post-traumatic stress disorder (PTSD) is a serious and chronic psychiatric condition that develops as a consequence of exposure to extremely stressful or life-threatening events [1]. Traditionally, it has been associated with war-related trauma, natural disasters, and violence; however, contemporary research increasingly confirms that medical experiences, particularly those related to critical illness and intensive care, may also have strong traumatic potential [2–4]. In this context, intensive care units (ICUs) are recognized as one of the most stressful environments within the healthcare system, where patients are exposed to invasive procedures, prolonged mechanical ventilation, sedation, delirium, pain, loss of control, and a constant threat to life [5].

An ICU stay is often characterized by fragmented or distorted memories, hallucinations, and feelings of helplessness and fear, which may significantly impair patients' psychological integrity [6, 7]. Although the primary goal of intensive care medicine is the preservation of life and stabilization of vital functions, increasing evidence shows that survival of critical illness does not necessarily imply full psychological recovery [8, 9]. Over the past decade, the concept of post-intensive care syndrome (PICS) has been developed to describe a set of persistent physical, cognitive, and psychological impairments among ICU survivors, with PTSD representing a central component of the psychological outcomes.

Post-traumatic stress disorder following intensive care is characterized by intrusive memories related to the ICU stay, nightmares, avoidance behaviors, emotional numbing, hyperarousal, and persistent anxiety [9, 10]. Symptoms may persist for several months after hospital discharge, and some studies have reported persistence of symptoms beyond one year [4, 11, 20, 23, 24]. Unlike classical forms of trauma, medical trauma often remains underrecognized, and the psychological consequences of intensive care are still rarely monitored systematically in clinical practice.

With advances in intensive care medicine, the number of ICU survivors continues to increase, highlighting the growing need to recognize and manage long-term psychological consequences in this population [11]. Despite this, psychological outcomes after intensive care remain marginalized in comparison with somatic outcomes, and standardized protocols for psychological screening and follow-up after ICU discharge have not yet been routinely implemented in most healthcare systems.

Given the growing clinical and public health importance of this issue, it is necessary to systematically examine the available scientific evidence on the prevalence of PTSD after ICU stay, identify key risk factors, understand the mechanisms underlying psychological trauma, and assess the effectiveness of existing preventive and therapeutic approaches. This systematic review aims to synthesize current knowledge on PTSD in adult patients following intensive care, with particular emphasis on long-term psychological consequences and implications for clinical practice.

METHODS

A systematic literature search was conducted in January 2026 in the electronic databases PubMed and Scopus in accordance with the PRISMA 2020 guidelines. The search aimed to identify studies addressing post-traumatic stress disorder in adult patients after ICU stay, with particular emphasis on prevalence, risk factors, psychological outcomes, and long-term consequences.

The search was limited to studies published between 2021 and 2026, available in English, and accessible via abstract and full text. Original scientific articles classified as clinical trials, controlled clinical trials, randomized controlled trials, multicenter studies, and prospective and retrospective observational studies were included.

The search strategy used a combination of controlled vocabulary and free text keywords covering three main domains: post-traumatic stress disorder, intensive care, and psychological outcomes after critical illness. Inclusion and exclusion criteria were defined in advance and are presented in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Studies published between 2021 and 2026	Studies published before 2021
Original research articles available in English with full text	Articles in other languages; editorials; letters to the editor; commentaries
Clinical and observational studies (randomized controlled trials; cohort studies; multicenter studies)	Qualitative studies; study protocols; case reports
Adult patients after ICU stay	Pediatric or neonatal populations
Studies investigating the prevalence of PTSD and psychological outcomes after ICU stay	Studies focusing on psychological outcomes in family members or caregivers (PICS-F)
Studies analyzing risk factors and diagnostic instruments	Studies including healthcare professionals as the study population
Long term psychological outcomes and therapeutic approaches in ICU survivors	Ethical contexts, organ donation, or end-of-life care without reported patient clinical outcomes
Quantitative data on the prevalence and/or predictors of PTSD	Studies on COVID-19 without analysis of long-term psychological outcomes in ICU survivors

Source: Authors' own work.

A total of 175 records were identified in the initial search (PubMed n = 63, Scopus n = 112). After removal of duplicates (n = 26), 149 records were included in the screening phase. Based on the review of titles and abstracts, 87 articles were excluded due to insufficient relevance to the topic. Sixty-two articles were retained for full-text assessment, all of which were available in full-text.

