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Original scientific paper

Patient Satisfaction with Preoperative and Postoperative Health Care Treated at the Surgery Clinic of "Sveti Duh" Clinical Hospital

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Keywords: patient; surgery; preoperative preparation; postoperative care; satisfaction

Abstract

Introduction. Good preoperative preparation as one of the most important predictors of overall patient satisfaction increases cooperation and their desire to continue treatment.

Aim. The aim of the research was to examine the respondents' satisfaction with the pre-operative preparation and post-operative health care of patients treated at the Surgery Clinic of the "Sveti Duh" Clinical Hospital in Zagreb, Croatia.

Methods. The measuring instrument of this research was an anonymous questionnaire created for the purposes of the research itself. The survey included 60 respondents with an average age of 51.

Results. The results of the conducted research showed that the majority of respondents were satisfied with the healthcare provided, with 53 (88.3%) responding that they were satisfied, and 54 (90%) of the respondents answered that they could confidently to contact the health workers of the clinic, who showed concern and understanding for their problem. An important factor in postoperative satisfaction was postoperative pain. After the procedure, the median pain (on a scale of 0 to 5) was 4, and immediately after the subjects started to feel pain and asked the nurse/technician for analgesic, 35 (58%) patients received it. A total of 44 (73%) patients expressed satisfaction with the speed of the nurses' intervention after they reported feeling pain.

Conclusion. A survey conducted at the Surgery Clinic of the "Sveti Duh" Clinical Hospital showed that the

largest number of respondents, a total of 53 (88.3%) were satisfied with the healthcare provided during hospitalization. It was observed that women were more satisfied than men, and that respondents aged 46 to 60 reported significantly higher levels of satisfaction compared to those aged up to 45.

It is important to ensure that patients are well prepared for the transition phases in surgical care, to identify the most effective resources in increasing the feeling of readiness (conversation with the doctor, nurse, family support, etc.). Greater exposure to information before and after surgery enables patients to feel more prepared for the transitions of health care phases (12 – 14).

Introduction

Patient's readiness for surgery is one of the factors on which the postoperative outcome largely depends and it is necessary that when entering the operating room, i.e., just before the operation, the patient is optimally physically and emotionally prepared. Readiness is achieved through preoperative preparation, that is, through a series of procedures during the preoperative period (1, 2). Preoperative care includes preoperative interventions aimed at reducing later complications, providing procedural information to the patient and their family, interventions aimed at promoting patient cooperation in the post-procedure process, and interventions aimed at reducing psychological stress before surgery (3, 4).

Preoperative preparation of the patient for surgery begins after the doctor's indication for the surgery. It is divided into three periods: preoperative, intraoperative, and postoperative phase. Each phase of preoperative health care includes activities from the scope of work of health professionals, and the importance of preparation is to ensure the patient's readiness for surgery. The preoperative phase includes mental and physical preparation of the patient and ends with the patient's arrival in the operating room. The intraoperative phase begins with the patient's arrival in the operating theater and ends at the end of the operation. The postoperative phase begins with the patient's arrival at the ward and lasts until the patient is discharged from the hospital (5 – 7).

The importance of health care at each stage is that the patient receives important information, understands the treatment plan and is well prepared for each upcoming step (8). Numerous studies have shown that ineffective preparation endangers the patient, contributes to dissatisfaction and increases the risk of readmission to the hospital (9 – 11).

Aim

The aim of the research was to examine the respondents' satisfaction with the pre-operative preparation and post-operative health care of patients treated at the Surgery Clinic of the "Sveti Duh" Clinical Hospital in Zagreb, Croatia.

Methods

Structure of the study

A cross-sectional scientific study was conducted.

Respondents

The survey included 60 respondents with an average age of 51. In this research, the appropriate sample was a group of patients hospitalized at the Department of Surgery of the "Sveti Duh" Clinical Hospital after elective or emergency surgery under general anaesthesia. The approval of the Ethics Committee of the "Sveti Duh" Clinical Hospital was obtained for the implementation of the research (Class: 01-03-1014/10). The research was conducted between April and June 2022. The criteria for the inclusion of subjects in this research were the following: the participants were patients undergoing surgery under general anaesthesia older than 18 and they had been admitted to the hospital via emergency or regular hospital admission. The criteria excluded vitally endangered patients or patients with poor general health status.

Instrument

The study was conducted through a written survey consisting of a total of 29 questions. Of these, five questions pertained to the general characteristics of the respondents, 12 questions focused on preoperative preparation and postoperative care, while the remaining 12 statements assessed satisfaction with preoperative preparation and postoperative care following surgical procedures performed under spinal or general anaesthesia.

Respondent anonymity was ensured by the following measures: no personal data were collected (the survey did not request personal information such as name, surname, address, or any other details that could identify the respondents); the collected data were coded and processed in a manner that prevented linking responses to specific individuals; all participants provided informed consent by signing a consent form, which explicitly stated that the study was anonymous; data were securely stored (protected against unauthorized access and used exclusively for scientific research purposes); and the results were analyzed and presented solely at the group level, without the possibility of isolating individual responses or identifying participants. The required time to fill out the questionnaire was 15 minutes.

Statistics

The statistical methods utilized in the research included absolute and relative frequencies. The normality of the distribution of numerical variables was assessed using the Shapiro-Wilk test. Given the normal distribution of the data, the results were described using the mean and standard deviation. Comparisons between two independent groups were conducted using the t-test, while differences among three or more groups were analyzed using ANOVA, with post hoc comparisons performed using the Student-Newman-Keuls test. All P-values were two-sided, and statistical significance was set at α=0.05. Data analysis was performed using MedCalc® Statistical Software version 23.1.1 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2025).

Results

Table 1. **Basic characteristics and characteristics related to hospitalization and surgery**

Gender	**n (%)**
Male	36 (60)
Female	24 (40)
Age (years) [Mdn (IQR)]	51 (39 - 65)
Age group	
18 - 45 years	22 (37)
46 - 60 years	24 (40)
60+ years	14 (23)
Vocational training	
Lower vocational education	3 (5)
High school education	35 (58)
College education	12 (20)
Higher vocational education	10 (17)
Admission to hospital	
Through emergency admission	22 (37)
Planned arrival	38 (63)
Department where they were hospitalized	
Trauma ward	23 (38)
Vascular or plastic surgery	8 (13)
Abdominal surgery	29 (49)
Surgery performed on the day it was planned	
Yes No	50 (84) 8 (13)
It was an emergency operation	2 (3)
If the procedure was not performed on the day it was planned, who informed the patients that they would not be operated on	
Doctor	8 (13)
Someone else	2 (3)
They were operated on the day it was planned	50 (83)
They would recommend treatment in surgical departments to others [n (%)]	
Yes No	55 (92) 0 (0)
I do not know	5 (8)

The research was conducted on 60 patients, of whom 36 (60%) were men and 24 (40%) were women. The median age of the respondents was 51, ranging from 18 to 60 years. When it comes to the level of education, the largest share had secondary vocational education (58%). A total of 63% of patients had a planned visit to the hospital. Most of them were being treated at the department of abdominal surgery (49%). The surgery was not performed on the day it was planned for 10 (16%) patients, and in most cases, they were informed about that by the physician. A total of 92% of respondents would recommend treatment at the surgical departments of "Sveti Duh" Clinical Hospital (Table 1).

The behavior of the nurses/technicians at the department was stated by 72% of the patients as extremely kind, ranging from correct to extremely kind. For the most part, patients or their families had no problems with getting information about health care. A total of 53% of the patients were extremely satisfied with the health care provided by the nurse/technician. After the procedure, the median pain (on a scale of 0 to 5) was 4, and immediately after they had started to feel pain and asked the nurse/technician for an analgesic, 35 (58%) patients received it. A total of 44 patients expressed satisfaction with the speed of the nurses' intervention after they had reported pain (Table 2).

The self-assessment of patient satisfaction with health care is shown in Table 3. A total of 53 (88.3%) participants were satisfied with the health care provided, the largest number of participants 54 (90%) answered that they could confidently turn to the clinic's health workers who showed concern and understanding for their problem.

Women rated significantly higher than men the following aspects of healthcare satisfaction: confidence in turning to the clinic's healthcare workers (p=0.01), the concern and understanding shown by nurses/medical technicians for their health problems (p=0.01), the education provided by nurses/medical technicians regarding post-hospital discharge lifestyle (p=0.02), the verbal instructions given by nurses/medical technicians for each intervention (p=0.005), the explanation of the importance of preoperative preparation (p=0.001), overall satisfaction with the healthcare provided (p=0.009), satisfaction with postoperative pain management (p=0.005), and satisfaction with the encouragement provided by healthcare staff to achieve independence after surgery (p=0.002) (Table 4).