In the final stage of full-text evaluation, an additional 36 studies were excluded for methodological and thematic reasons. Reasons for exclusion included psychological outcomes in family members or caregivers (PICS-F) (n = 11); pediatric or neonatal populations (n = 6); healthcare professionals as the study population (n = 4); ethical contexts, organ donation, or end-of-life care without reported patient clinical outcomes (n = 2); studies conducted in a COVID-19 context without analysis of long-term psychological outcomes in ICU survivors (n = 3); and qualitative studies, study protocols, and case reports (n = 10).

After these steps, a total of 26 studies met all inclusion criteria and were included in the final synthesis. The phases of identification, screening, eligibility, and inclusion are presented in the PRISMA flow diagram (Figure 1).

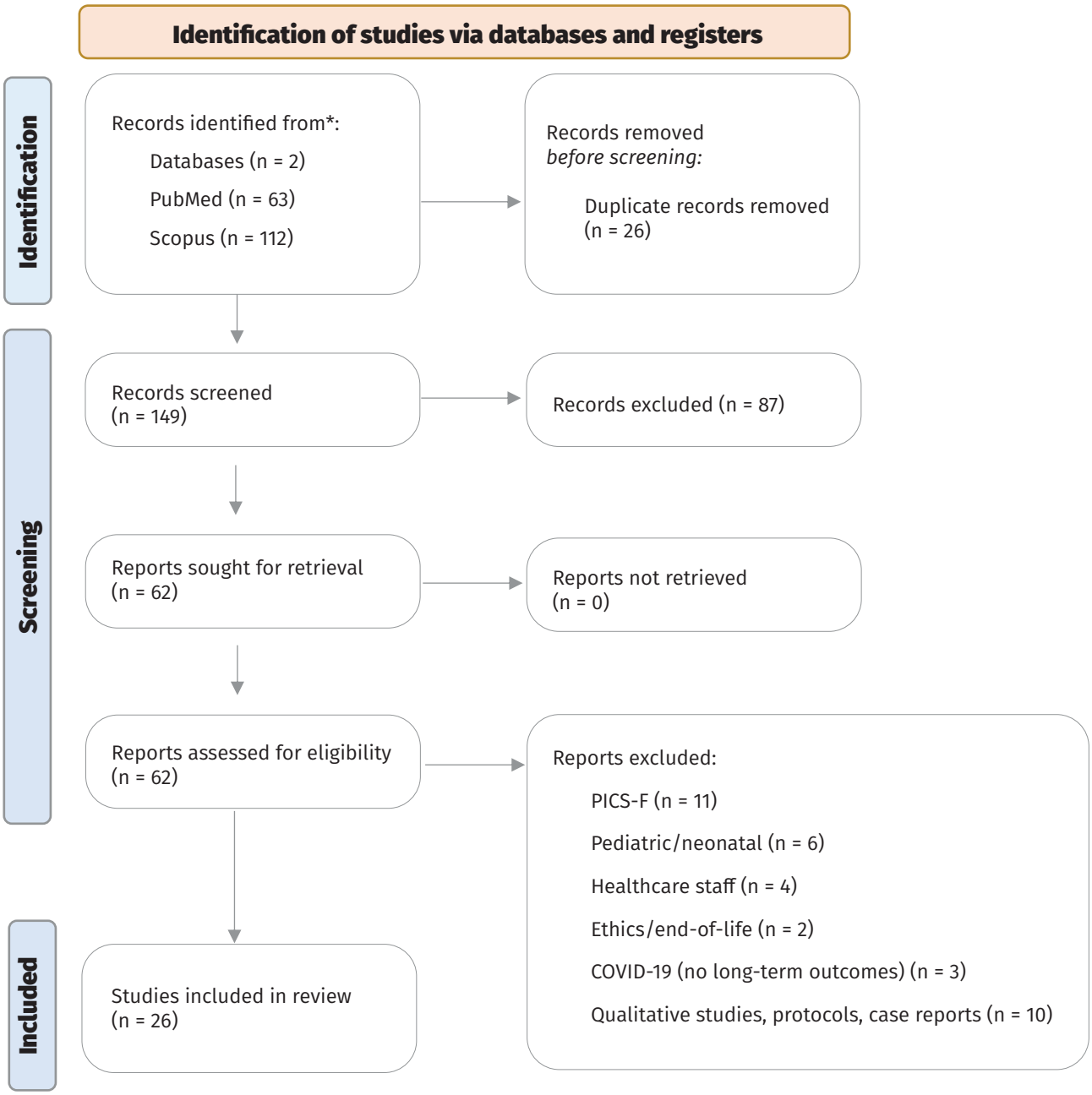

Figure 1. PRISMA 2020 flow diagram of the study selection process

Source: Adapted from PRISMA 2020, authors' modification.