Table 2. **Patients' opinions/remarks/answers on preoperative preparation and postoperative pain management by nurses/technicians**

	n (%)
If personal hygiene was carried out by a nurse/technician, how satisfied patients were they with the health care provided?	
Extremely satisfied	32 (53)
Satisfied	13 (22)
Partially satisfied	1 (2)
They take care of personal hygiene themselves	14 (23)
Assessment of pain on a scale from 0 (no pain) to 5 (the strongest possible pain) [Median (IQR)]	4 (3 – 5)
The behavior of the nurses/technicians at the ward was:	
Correct	6 (10)
Kind	11 (18)
Extremely kind	43 (72)
Have they or their family had problems getting information about health care?	
They haven't, they've received all the information they were interested in	55 (92)
Partially	5 (8)
Did they ask the nurse/technician for an analgesic immediately after they started feeling pain?	
Yes	35 (58)
No	15 (25)
I do not know	1 (2)
They endured pain until they couldn't tolerate it anymore	2 (3)
They felt no pain	7 (12)
Are they satisfied with the timeliness of response to their problem?	
Yes, the nurse applied an analgesic immediately after the patient had reported pain	44 (73)
Yes, the nurse administered the analgesic after some time, after the patient had said that there are no issues with pain	1 (2)
They had no problem with pain	15 (25)

Table 3. **Self-assessment of patient satisfaction with health care**

	Number (%) of patients					
	I completely disagree	I disagree	I neither agree nor disagree	I agree	I completely agree	Mean (SD)
The information I received during my stay at the Clinic was clear.	0	1 (1.7)	2 (3.3)	15 (25)	42 (70)	4.60 (0.6)
I received more information about my illness at the Clinic.	1 (1.7)	2 (3.3)	7 (11.7)	20 (33.3)	30 (50)	4.27 (0.9)
I was able to turn to the Clinic's health workers with confidence.	0	0	0	6 (10)	54(90)	4.90 (0.3)
The nurse/medical technician showed concern and understanding for my health problem.	0	0	0	6 (10)	54 (90)	4.90 (0.3)
The nurse/medical technician educated me about the lifestyle after dismissal from hospital.	0	1 (1.7)	8 (13.3)	14 (23.3)	37 (61.7)	4.45 (0.8)
The nurse/medical technician gave me verbal instructions for each intervention.	0	0	2 (3.3)	10 (16.7)	48 (80)	4.77 (0.5)
The nurse/medical technician explained to me the importance of preparing for surgery intervention.	0	0	6 (10)	14 (23.3)	40 (66.7)	4.57 (0.7)
My privacy was ensured.	1 (1.7)	1 (1.7)	7 (11.7)	7 (11.7)	44 (73.2)	4.50 (0.9)
The environment in which I stayed was safe.	0	1 (1.7)	2 (3.3)	10 (16.7)	47 (78.3)	4.70 (0.6)
I am satisfied with the health care provided.	0	0	1 (1.7)	6 (10)	53 (88.3)	4.90 (0.4)
I am satisfied with the postoperative pain relief.	0	0	1 (1.7)	7 (11.7)	52 (86.6)	4.9 (0.4)
I am satisfied with the encouragement of the health care staff to become independent after surgery.	0	0	3 (5)	10 (16.7)	47 (78.3)	4.7 (0.55)

SD – standard deviation

The study examined the patients' self-assessment of satisfaction with healthcare services in relation to their age. The results indicate that respondents aged 46 – 60 years reported significantly higher satisfaction levels compared to those aged up to 45 years. Specifically, older patients expressed greater agreement with statements regarding the healthcare staff's including the perception that the nurse/medical technician showed concern and understanding for their health problem (p=0.04) and explained the importance of preparing for surgical intervention (p=0.008). Additionally, the respondents in the 46 – 60 age group reported a significantly greater sense of privacy being ensured (p=0.01) and perceived the environment in which they stayed as safe compared to respondents younger than 45 years. No significant differences were found in satisfaction levels across other assessed aspects of healthcare services in relation to the patients' age. These findings suggest that age-related factors may be associated with the patients' perceptions of the quality and adequacy of care received (Table 5).

There is no significant difference in satisfaction with healthcare in relation to the level of education (Table 6).

Table 4. **Self-assessment of patients' satisfaction with health care in relation to gender**

	Mean (standard deviation)		*t*	*p**
	Men	**Women**		
The information I received during my stay at the Clinic was clear.	4.6 (0.73)	4.8 (0.44)	-1.28	0.21
I received more information about my illness at the Clinic.	4.17 (0.91)	4.4 (0.93)	-1.03	0.31
I was able to turn to the Clinic's health workers with confidence.	4.83 (0.38)	5 (0)	-2.65	**0.01**
The nurse/medical technician showed concern and understanding for my health problem.	4.83 (0.38)	5 (0)	-2.65	**0.01**
The nurse/medical technician educated me about the lifestyle after dismissal from hospital.	4.28 (0.88)	4.7 (0.55)	-2.33	**0.02**
The nurse/medical technician gave me verbal instructions for each intervention.	4.64 (0.59)	5 (0.2)	-2.98	0.005
The nurse/medical technician explained to me the importance of preparing for surgery intervention.	4.36 (0.76)	4.9 (0.34)	-3.56	**0.001**
My privacy was ensured.	4.4 (1.03)	4.7 (0.64)	-1.03	0.31
The environment in which I stayed was safe.	4.7 (0.57)	4.7 (0.69)	0.09	0.93
I am satisfied with the health care provided.	4.8 (0.48)	5 (0)	-2.75	0.009
I am satisfied with the postoperative pain relief.	4.8 (0.5)	5 (0)	-3.0	**0.005**
I am satisfied with the encouragement of the health care staff to become independent after surgery.	4.6 (0.65)	5 (0.2)	-3.23	**0.002**

*T-test; Bold denotes statistical significance

Discussion

A study conducted at the Surgery Clinic of the "Sveti Duh" Clinical Hospital showed that 53 (88.3%) participants were satisfied with the healthcare provided, and the largest number of participants, 54 (90%) of them, responded that they could safely turn to healthcare professionals who showed care and understanding for their problem. There is a statistically significant difference in the satisfaction of respondents with preoperative preparation depending on the age and gender of the respondents. It was observed that women were significantly more satisfied than men, and considering the differences by age groups, the respondents up to 45 years of age were significantly less satisfied compared to those aged 46 to 60. There were no significant differences in overall satisfaction with health care according to other characteristics of the respondents. In Saudi Arabia, a study was conducted on the topic of satisfaction after surgical procedures, and female respondents expressed greater satisfaction in similar questions compared to male respondents (15). During the postoperative care of the patients at the "Sveti Duh" Surgery Clinic, in addition to all interventions, special attention was paid to the problem of pain, which was tried to be reduced to a minimum level and could affect the overall satisfaction/dissatisfaction in the postoperative period. The research conducted at "Sveti Duh" Clinical Hospital showed that the median pain (on a scale of 0 to 5) was 4, and pain was reported by 35 (58%) respondents immediately after they started feeling it. A total of 44 (73%) respondents stated that the nurse applied an analgesic immediately after they had reported the pain, while

Table 5. **Patients' self-assessment of satisfaction with healthcare in relation to the age**

	Mean (SD) Age			*p**
	≤ 45	**46 - 60**	**> 60**	
The information I received during my stay at the Clinic was clear.	4.59 (0.8)	4.71 (0.6)	4.57 (0.5)	0.60
I received more information about my illness at the Clinic.	3.95 (1.1)	4.54 (0.7)	4.29 (0.7)	0.12
I was able to turn to the Clinic's health workers with confidence.	4.91 (0.3)	4.88 (0.3)	4.93 (0.3)	0.86
The nurse/medical technician showed concern and understanding for my health problem.	4.77 (0.4)	4.96 (0.2)	5 (0)	**0.04**†
The nurse/medical technician educated me about the lifestyle after dismissal from hospital.	4.32 (0.8)	4.54 (0.8)	4.5 (0.8)	0.43
The nurse/medical technician gave me verbal instructions for each intervention.	4.64 (0.5)	4.83 (0.6)	4.86 (0.4)	0.08
The nurse/medical technician explained to me the importance of preparing for surgery intervention.	4.27 (0.7)	4.79 (0.6)	4.64 (0.6)	**0.008**†
My privacy was ensured.	4.14 (1.1)	4.75 (0.7)	4.79 (0.6)	**0.01**†
The environment in which I stayed was safe.	4.45 (0.9)	4.96 (0.2)	4.71 (0.5)	**0.02**†
I am satisfied with the health care provided.	4.73 (0.5)	4.92 (0.4)	5 (0)	0.09
I am satisfied with the postoperative pain relief.	4.68 (0.6)	4.96 (0.2)	4.93 (0.3)	0.06
I am satisfied with the encouragement of the health care staff to become independent after surgery.	4.55 (0.7)	4.79 (0.5)	4.93 (0.3)	0.09

*ANOVA (***Post hoc test*** Student-Newman-Keuls); Bold denotes statistical significance
†a statistically significant difference ($p<0.05$) was observed between (≤ 45) vs (46 – 60)

15 (25%) of them stated that they had no problem with feeling pain. In a study conducted in the Netherlands, postoperative pain was reported by 69.4% of patients. Some studies report that psychological preparation techniques reduce post-procedure pain, improve recovery (individuals return to daily activities faster), and reduce the length of hospital stay as well as negative emotions (e.g. feelings of anxiety or depression) (16). The research carried out at the "Sveti Duh" Clinical Hospital Surgery Clinic shows that many respondents (90%) answered that they could always turn to health professionals with confidence, who would show concern and understanding for their problem. The respondents were almost always satisfied with the health care provided (88.3%). Communication and interpersonal aspects of health care are often ranked as very important. They include: friendliness, competence, access, communication and availability of doctors and nurses (17). In a study conducted in Ethiopia on the topic of patient satisfaction with preoperative preparation, 20.1% of respondents were completely satisfied with the information provided about treatment options and the occurrence of postoperative pain. In that research, it was concluded that providing information before and after the procedure is crucial for patient satisfaction (18, 19). The patient's overall satisfaction is an important measure of the outcome of the treatment previously associated with the patient's general health condition and numerous physical and psychosocial predictors (20, 21). Considering the relatively small sample in the research conducted in Zagreb, it opens up possibilities for further research that would include a larger number of respondents.

Table 6. **Patients' self-assessment of satisfaction with healthcare in relation to their level of education**

	Mean (standard deviation)				
	Lower vocational education	High school education	College education	Higher vocational education	*p**
The information I received during my stay at the Clinic was clear.	4.33 (0.6)	4.57 (0.7)	4.83 (0.4)	4.7 (0.7)	0.53
I received more information about my illness at the Clinic.	3.67 (1.5)	4.2 (0.9)	4.5 (0.9)	4.4 (0.7)	0.49
I was able to turn to the Clinic's health workers with confidence.	5 (0)	4.94 (0.2)	4.83 (0.4)	4.8 (0.4)	0.45
The nurse/medical technician showed concern and understanding for my health problem.	5 (0)	4.91 (0.3)	4.83 (0.4)	4.9 (0.3)	0.81
The nurse/medical technician educated me about the lifestyle after dismissal from hospital.	3.67 (1.2)	4.37 (0.8)	4.5 (0.9)	4.9 (0.3)	0.08
The nurse/medical technician gave me verbal instructions for each intervention.	4.67 (0.6)	4.83 (0.4)	4.75 (0.6)	4.6 (0.7)	0.63
The nurse/medical technician explained to me the importance of preparing for surgery intervention.	4 (1)	4.51 (0.7)	4.67 (0.7)	4.8 (0.4)	0.29
My privacy was ensured.	4 (1.7)	4.54 (0.9)	4.42 (0.9)	4.8 (0.4)	0.55
The environment in which I stayed was safe.	5 (0)	4.66 (0.7)	4.75 (0.5)	4.8 (0.4)	0.77
I am satisfied with the health care provided.	5 (0)	4.89 (0.3)	4.75 (0.6)	4.9 (0.3)	0.67
I am satisfied with the postoperative pain relief.	4.33 (1.2)	4.91 (0.3)	4.92 (0.3)	4.7 (0.5)	0.06
I am satisfied with the encouragement of the health care staff to become independent after surgery.	4.33 (1.2)	4.71 (0.6)	4.92 (0.3)	4.7 (0.5)	0.40

SD – standard deviation; *ANOVA

Conclusion

A study conducted at the Surgery Clinic of the "Sveti Duh" Clinical Hospital showed that the largest number of respondents, a total of 53 (88.3%), were satisfied with the health care provided during hospitalization. There is a statistically significant difference in the satisfaction of respondents with preoperative preparation depending on their age and gender. It was observed that women are significantly more satisfied than men, and considering the differences by age group, the respondents up to 45 years of age are significantly less satisfied compared to those aged 46 to 60. An important factor in postoperative satisfaction was postoperative pain. A total of 44 (73%) patients expressed satisfaction with the timeliness of the nurses' intervention after they had reported pain.

The conducted study did not prove that the professional qualifications of the respondents and the type of admission to the hospital affect satisfaction with preoperative preparation. The factors that led to a small share of dissatisfied respondents in the survey are younger age and poorer understanding of the information received.

Author contributions

Conceptualization (ŠK, VK, JP, FL, MK, MH, MB); Data Curation (ŠK, VK, JP, FL, MK, MH, MB); Formal Analysis (ŠK, VK, JP, FL, MK, MH, MB); Investigation (ŠK, VK, JP, FL, MK, MH, MB); Methodology (ŠK, VK, JP, FL, MK, MH, MB); Project Administration (ŠK, VK, JP, FL, MK, MH, MB); Resources (ŠK, VK, JP, FL, MK, MH, MB); Supervision (ŠK, VK, JP, FL, MK, MH, MB); Validation: (ŠK, VK, JP, FL, MK, MH, MB); Visualization (ŠK, VK, JP, FL, MK, MH, MB); Writing – Original Draft (ŠK, VK, JP, FL, MK, MH, MB); Writing – Review & Editing (ŠK, VK, JP,

FL, MK, MH, MB). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. Walburn J, Vedhara K, Hankins M, Rixon L, Weinman J. Psychological stress and wound healing in humans: A systematic review and meta-analysis. J Psychosom Res. 2009;67(3):253-71. https://doi.org/10.1016/j.jpsychores.2009.04.002
2. Auer C, Glombiewski J, Doering B, Winkler A, Laferton J, Broadbent E, et al. Patients' Expectations Predict Surgery Outcomes: A Meta-Analysis. Int J Behav Med. 2015;23(1):49-62. https://doi.org/10.1007/s12529-015-9500-4
3. Peters M, Sommer M, Kleef M, Marcus M. Predictors of physical and emotional recovery 6 and 12 months after surgery. Br J Surg. 2010;97(10):1518-27. https://doi.org/10.1002/bjs.7152
4. Mavros M, Athanasiou S, Gkegkes I, Polyzos K, Peppas G, Falagas M. Do Psychological Variables Affect Early Surgical Recovery? PLoS ONE. 2011;6(5):e20306. https://doi.org/10.1371/journal.pone.0020306
5. Lee K, Chao Y, Yiin J, Hsieh H, Dai W, Chao Y. Evidence That Music Listening Reduces Preoperative Patients' Anxiety. Biol Res Nurs. 2012;14(1):78-84. https://doi.org/10.1177/1099800410396704
6. Hole J, Hirsch M, Ball E, Meads C. Music as an aid for postoperative recovery in adults: a systematic review and meta-analysis. The Lancet. 2015;386(10004):1659-71. https://doi.org/10.1016/S0140-6736(15)60169-6
7. Coleman EA, Berenson RA. Lost in transition: challenges and opportunities for improving the quality of transitional care. Ann Intern Med. 2004;141(7):533-6. https://doi.org/10.7326/0003-4819-141-7-200410050-00009
8. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. The incidence and severity of adverse events affecting patients after discharge from the hospital. Ann Intern Med. 2003;138(3):161–7. https://doi.org/10.7326/0003-4819-138-3-200302040-00007
9. Kripalani S, Jackson AT, Schnipper JL, Coleman EA. Promoting effective transitions of care at hospital discharge: a review of key issues for hospitalists. J Hosp Med. 2007;2(5):314–23. https://doi.org/10.1002/jhm.228
10. Uppal NK, Eisen D, Weissberger J, Wyman RJ, Urbach DR, Bell CM. Transfer of care of postsurgical patients from hospital to the community setting: cross-sectional survey of primary care physicians. Am J Surg. 2015;210(4):778-82. https://doi.org/10.1016/j.amjsurg.2015.03.006
11. QuestionPro, What is a Likert Scale – Definition, example, characteristics, & advantages [Internet]. Available at: https://www.questionpro.com/blog/what-is-likert-scale/. Accessed: 18.07.2022.
12. Petz B. Basic statistical methods for non-mathematicians. 6th ed. Jastrebarsko: Naklada Slap; 1997.