The review of titles and abstracts and the assessment of full-text articles were conducted by the authors according to predefined inclusion and exclusion criteria. In cases of uncertainty, the criteria were rechecked through consultation of the full-text. Data extraction from the included studies was performed by the authors using a predefined data extraction table, and all key outcomes, measurement instruments, and basic study characteristics were double-checked to reduce the risk of error.

Data from the included studies were systematically extracted by the authors according to a predefined data extraction protocol. The accuracy and reliability of the collected information were ensured through repeated verification of all relevant variables, including population characteristics, study design, psychometric instruments used, and key outcomes.

The quality of the included studies was assessed according to criteria of methodological rigor, including study design, sample adequacy, clarity of reporting,

and relevance of outcomes to the objectives of this review. The results were synthesized narratively and presented in tabular form, without conducting a meta-analysis due to heterogeneity in study designs, populations, and measurement instruments.

The reliability of the collected data was further supported by repeated verification of all key variables by the authors, contributing to a high level of internal consistency and methodological robustness of the results.

RESULTS

A systematic literature search identified a total of 175 records (PubMed n = 63, Scopus n = 112). After removal of duplicates (n = 26), 149 articles were included in the screening phase. Based on the review of titles and abstracts, 87 articles were excluded due to insufficient relevance to the topic. Sixty-two articles were retained for full-text assessment, and after analysis of the full-text articles, an additional 36 studies were excluded for methodological reasons. A total of 26 scientific studies were included in the final synthesis and constitute the corpus of this systematic review.

The included studies were published between 2021 and 2026 and involved adult patients after an ICU stay. Most studies were conducted in Europe (Spain, the Netherlands, Italy, Germany, Greece, France, Belgium, and Cyprus), while the remaining studies were carried out in Asia (China, Japan, Iran, and Tunisia), the United States, Brazil, Israel, and South Africa.

According to the study design, the review included 10 cross-sectional studies, 9 prospective cohort studies, 5 cohort studies, 1 multicenter study, and 1 observational study. The total sample of the included studies comprised several thousand patients who had been treated in the ICU for various critical conditions, including acute respiratory distress syndrome, sepsis, COVID-19, surgical procedures, liver transplantation, and prolonged mechanical ventilation.

Table 2 presents the key characteristics of the included studies, including objectives, population, study design, and main findings. All analyzed studies reported a high frequency of post-traumatic stress disorder among ICU survivors, with the prevalence of PTSD ranging from 13% to 60%, depending on the population, follow-up duration, and diagnostic instruments used.

Table 2. Characteristics of the included studies on post-traumatic stress disorder after intensive care unit stay

Authors	Year	Study design	Aim	Country	Population and sample	Key findings
Dell'Oste et al. [4]	2025	Cohort study	Long-term psychiatric and physical outcomes in ICU survivors with PTSD	Italy	ICU survivors	PTSD was associated with long-term psychiatric and physical impairment
Kooken et al. [12]	2025	Multicenter longitudinal cohort study	Role of ICU memories	Netherlands	ICU survivors	Delirium and ICU memories were associated with post-traumatic stress symptoms
Askari Hosseini et al. [13]	2021	Cross-sectional study	ICU memories and post-traumatic stress disorder	Iran	ICU survivors	Delusional memories were associated with increased PTSD symptoms

Authors	Year	Study design	Aim	Country	Population and sample	Key findings
Patel et al. [14]	2026	Observational study	Memories of ICU stay	United States	ICU survivors	Hallucinations and delusional memories were associated with psychological distress
Castillejos et al. [15]	2023	Cross-sectional study	Effect of deep sedation on psychological outcomes	Spain	ICU survivors	Deep sedation was associated with higher PTSD frequency
Pan et al. [16]	2023	Cross-sectional study	Association between analgesic use and PTSD	China	ICU survivors	An association between analgesic use and PTSD symptoms was reported
Yoshino et al. [17]	2024	Prospective study	Role of social support in psychological outcomes	Japan	ICU survivors	Higher social support was associated with fewer postdischarge mental health symptoms
Frankort et al. [18]	2024	Cohort study	Quality of life after thoracoabdominal aortic surgery	Netherlands	Surgical ICU patients	Quality of life impairment was observed in patients after ICU stay, including those with PTSD symptoms
Szymczak et al. [19]	2023	Prospective study	Long-term psychological outcomes three years after ARDS	Germany	ICU patients with ARDS	Persistent psychological disorders were observed
Godoy-González et al. [20]	2023	Cohort study	Relationship between cognitive function and PTSD	Spain	ICU patients treated for COVID-19	PTSD symptoms were associated with impaired cognitive functioning
Van der Merwe et al. [21]	2024	Prospective study	Psychological outcomes after 6 weeks and 6 months	South Africa	ICU survivors	Psychological symptoms were present in a substantial proportion of patients
Navarra-Ventura et al. [22]	2024	Longitudinal study	Persistence of depression and PTSD symptoms	Spain	ICU patients treated for COVID-19	Persistent depression and PTSD symptoms were observed
Miori et al. [23]	2023	Cohort study	Incidence of PTSD after COVID-19 ARDS	Italy	ICU patients with ARDS	PTSD symptoms persisted after ICU discharge

Authors	Year	Study design	Aim	Country	Population and sample	Key findings
Neville et al. [24]	2022	Cohort study	Long-term psychological outcomes after severe COVID-19	United States	ICU survivors	Suspected PTSD was present in 20 percent of patients
Sun et al. [25]	2024	Cross-sectional study	Factors influencing stress disorders after liver transplantation	China	Liver transplant patients treated in the ICU	PTSD symptoms were identified after liver transplantation
Saida et al. [26)	2025	Prospective observational study	PTSD, anxiety, and depression in ICU survivors	Tunisia	ICU survivors	PTSD symptoms were present after ICU discharge
Zarour et al. [27]	2024	Cross-sectional study	PTSD within post-ICU syndrome	Israel	ICU survivors	PTSD symptoms were identified among ICU survivors
Gauchery et al. [28]	2024	Cohort study	Impact of medical evacuation on psychological stress	France	ICU patients with COVID-19-related ARDS	Medical evacuation was associated with psychological distress
Calsavara et al. [29]	2021	Prospective study	PTSD after sepsis	Brazil	ICU patients with sepsis	PTSD, anxiety, and depression symptoms were reported after ICU discharge
Gil et al. [30]	2022	Prospective study	PTSD in patients with COVID-19 and ARDS	Spain	ICU patients with ARDS	Persistent PTSD symptoms were reported after ICU discharge
Demoule et al. [31]	2022	Prospective cohort study	Clinical impact of dyspnea in mechanically ventilated ICU patients	France	Mechanically ventilated ICU patients	Dyspnea was associated with poorer psychological outcomes in mechanically ventilated ICU patients
Watanabe et al. [32]	2022	Multicenter prospective cohort study	Effect of early mobilization on psychological outcomes	Japan	ICU patients	Early mobilization was associated with improved psychological outcomes after ICU stay
Janssen et al. [33]	2026	Prospective study	Relationship between dyspnea and clinical outcomes	Netherlands	Tracheostomized ICU patients	Dyspnea was associated with psychological burden in tracheostomized ICU patients

Authors	Year	Study design	Aim	Country	Population and sample	Key findings
Li et al. [34]	2021	Cross-sectional study	Functional outcomes after mechanical ventilation	China	Mechanically ventilated ICU patients	PTSD was present in 17.7 percent of patients
Li et al. [35]	2025	Cross-sectional study	PTSD in mechanically ventilated patients	China	Mechanically ventilated ICU patients	PTSD symptoms were present in mechanically ventilated ICU survivors
Wang et al. [36]	2024	Predictive modeling study	Mental disorders within post-ICU syndrome	China	ICU patients	A predictive model for PTSD risk assessment was developed

The factors most frequently associated with post-traumatic stress disorder symptoms included delirium during the intensive care unit stay [12], hallucinations and delusional memories [13, 14], deep sedation [15], prolonged mechanical ventilation, dyspnea, the use of analgesics [16], while lower levels of social support were associated with poorer post-intensive care psychological outcomes [17]. Several studies confirmed that psychological symptoms were often associated with reduced quality of life [18, 19], impaired cognitive function [20], depression and anxiety [21–23], and difficulties in returning to everyday activities [19, 24]. Additional studies conducted among ICU survivors after sepsis, liver transplantation, and COVID-19-related ARDS also reported clinically relevant frequencies of post-traumatic stress disorder symptoms and persistent psychological burden after intensive care [25–29].