13. Ivanković D. Basics of statistical analysis for medical professionals. Zagreb: Faculty of Medicine, University of Zagreb; 1988.
14. Mehari AY, Elsholz T, Gebreyohannes G, Eyasu HT. Patient satisfaction with peri-operative anesthesia care and associated factors at two National Referral Hospitals: a cross-sectional study in Eritrea. BMC Health Serv Res. 2019;19(1):669. https://doi.org/10.1186/s12913-019-4499-x
15. Gebreegziabher EG, Girmay Fitiwi L. Patient satisfaction with the perioperative surgical services and associated factors at a University Referral and Teaching Hospital, a cross-sectional study. Pan Afr Med J. 2017;2:176. https://doi.org/10.11604/pamj.2017.27.176.10671
16. Powell R, Scott NW, Manyande A, Bruce J, Vögele C, Byrne-Davis LMT, et al. Psychological preparation and postoperative outcomes for adults undergoing surgery under general anesthesia. Cochrane Database of Systematic Reviews. 2016;2016(5):CD008646. https://doi.org/10.1002/14651858.CD008646.pub2
17. Caljouw MAA, Beuzekom M, Boer F. Patient's satisfaction with perioperative care: development, validation, and application of a questionnaire. Br J Anaesth. 2008;100(5):637-44. https://doi.org/10.1093/bja/aen034
18. Dina NB, Walid HN, Nauman AA. Patient satisfaction in anesthesia: A modified Iowa Satisfaction in Anesthesia Scale. Anesth Essays Res. 2010;4(2):85-90. https://doi.org/10.4103/0259-1162.73513
19. Martin LA, Finlayson SRG, Brooke BS. patient preparation for transitions of surgical care: is failing to prepare surgical patients preparing them to fail? World J Surg. 2017;41(6):1447-53. https://doi.org/10.1007/s00268-017-3884-z
20. Kiebzak GM, Vain PA, Gregory AM, Mokris JG, Mauerhan DR. SF-36 general health status survey to determine patient satisfaction at short-term follow-up after total hip and knee arthroplasty. J South Orthop Assoc. 1997;6(3):169-72.
21. TL Powers, D. Bendall. The influence of time on changes in health status and patient satisfaction. Health Care Manage Rev. 2004;29(3):240-8. https://doi.org/10.1097/00004010-200407000-00009

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Original scientific paper

Vaccination coverage and its association with COVID-19 morbidity and mortality in Primorje-Gorski Kotar County: a retrospective study

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Abstract

Introduction. The COVID-19 pandemic remains a global challenge despite extensive vaccination efforts. Although vaccination coverage has increased, coverage varies by population group, affecting hospitalization and mortality rates. Understanding the distribution of immunization coverage and its association with severe disease outcomes is essential for public health planning.

Aim. To analyze the association between COVID-19 vaccination status, hospitalizations and mortality among adult residents of Primorje-Gorski Kotar County admitted to the Rijeka Clinical Hospital Center. Specific objectives included assessing the distribution of vaccinations by gender and age, the proportion of vaccinated persons among hospitalized patients and the proportion of vaccinated persons among those who died from COVID-19 between December 27, 2020 and March 27, 2022.

Methods. This retrospective study included 6,025 adult patients admitted with a confirmed COVID-19 diagnosis (ICD-10 code U07.1: COVID-19, virus identified). The data were obtained from the Integrated Hospital System of the Clinical Hospital Center Rijeka and the Croatian Institute of Public Health.

Results. Among hospitalized patients, men accounted for 57.8% of cases. Vaccination coverage was higher in persons aged ≥65 years than in younger patients. Unvaccinated patients were hospitalized more frequently (50.19%) than vaccinated patients (44.9%). Mortality was significantly higher in unvac-

cinated patients (1.36%) than in vaccinated patients (0.2%). The statistical analysis confirmed a significant correlation between vaccination status, hospitalization and mortality.

Conclusion. The results suggest that vaccination coverage was higher in individuals aged ≥65 years, while hospitalization and mortality rates were higher in unvaccinated patients. A statistically significant association was found between vaccination status and severe COVID-19 outcomes; however, causality cannot be established. Public health efforts should focus on maintaining high vaccination coverage, counteracting vaccination fatigue and ensuring access to booster vaccinations, especially for high-risk groups.

Introduction

On January 30, 2020, the World Health Organization (WHO) declared the outbreak of COVID-19 an international health emergency. Just weeks later, on March 11, 2020, it was officially classified as a global pandemic. COVID-19, which stands for coronavirus disease 2019, is caused by the novel virus SARS-CoV-2 (1). Due to its high transmissibility and the lack of prior immunity in the population, the virus spread rapidly worldwide.

Those at highest risk of severe COVID-19 disease requiring hospitalization or intensive care include older adults, men and people with pre-existing conditions such as obesity, hypertension or diabetes (2). Croatia took early public health measures to bring the outbreak under control; the first confirmed case was reported on February 25, 2020. The nationwide vaccination campaign started at the end of December 2020, and by March 2022, over 60% of the Croatian population was fully vaccinated, with similar vaccination trends in Primorje-Gorski Kotar County (3, 4).

The first COVID-19 vaccine administered outside of a clinical trial was given on December 8, 2020. To ensure global vaccine equity, initiatives such as COVID-19 Vaccine Global Access (COVAX) and the WHO have set targets for distributing vaccines to low- and middle-income countries (5, 6). Despite these efforts, vaccine distribution remains uneven and vaccine hesitancy continues to pose a significant global challenge (7).

While COVID-19 vaccination has been associated with a decrease in severe disease and mortality, vaccination coverage varies by demographic and socioeconomic group, influencing morbidity and mortality trends (8-11). Regional differences in immunization coverage and their impact on severe disease remain critical for public health planning and resource allocation.

Aim

The aim of this study was to analyze vaccination coverage in Primorje-Gorski Kotar County and its association with COVID-19 morbidity and mortality. In particular, the study examined the distribution of vaccinations by gender and age, the proportion of vaccinated persons among admitted patients and the proportion of vaccinated persons among patients who died of COVID-19 at the Clinical Hospital Center Rijeka. Understanding these patterns provides valuable insights into how vaccination status relates to hospitalization and mortality, thus contributing to public health strategies aimed at improving vaccination coverage and reducing the burden of COVID-19, especially in high-risk groups.

Methods

Participants and characteristics of the sample

This retrospective study included all adult residents of Primorje-Gorski Kotar County who were admitted to the Clinical Hospital Center Rijeka between December 27, 2020 and March 27, 2022 with the diagnosis 'U07.1 COVID-19, virus identified' The total

sample included 6,025 participants, representing the entire population of COVID-19 patients admitted to the hospital during the study period.

Data collection

Data were collected from the integrated hospital information system of the Clinical Hospital Center Rijeka via the centralized emergency department. Information retrieved included patient demographics, COVID-19 test results, place of residence, hospitalization details and disease outcome (cure or death). Additional vaccination data were obtained from publicly available records from the Croatian Institute of Public Health, covering the same period as the hospital data.

Patients were categorized as unvaccinated or vaccinated based on their vaccination status, regardless of the number of vaccine doses received.

Ethics

This study complied with the ethical principles of biomedical research as laid down in the Declaration of Helsinki. The Ethics Committee of the Clinical Hospital Center Rijeka granted ethical approval on June 27, 2022 (Class: 003-05/22-1/58; No.: 2170-29-02/1-22-2). The Ethics Committee ensures compliance with medical ethics and deontology and approves the scientific research conducted at the Clinical Hospital Center Rijeka. All data were anonymized to protect the confidentiality of the participants and did not contain any personal identifiers (e.g. names, dates of birth or addresses).

Statistics

Descriptive and inferential statistical methods were used to analyze the data. The descriptive statistics included absolute and relative frequencies for categorical variables as well as mean and standard deviation for continuous variables.

For inferential analysis, chi-square tests (χ^2 test) were used to assess associations between categorical variables, including gender, age, vaccination status, hospitalization, and mortality. Independent-samples t-tests were performed to compare age differences between groups (e.g., vaccinated vs. not vaccinated, recovered vs. deceased).

All statistical analyzes were performed using SPSS software (version 20.0; SPSS Inc., Chicago, IL, USA). Statistical significance was set at $p<0.05$.