It was particularly emphasized that interventions such as early mobilization (26, 30], together with timely psychological screening, risk assessment, and consideration of demographic, psychosocial, and medical factors associated with post-intensive care psychological morbidity [18, 27, 28], may support early identification of patients at increased risk of post-traumatic stress disorder. Studies that followed patients over longer periods showed that in a substantial proportion of participants, symptoms persisted for more than one year after discharge from the intensive care unit [19, 22, 23], confirming the long-term nature of the psychological consequences of critical illness.

The included studies were assessed descriptively according to methodological characteristics such as study design, sample adequacy, clarity of reporting, and relevance of outcomes to the objectives of this review. Cross-sectional studies were potentially subject to information and selection bias, whereas prospective cohort studies provided more methodologically robust data on the development and course of post-traumatic stress disorder. All key outcomes were clearly defined, and the data were synthesized narratively and presented in tabular form due to heterogeneity in study designs and measurement instruments.

The analyzed studies consistently confirm that post-traumatic stress disorder is a frequent and clinically significant consequence of intensive care unit stay, with long-term effects on mental health, quality of life, and functional recovery. The findings indicate the need for systematic psychological follow-up of intensive care unit survivors, early identification of high-risk patients, and integration of psychological care into standard intensive care protocols.

DISCUSSION

Prevalence of post-traumatic stress disorder after intensive care unit stay and heterogeneity of findings

The findings of this systematic review confirm that post-traumatic stress disorder is a frequent and clinically significant consequence of intensive care unit stay. The included studies reported a prevalence of post-traumatic stress disorder ranging from approximately 13% to 60%, with differences arising from heterogeneity in study populations, variation in the timing of assessment after discharge, and the use of different instruments for symptom evaluation.

In studies conducted among patients after acute respiratory distress syndrome and COVID-19, the frequency of symptoms was often higher at longer follow-up, with persistence of symptoms in a proportion of patients even after one year [19, 22, 23, 31]. This indicates that post-traumatic stress disorder is not merely a transient reaction to acute stress but a disorder that may persist throughout the recovery period and lead to long-term functional consequences.

Delirium, hallucinations, and ICU memories as key psychological mechanisms of risk

One of the most consistent findings across the included studies relates to the importance of patients' experiences during the intensive care unit stay, particularly delirium, hallucinations, and delusional memories. Delirium during intensive care treatment has been associated with subsequent traumatic symptoms [12], while hallucinations and delusional memories have been consistently associated with a higher risk of developing post-traumatic stress disorder [13, 14].

These findings suggest that the quality and content of memories related to intensive care treatment may be associated with later psychological outcomes. In this context, systematic recognition of delirium, timely documentation of changes in mental status, and reduction of factors associated with delirium may contribute to improved long-term psychological outcomes after discharge from the intensive care unit.

Respiratory burden, dyspnea, and mechanical ventilation as clinical risk factors

Several studies have emphasized that respiratory burden during intensive care unit stay represents a strong risk context for the development of post-traumatic stress disorder. Dyspnea represents an important and distressing symptom in mechanically ventilated and weaning patients and may contribute to psychological burden during and after intensive care treatment [32, 33].

Studies conducted in populations of mechanically ventilated patients reported measurable frequencies of post-traumatic stress disorder symptoms and highlighted the importance of continued psychological follow-up after discharge from the intensive care unit [34, 35]. These findings suggest that respiratory distress and the subjective experience of breathing difficulty may be relevant contributors to psychological morbidity in ICU survivors, although the available evidence does not establish a direct causal relationship with post-traumatic stress disorder.

Sedation, analgesia, and medications associated with an increased risk of post-traumatic stress disorder symptoms

Among clinical factors, patterns of sedation and analgesia also play an important role. Deep sedation has been associated with a higher frequency of post-traumatic stress disorder in a study that analyzed survivors of critical illness, suggesting the need for caution when determining the depth of sedation and for careful monitoring of its consequences [15].