Results

A total of 6,025 participants from Primorje-Gorski Kotar County who were admitted to hospital between December 27, 2020 and March 27, 2022 with the diagnosis 'U07.1 COVID-19, virus identified' were included in the study. The majority of patients were men, and a chi-square test confirmed that their proportion was statistically significantly higher than that of women (χ^2= 146.34, df=1, $p<0.0001$). Additionally, the average age of female patients was significantly higher than that of male patients (t=-12.74, $p<0.001$) (Table 1). The largest proportion of participants belonged to the 65-74 age group (28.6%), followed by the 75-84 age group (25.8%). Overall, more than two thirds (68.3%) of the patients admitted were aged 65 or older.

Table 1. **Descriptive statistics on gender**

Gender	Frequency	Percentage (%)	Mean age	Standard Deviation (Age)
Male	3,482	57.8	68.00	14.07
Female	2,543	42.2	71.85	14.89
Total	**6,025**	**100.0**	**69.62**	**14.55**

Hospitalization status

Of the total number of participants, the majority required hospitalization, while a smaller group was discharged for home treatment as their condition did not require hospitalization. A t-test confirmed a statistically significant age difference between these groups, with the hospitalized patients having a higher mean age (t=2.14, p=0.032) (Table 2).

Table 2. **Hospitalization statistics**

Hospitalization Status	Frequency	Percentage (%)	Mean age	Standard Deviation (Age)
Hospitalized	5,729	95.1	69.69	14.55
Not Hospitalized	296	4.9	68.23	14.31
Total	**6,025**	**100.0**	**69.62**	**14.55**

Results of the treatment

The mean age of the deceased patients (82.03 years, SD=7.75) was significantly higher than that of the recovered patients (69.42 years, SD=14.54), a difference that was confirmed by a t-test (t=7.89, $p<0.001$) (Table 3).

Table 3. **Treatment outcomes**

Treatment Outcome	Frequency	Percentage (%)	Mean Age	Standard Deviation (Age)
Fatal	94	1.6	82.03	7.75
Recovered	5,931	98.4	69.42	14.54
Total	**6,025**	**100.0**	**69.62**	**14.55**

Vaccination status

A larger proportion of admitted patients were unvaccinated (53.5%) compared to vaccinated persons (46.5%). A chi-square test confirmed that unvaccinated individuals were significantly more likely to be hospitalized (χ^2=3441.83, df=1, $p<0.0001$) (Table 4). A t-test confirmed that vaccinated individuals were significantly older than unvaccinated individuals (t=4.55, $p<0.001$), further supporting the trend that vaccination rates increase with age, although the age difference between the two groups was very small.

Table 4. **Vaccination status**

Vaccination Status	Frequency	Percentage (%)	Mean Age	Standard Deviation (Age)
Vaccinated	2,799	46.5	69.99	13.28
Unvaccinated	3,226	53.5	69.30	15.55
Total	**6,025**	**100.0**	**69.62**	**14.55**

Vaccination by gender

A statistically significant difference in vaccination rates between men and women was found (χ^2=13.940, df=1, $p<0.05$). More men than women were vaccinated, both in absolute numbers and as a proportion of their gender group (48.4% of men vs. 43.7% of women) (Table 5).

Table 5. **Vaccination by gender**

Gender	Vaccinated (n, %)	Unvaccinated (n, %)	Total (n, %)
Male	1,687 (60.3%)	1,795 (55.6%)	3,482 (57.8%)
Female	1,112 (39.7%)	1,431 (44.4%)	2,543 (42.2%)
Total	**2,799 (100%)**	**3,226 (100%)**	**6,025 (100%)**

Vaccination and fatal outcomes

A statistically significant association was found between vaccination status and fatal outcomes (χ^2=43.573, df=1, $p<0.05$). Among hospitalizations, unvaccinated patients had a significantly higher mortality rate (1.36%) than vaccinated patients (0.24%), indicating a lower risk of fatal outcomes in vaccinated individuals (Table 6).

Table 6. **Fatal outcomes and vaccination**

Vaccination Status	Fatal Outcome (n, %)	Survived (n, %)	Total (n, %)
Vaccinated	3 (0.24%)	1,254 (99.76%)	1,257 (100%)
Unvaccinated	22 (1.36%)	1,597 (98.64%)	1,619 (100%)
Total	**25 (100%)**	**2,851 (100%)**	**5,729 (100%)**

Discussion

Our study included 6,025 hospitalized COVID-19 patients from Primorje-Gorski Kotar County, 57.8% of whom were men. This is in line with previous research indicating that men are disproportionately affected by severe COVID-19 cases worldwide (12, 13). Biological and immunological factors may contribute to this difference, including a weaker initial immune response and higher levels of angiotensin-converting enzyme 2 (ACE2) receptors in men, which facilitate viral entry into cells (14, 15). Studies from China and Europe have come to similar conclusions, emphasizing the role of gender-specific immunological differences in disease severity (16, 17).

The mean age of hospitalized patients was 69.62 years, and 68.25% were ≥65 years old, confirming the known association between older age and severe COVID-19 disease. Similar trends have been observed worldwide, where older populations consistently have higher hospitalization and mortality rates compared to younger populations (16-19). This pattern is largely attributed to the age-related decline of the immune system (immunosenescence), multimorbidity and reduced physiological resilience (17, 18).

In our study, hospitalization rates were higher in unvaccinated individuals (55.1%) than in vaccinated individuals (44.9%), supporting the growing body of evidence that vaccination significantly reduces the risk of severe disease. This finding is consistent with studies from Germany and the UK, which consistently report lower hospitalization rates in vaccinated individuals (20-22). The effect of vaccination on reducing the hospital burden has been widely documented, with studies highlighting that in countries with high vaccination rates, the number of hospital admissions during COVID-19 waves was lower (21, 22).

In addition, the mortality rate was significantly lower in vaccinated patients (0.2%) than in unvaccinated patients (1.36%), underlining the protective role of COVID-19 vaccines against severe outcomes. Studies from North America and Europe consistently show that COVID-19-related deaths occur predominantly in unvaccinated individuals (20-22). In Pennsylvania, for example, 97% of COVID-19-related deaths were reported in unvaccinated or partially vaccinated individuals, underscoring the critical importance of vaccination in reducing mortality (23). In Croatia, the introduction of vaccines led to a drastic decrease in the national COVID-19 mortality rate from 1.79% before vaccination to 0.01% during the study period (24), reflecting similar trends observed worldwide.

In terms of gender-specific vaccination patterns, the absolute number of vaccinated men was higher than that of vaccinated women. This result is consistent with several international studies that have found lower vaccination rates among women (25-27). Various factors may contribute to this difference, including cultural and occupational influences, access to healthcare and differences in risk perception. However, other studies suggest the opposite trend, with women in certain contexts showing higher health awareness and willingness to be vaccinated (25–27), suggesting that gender differences in vaccination rates are context-dependent and may vary by region and population.

In addition, vaccination rates were significantly higher in people aged ≥65 years than in younger age groups, which is consistent with global trends (28-31). This pattern is likely influenced by early strategies to prioritize vaccines for older adults as well as higher perceived risk in older populations (29-31). Studies from Canada and Australia have shown that older adults are more likely to adhere to public health measures and immunization campaigns, contributing to higher vaccination rates in this group (28-31).

Our results confirm that unvaccinated individuals were disproportionately represented among COVID-19-related deaths during hospitalization. Similar results have been observed in several studies showing that mortality rates remain significantly higher in unvaccinated populations (20-22). European and North American data support the critical role of COVID-19 vaccination in preventing deaths, particularly in high-risk groups (20-22).

Study limitations

This study provides important insights into the association between vaccination status and severe COVID-19 disease in a specific population. By analyzing admitted patients in a specific region, we were able to assess real trends in hospitalizations and mortality in vaccinated and unvaccinated individuals.

However, several limitations should be noted. First, since this is a retrospective observational study, no causal relationships cannot be established. The observed differences in hospitalizations and mortality may have been influenced by unmeasured confounders, such as pre-existing conditions, socioeconomic status, unequal access to healthcare, and behavioral factors.

Second, this study did not account for differences in vaccine types, dosing regimens, or booster doses that may have influenced the immunity levels of vaccinated individuals. In addition, data on previous SARS-CoV-2 infections were missing, meaning that some unvaccinated individuals may have had natural immunity, potentially affecting hospitalization and mortality rates.

Finally, our results refer only to the patients admitted to the hospital and cannot be generalized to the entire population of Primorje-Gorski Kotar County or Croatia. Future research should include longitudinal studies and multivariable models to better understand the long-term effects of vaccination and the impact of booster vaccinations. Further research on comorbidities, socioeconomic variables and access to healthcare would provide a more comprehensive understanding of factors contributing to hospitalization and mortality risk.

Conclusion

This study examined the association between COVID-19 vaccination status and hospitalization and mortality rates in patients admitted to the Rijeka Clinical Hospital Center. The results indicate that unvaccinated individuals were significantly more likely to experience hospitalization and death due to COVID-19 compared to vaccinated individuals. Furthermore, vaccination rates were significantly higher in people aged ≥65 years, in contrast to younger age groups. Additionally, a statistically significant gender difference in vaccination coverage was found.

While these results confirm that vaccination is associated with lower hospitalization and mortality rates, further research is needed to investigate additional factors that influence the incidence of severe disease, such as comorbidities, vaccine type and the effect of booster doses.

Public health strategies should continue to monitor vaccination trends, combat vaccine hesitancy and ensure equitable distribution of vaccines, particularly for high-risk groups. Future studies should focus on longitudinal analyzes to assess the durability and efficacy of vaccines, especially against emerging SARS-CoV-2 variants.

Author contributions

Conceptualization (KI, KV); Data Curation (KV, SV); Formal Analysis (KV, SV); Writing – Original Draft (KI, KV, SV); Writing – Review & Editing (KI, KV, SV). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. World Health Organization. Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV) [Internet]. 2020. Available at: https://www.who.int/news-room/detail/30-01-2020-statement-on-the-second-meeting-of-the-internationa
2. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020;395(10223):507–13. https://doi.org/10.1016/S0140-6736(20)30211-7
3. Ministarstvo zdravstva Republike Hrvatske. Odluka o proglašenju epidemije bolesti COVID-19 uzrokovana virusom SARS-CoV-2 [Internet]. 2020. Available at: https://www.iusinfo.hr/Appendix/DDOKU_HR/DDHR20201106N133_16_1.pdf
4. Hrvatski zavod za javno zdravstvo. Izvješće o cijepljenju [Internet]. 2022. Available at: https://www.koronavirus.hr/uploads/Izvjestaj_o_cijepljenju_2703_docx_921d95b8d9.pdf
5. Watson OJ, Barnsley G, Toor J, Hogan AB, Winskill P, Ghani AC. Global impact of the first year of COVID-19 vaccination: a mathematical modelling study. Lancet Infect Dis. 2022;22(9):1293-302. https://doi.org/10.1016/S1473-3099(22)00320-6
6. Gavi. COVAX explained [Internet]. Gavi, the Vaccine Alliance: 2021. Available at: https://www.gavi.org/vaccineswork/covax-explained
7. MacDonald NE, Eskola J, Liang X, Chaudhuri M, Dube E, Gellin B, et al. Vaccine hesitancy: Definition, scope and determinants. Vaccine. 2015;33(34):4161–4. https://doi.org/10.1016/j.vaccine.2015.04.036
8. Biasio LR. Vaccine literacy is undervalued. Hum Vaccin Immunother. 2019;15(11):2552-3. https://doi.org/10.1080/21645515.2019.1609850
9. Stringhini S, Wisniak A, Piumatti G, Azman AS, Lauer SA, Baysson H, et al. Seroprevalence of anti-SARS-CoV-2 IgG antibodies in Geneva, Switzerland (SEROCoV-POP): a population-based study. Lancet. 2020;396(10247):313-9. https://doi.org/10.1016/S0140-6736(20)31304-0
10. Gusar I, Konjevoda S, Babić G, Hnatešen D, Čebohin M, Orlandini R, et al. Pre-vaccination COVID-19 vaccine literacy in a Croatian adult population: A cross-sectional study. Int J Environ Res Public Health. 2021;18(13):7073. https://doi.org/10.3390/ijerph18137073
11. Jia Z, Gong W. Will Mutations in the Spike Protein of SARS-CoV-2 Lead to the Failure of COVID-19 Vaccines? J Korean Med Sci. 2021;36(18):e124. https://doi.org/10.3346/jkms.2021.36.e124
12. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med. 2020;382(18):1708–20. https://doi.org/10.1056/NEJMoa2002032
13. Bhatraju PK, Ghassemieh BJ, Nichols M, Kim R, Jerome KR, Nalla AK, et al. Covid-19 in Critically Ill Patients in the Seattle Region — Case Series. N Engl J Med. 2020;382(21):2012–22. https://doi.org/10.1056/NEJMoa2004500
14. Scully EP, Haverfield J, Ursin RL, Tannenbaum C, Klein SL. Considering how biological sex impacts immune responses and COVID-19 outcomes. Nat Rev Immunol. 2020;20(7):442–7. https://doi.org/10.1038/s41577-020-0348-8
15. Klein SL, Dhakal S, Ursin RL, Deshpande S, Sandberg K, Mauvais-Jarvis F. Biological sex impacts COVID-19 outcomes. PLoS Pathog. 2020;16(6):e1008570. https://doi.org/10.1371/journal.ppat.1008570
16. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497–506. https://doi.org/10.1016/S0140-6736(20)30183-5
17. Wu Z, McGoogan JM. Characteristics of and Important Lessons from the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72314 Cases from the Chinese Center for Disease Control and Prevention. JAMA. 2020;323(13):1239–42. https://doi.org/10.1001/jama.2020.2648
18. Barber RM, Sorensen RJD, Pigott DM, Bisignano C, Carter A, Amlag JO, et al. Estimating global, regional, and national daily and cumulative infections with SARS-CoV-2 through Nov 14, 2021: a statistical analysis. Lancet. 2022;399(10344):2351–80. https://doi.org/10.1016/S0140-6736(22)00484-6
19. Williamson EJ, Walker AJ, Bhaskaran K, Bacon S, Bates C, Morton CE, et al. Factors associated with COVID-19-related death using OpenSAFELY. Nature. 2020;584(7821):430–6. https://doi.org/10.1038/s41586-020-2521-4
20. Dagan N, Barda N, Kepten E, Miron O, Perchik S, Katz MA, et al. BNT162b2 mRNA Covid-19 Vaccine in a Nationwide Mass Vaccination Setting. N Engl J Med. 2021;384(15):1412–23. https://doi.org/10.1056/NEJMoa2101765
21. Ioannou GN, Locke E, Green P, Berry K, O'Hare AM, Shah JA, et al. Risk Factors for Hospitalization, Mechanical Ventilation, or Death among 10131 US Veterans with SARS-CoV-2 Infection. JAMA Netw Open. 2020;3(9):e2022310. https://doi.org/10.1001/jamanetworkopen.2020.22310
22. Bar-On YM, Goldberg Y, Mandel M, Bodenheimer O, Freedman L, Alroy-Preis S, et al. Protection against Covid-19 by BNT162b2 Booster across Age Groups. N Engl J Med. 2021;385(26):2421–30. https://doi.org/10.1056/NEJMoa2115926
23. O'Neill M. Vaccines Work: 97% of COVID Deaths, 95% of Hospitalizations and 94% of Cases are Among Un-

vaccinated Pennsylvanians [Internet]. Pennsylvania Pressroom; 2021 Available at: https://www.media.pa.gov/pages/health-details.aspx?newsid=1595

24. Ritchie H, Mathieu E, Rodés-Guirao L, Appel C, Giattino C, Ortiz-Ospina E, et al. Coronavirus Pandemic Data [Internet]. Our World in Data; 2020. Available at: https://ourworldindata.org/coronavirus
25. Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, et al. A global survey of potential acceptance of a COVID-19 vaccine. Nat Med. 2021;27(2):225-8. https://doi.org/10.1038/s41591-020-1124-9
26. Huebener M, Wagner GG. Unterschiede in Covid-19-Impfquoten und in den Gründen einer Nichtimpfung nach Geschlecht, Alter, Bildung und Einkommen. Berlin: Deutsches Institut für Wirtschaftsforschung (DIW); 2021. German.
27. Gesundheitsministerium Österreich. Impfdashboard - Corona-Schutzimpfung in Österreich [Internet]. 2022. Available at: https://info.gesundheitsministerium.at/
28. Lazarus JV, Wyka K, Rauh L, Rabin K, Ratzan S, Gostin LO, et al. Hesitant or Not? The Association of Age, Gender, and Education with Potential Acceptance of a COVID-19 Vaccine: A Country-level Analysis. J Health Commun. 2020;25(10):799-807. https://doi.org/10.1080/10810730.2020.1868630
29. Gallè F, Sabella EA, Roma P, Da Molin G, Diella G, Montagna MT, et al. Acceptance of covid-19 vaccination in the elderly: A cross-sectional study in Southern Italy. Vaccines. 2021;9(11):1222. https://doi.org/10.3390/vaccines9111222
30. Fadda M, Suggs LS, Albanese E. Willingness to vaccinate against Covid-19: A qualitative study involving older adults from Southern Switzerland. Vaccine X. 2021;8:100108. https://doi.org/10.1016/j.jvacx.2021.100108
31. Nikolovski J, Koldijk M, Weverling GJ, Spertus J, Turakhia M, Saxon L, et al. Factors indicating intention to vaccinate with a COVID-19 vaccine among older U.S. adults. PLoS One. 2021;16(5):e0251963. https://doi.org/10.1371/journal.pone.0251963

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Original scientific paper

Lifestyle Habits and Obesity Risk Among Adolescent Medical Students: Screening and Prevention Challenges

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Abstract

Introduction. Obesity is a significant public health issue and a prevalent preventable nutritional disorder. It can result from hereditary factors, prenatal conditions, environmental influences, metabolism, and lifestyle choices. This condition leads to an accumulation of adipose tissue and increased body mass.