Additionally, analgesic use in one cross-sectional study was associated with post-traumatic stress disorder symptoms [16]. Although these findings do not allow causal conclusions, they consistently indicate that therapeutic interventions that alter consciousness, perception, and memory may influence later psychological outcomes, particularly in interaction with delirium and hallucinations.

Social support, psychological screening, and organization of care after discharge from the intensive care unit

In addition to risk factors, the analyzed studies also identify protective factors and organizational elements of care. Higher levels of social support were associated with a lower risk of developing post-traumatic stress disorder, confirming the importance of systematic patient support in the post-intensive care period [17].

Furthermore, the development of a predictive model for risk assessment within post-intensive care syndrome indicates the need for standardized screening, especially in patients with a greater burden of risk factors [36]. In practice, this means that follow-up after discharge from the intensive care unit should include a structured assessment of psychological outcomes, with clear criteria for referral and continuation of care.

In this context, nurses play a key role in the early recognition of psychological distress, continuous monitoring of patients' behavior and emotional responses, and timely referral of patients at increased risk of post-traumatic stress disorder, both during intensive care treatment and in the post-intensive care follow-up period, which contributes to improved long-term outcomes.

Interventions that may reduce the frequency and severity of post-traumatic stress disorder symptoms

Among interventions with potentially beneficial effects, early mobilization during intensive care unit stay has been highlighted, as it was associated with a reduction in post-traumatic stress disorder symptoms in a multicenter study. In this context, such interventions are directed not only at physical recovery but also at reducing the psychological burden associated with critical illness, indicating that psychological prevention represents an integral component of comprehensive intensive care.

Long-term consequences, quality of life, and cognitive outcomes

The results of this review confirm that post-traumatic stress disorder in the post-intensive care period is often not an isolated condition, but is associated with broader consequences, including reduced quality of life, depressive and anxiety symptoms, and difficulties in everyday functioning [4, 19, 20, 22–25]. In one cohort study, post-traumatic stress disorder was associated with a decline in cognitive functioning, further emphasizing the need for long-term follow-up and rehabilitation approaches that also address cognitive domains [20]. These findings indicate that psychological outcomes after intensive care unit stay are multidimensional and require an integrated approach that extends beyond short-term post-hospital follow-up.

Limitations of the evidence and limitations of this review

A substantial proportion of cross-sectional and cohort studies was included, which allows insight into associations but limits causal inference. Cross-sectional studies may be subject to selection and information bias, while prospective cohort studies provide more robust data on the development and course of post-traumatic stress disorder symptoms over time. Furthermore, heterogeneity in populations, clinical conditions, and measurement instruments justified a narrative synthesis and tabular presentation without meta-analysis.

This review was conducted by a limited number of authors, which may increase the risk of subjectivity in study selection and interpretation. However, inclusion criteria were defined in advance, and data were repeatedly verified to ensure consistency and accuracy. The search included full-text articles, which may have limited the scope of the literature and potentially introduced selection bias. However, most recent clinical studies in this field are available in open access or through institutional repositories, and the likelihood of a substantial impact on the main findings was therefore considered low.

CONCLUSION

This systematic review demonstrates that post-traumatic stress disorder is a frequent and clinically relevant consequence of prolonged hospitalization and intensive care unit stay, with prevalence in recent studies varying widely depending on the population, duration of follow-up, and assessment instruments used. The findings of the included studies suggest that delirium, hallucinations, and delusional memories, deep sedation, prolonged mechanical ventilation, and dyspnea may be associated with post-traumatic stress disorder symptoms after intensive care, while lower levels of social support were associated with poorer psychological outcomes after intensive care. Post-traumatic stress disorder frequently co-occurs with depression and anxiety and is associated with reduced quality of life, cognitive difficulties, and impaired functional recovery.

The results indicate that outcomes may be improved through the introduction of structured psychological screening and follow-up after discharge, early mobilization, and interventions aimed at reducing traumatic memories and delirium. These results indicate the need to integrate psychological care into standard intensive care and post-intensive rehabilitation protocols, with particular emphasis on early identification of high-risk patients and continuous multidisciplinary support.

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Declaration of Conflicting Interest:

The authors declares no conflict of interest.

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