Aim. This study aimed to identify participants' lifestyle habits, determine their nutritional status, and assess potential predictors of obesity.

Methods. The cross-sectional study included 354 students from the Sarajevo High School of Medicine, of whom 236 (approximately 70%) were female. Participants were aged 14 to 18 years, with a mean age of 16.32 ± 1.74 years. The study involved collecting anthropometric data from physical education class records and administering a structured questionnaire (socio-demographic characteristics and assessment of life habits) designed for this study.

Results. It was found that approximately one quarter of the subjects were overweight/obese. Unhealthy eating habits were prevalent, with around 50% of respondents consuming fruits and vegetables every day, 80% consuming sugar-sweetened beverages, snacks and fast food. The Pearson correlation test and linear regression determined that inappropriate eating habits, lack of physical activity and pronounced sedentary habits significantly affect the occurrence of excessive body mass/obesity in the subjects.

Conclusion. Research shows many adolescents have unhealthy habits and obesity, which pose serious health risks. Early screening and prevention are crucial to reduce these risks and promote long-term health.

Introduction

Adolescence is the period between childhood and adulthood characterized by significant physical, cognitive, hormonal, emotional, and social development. It typically spans ages 10 to 19; however, Kingorn A. et al. (1) categorize adolescence into early (10–14 years), middle (15–19 years), and late adolescence (20–24 years), highlighting that this phase is subject to various epidemiological, social, and environmental influences distinct from those of childhood and adulthood. Early adolescence is considered one of the healthiest life stages but also a critical time when risky behaviors (e.g., smoking, alcohol and substance abuse, unprotected sexual activity) are often adopted and can persist into adulthood, impacting long-term health (2). Adolescence is a period marked by a higher prevalence of obesity, with estimates suggesting approximately 80% of obese adolescents will remain so into adulthood (3). Obesity constitutes a major public health challenge, ranking as the fifth leading cause of death globally and the principal cause of chronic noncommunicable diseases in adulthood (4). According to the World Health Organization (WHO), around 39 million children under five were overweight or obese in 2020, and over 18% of children and adolescents aged 5–19 were overweight or obese in 2016 (5). Between 1975 and 2016, the prevalence of overweight or obesity in the 5–19 age group increased approximately 4.5 times. In the United States, obesity rates have more than doubled in children and tripled in adolescents over the past three decades, with 2015-2016 data indicating an obesity prevalence of around 18% in children aged 6–11 and approximately 20% in adolescents aged 12–19 (6). Obesity is a multifactorial condition resulting from the interplay of genetic factors, prenatal influences, metabolism, environmental conditions, socioeconomic status, and other variables. Prolonged energy imbalance leads to excess energy storage in the body, culminating in obesity (7, 8). Lifestyle changes over the past four decades, particularly unhealthy dietary patterns characterized by excessive consumption of processed foods, fast food, sweets, snacks, and insufficient intake of fruits, vegetables, legumes, whole grains, nuts, and seafood, have significantly contributed to the rising prevalence of obesity among children and adolescents worldwide. Other contributing factors include skipping meals (notably breakfast), consuming large portions of unhealthy food outside the family home, limited family meals, high sugary drink consumption, inadequate physical activity, and prolonged sedentary behavior (8-11). Obesity is a chronic non-communicable disease that negatively impacts almost every organ system, necessitating early detection to prevent or mitigate associated conditions. Common comorbidities in adolescents with obesity include high blood pressure, dyslipidemia, asthma, obstructive sleep apnea, metabolic syndrome, type 2 diabetes, polycystic ovary syndrome, non-alcoholic fatty liver disease, pseudotumor cerebri, musculoskeletal disorders, social isolation, low self-esteem, anxiety, eating disorders, and adolescent depression (7-11). Obesity is linked to accelerated coronary atherosclerosis in adolescents and young adults, leading to premature cardiovascular disease (12). Adolescents with obesity exhibit carotid intima-media thickening and arterial stiffness, signifying early vascular damage (13). The notable prevalence of obesity, its persistence from adolescence to adulthood, and its association with comorbidities underscore the importance of obesity screening, balanced nutrition, regular physical activity, and reduced sedentary behavior. In treating obesity in adolescents (12–17 years), lifestyle modifications should be complemented by medical interventions, such as Liraglutide, a glucagon-like peptide (GLP)-1 analog, and bariatric surgery in appropriate cases (14).

Obesity among adolescents is a global concern. The inclusion of various age groups, sample sizes, measurement accuracy, and criteria for assessing nutritional status (WHO 2007 criteria, CDC 2000 criteria, and Cole International Obesity Task Force criteria) all influence obesity distribution. Many countries utilize national reference values to determine obesity; in the absence of such values, WHO Growth reference data for ages 5–19 were employed.

Aim

This study aimed to identify participants' lifestyle habits, determine their nutritional status, and assess potential predictors of obesity.

Methods

Respondents

A cross-sectional study involved 354 students from the Sarajevo Medical High School, Bosnia and Herzegovina, aged 14-18 years, conducted from February 12 to June 10, 2019. The students attended high school from the first to the fourth year. First-grade students were under 15 years old, second-grade students were mostly 15 and 16 years old, third-grade students were 16 and 17 years old, while fourth-year students were 17 and 18 years old. Only healthy students were included in the study. The school's management approved the research (approval number: 02-1-120/19, dated January 29, 2019). Participants provided informed consent in accordance with the ethical principles of the Helsinki Declaration and its 2002 and 2004 amendments.

Instruments

The study involved administering a questionnaire and collecting anthropometric data. A structured questionnaire with 19 questions gathered demographic details, information on acute/chronic illnesses, and lifestyle habits. The dietary habits section was based on "Quantitative models of foods and meals" by Senta A. et al. (15). Body weight and height were obtained from physical education class records.

Classification of variables

The questionnaire evaluated lifestyle habits, including meal frequency, regular breakfast consumption, food intake, physical activity, and sedentary behaviors. Adolescents were instructed on how to complete a questionnaire concerning the distribution of lifestyle habits. Multiple responses were offered, classified as follows: Regular dietary habits included five meals a day, daily breakfast, and daily consumption of fruits, vegetables, low-fat dairy, and whole grains. The frequency of food intake was measured on an ordinal scale with the following categories: Never, Rarely, Once per week, 2 to 3 times per week, and Every day. Limited consumption of fast food, sweets, snacks, and sugar-sweetened beverages was also considered. Adequate physical activity was defined as exercising for an hour or more, five times a week or more. Sedentary behavior included watching TV, using computers, or playing video games for over two hours, five or more times a week. Body mass index (BMI) is used to assess nutritional status by dividing body weight in kilograms by height in meters squared (kg/m^2). Participants' BMI values were compared with WHO 2007 Growth reference standards for ages 5-19. According to WHO criteria, participants were classified as thin (BMI < +1SD and > -2SD) or overweight (> +2SD) (16).

Statistics

The data obtained from the research were analyzed using IBM SPSS v27.1 (SPSS Inc, Chicago, IL, USA), version 27.0. The data were presented in the form of frequencies and relative representation within the sample (%). Analysis between the examined groups was performed using the Chi-square test. The normality of distribution for linear variables, including age and body mass index (BMI), was assessed using the Kolmogorov-Smirnov test. BMI exhibited a non-parametric distribution. Dietary habits, specifically the frequency of consumption of certain foods and the number of daily meals, were evaluated using an ordinal scale. Frequency was measured on a five-level ordinal scale, ranging from "never" to "every day." Based on WHO recommendations, the presence of healthy eating habits was assessed. Breakfast skipping was examined using a binary response format (Yes/No). Participants provided information regarding their physical activity over the past seven days, as well as sedentary behaviors (e.g., watching television, playing video games). These responses were subsequently classified as either present or absent. Number of meals had a range from 1 to 5 or more meals. The association of BMI values with dietary habits, number of meals, and regular consumption of certain foods was tested using Spearman's correlation. The accepted level of significance was set at $p<0.05$.

Results

The final analysis included 354 adolescents aged 14–18 years (average age 16.32±1.74 years), Out of the total sample, 236 (66.7%) were female respondents, while 118 (33.3%) were male respondents. Average age of male respondents was 16.05±1.88 years, and average age of female respondents was 16.52±1.32 years, with female respondents beeing significantly older (t=2.800; p=0.005). The distribution of students by gender did not show a statistically significant difference from the first to the fourth grade (x^2=5.743, df= 3; p=0.125). Dietary habits are presented in table 1.

The table presents dietary habits based on the frequency of food consumption, where the classification of good or poor habits was determined by the author according to specific numerical criteria for each food item. Good dietary habits for a particular food were assigned based on higher consumption frequencies, while lower frequencies indicated poorer habits. Dairy products such as low-fat milk and yogurt were classified as part of good dietary habits, whereas processed cheese was associated with poorer eating patterns. Similarly, frequent consumption of fresh vegetables, fruits, and lean meats was considered a good dietary habit, while processed meats, canned foods, and margarine were categorized as poor dietary choices. The classification aligns with WHO recommendations, emphasizing the importance of consuming certain foods regularly to maintain a healthy diet. Approximately 50% of adolescents consume fruits and vegetables daily, while about 50% regularly eat fish and 40% regularly consume whole grain bread and cereals. Approximately 80% of respondents consume fast food and snacks daily, and 80% of adolescents drink sugar-sweetened beverages daily. About 70% of respondents consume sweets daily. Figure 1 shows analysis of regular physical activity, sedentary habits, and breakfast regularity.

The analysis showed that 59.6% of respondents regularly consumed breakfast, with the highest frequency in first grade (74.03%), decreasing in later grades (χ^2=14.993, p=0.002). Regular physical activity was reported by 35.31% of respondents, peaking in second grade (49.33%) and declining in other grades, with a significant difference (χ^2=14.685, p=0.002). Sedentary habits were present in 71.75% of respondents, most notably in fourth grade, however no significant age-related difference was found (χ^2=4.428, p=0.212).

When compared with age of subjects, significant findings were observed only in regularity of breakfast (table 2).

Regular breakfast consumption was more common among younger participants, with a mean age of 16.9 ± 1.1 years, while those who did not regularly eat breakfast were significantly older, with a mean age of 17.2 ± 1.1 years (p < 0.001). No significant differences were found in relation to physical activity or sedentary habits.

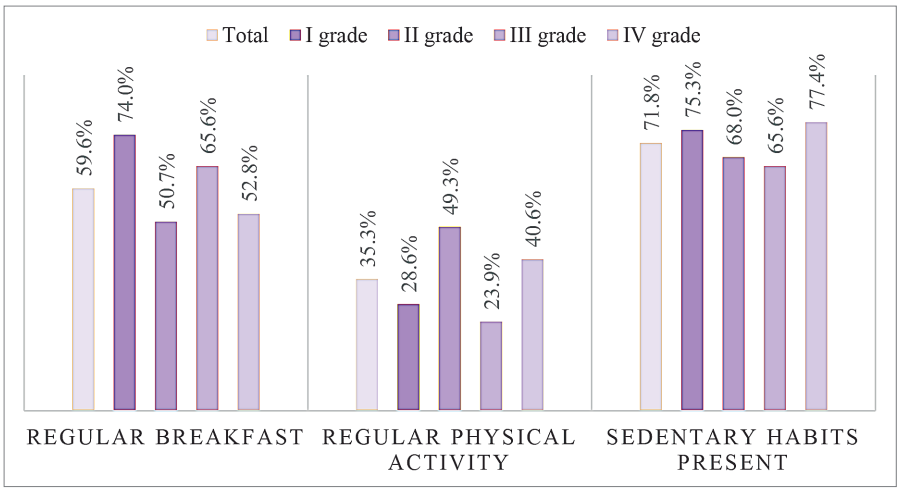

Figure 1. **Percentage of students reporting regular breakfast, regular physical activity, and sedentary habit across grades**

Table 1. **Dietary habits**

Food Items	Every Day (A)	2-3 Times per Week (B)	Once per Week (C)	Rarely (D)	Never (E)	Good Dietary Habits (N, %)	Poor Dietary Habits (N, %)
Milk and Dairy Products							
Milk (0.5-2%)	74	79	58	66	77	153 (43.22%)	201 (56.78%)
Milk (2.8%)	76	85	70	73	53	196 (55.37%)	161 (45.48%)
Milk (3.2 or 3.5%)	78	83	64	77	52	193 (54.52%)	161 (45.48%)
Yogurt, probiotic cultures, kefir	100	76	71	65	42	176 (49.72%)	178 (50.28%)
Cheese: Fresh	69	78	65	76	66	147 (41.53%)	207 (58.47%)
Processed	63	82	83	73	53	209 (59.04%)	145 (40.96%)
Hard cheese	52	66	94	81	61	236 (66.67%)	118 (33.33%)
Fats							
Sunflower oil	141	86	48	44	35	127 (35.88%)	227 (64.12%)
Olive oil	75	73	91	56	59	148 (41.81%)	206 (58.19%)
Butter	72	107	90	52	34	179 (50.56%)	175 (49.44%)
Margarine	43	61	72	97	81	250 (70.62%)	104 (29.38%)
Meat and Meat Products							
Beef	55	78	93	67	61	226 (63.84%)	128 (36.16%)
Veal	39	66	92	85	66	197 (55.65%)	157 (44.35%)
Lamb	47	65	94	99	49	206 (58.19%)	148 (41.81%)
Chicken	90	116	70	36	42	276 (77.97%)	78 (22.03%)
Turkey	53	63	66	96	76	182 (51.41%)	172 (48.59%)
Processed meats (sausages, salami)	107	95	67	48	37	85 (24.01%)	269 (75.99%)
Eggs	105	99	68	54	28	199 (56.21%)	155 (43.79%)
Fish and Seafood							
Freshwater fish	53	52	94	96	50	199 (56.21%)	155 (43.79%)
Saltwater fish	45	66	81	91	71	192 (54.24%)	162 (45.76%)
Canned fish, pâtés	72	79	88	66	49	115 (32.49%)	239 (67.51%)
Vegetables							
Leafy greens (spinach, kale, lettuce)	62	84	82	76	49	146 (41.24%)	208 (58.76%)
Root vegetables (carrots, beets)	61	86	97	68	42	147 (41.53%)	207 (58.47%)
Onions	39	67	76	105	67	182 (51.41%)	172 (48.59%)
Tomatoes, eggplants	61	96	71	76	50	157 (44.35%)	197 (55.65%)
Legumes (beans, peas)	110	69	95	45	35	179 (50.56%)	175 (49.44%)
Fruits							
Fresh fruit	81	113	77	40	43	194 (54.8%)	160 (45.2%)
Citrus fruits	61	103	106	53	31	164 (46.33%)	190 (53.67%)
Nuts	43	82	103	87	39	125 (35.31%)	229 (64.69%)
Dried fruits	52	69	76	87	70	145 (40.96%)	209 (59.04%)
Jams, marmalades	81	68	83	75	38	151 (42.66%)	203 (57.34%)

Table 2. **Breakfast eating, regular physical activity and presence of sedentary habits regarding age of subjects**

		Age			
		Mean	SD	t	*p*
Regular breakfast	Yes	16.9	1.1	6.34	<0.001
	No	17.16	1.08		
Regular physical activity	Yes	17.04	1.1	1.7	0.089
	No	16.98	1.12		
Presence of sedentary habits	Yes	17.01	1.15	0.33	0.743
	No	16.79	1.04		

Table 3. **Correlation between unhealthy lifestyle factors and body mass index**

Variables		BMI
Number of meals per day	Rho	0.507
	p	<0.001
Consumption of fruits	Rho	-0.627
	p	<0.001
Consumption of vegetables	Rho	-0.560
	p	<0.001
Consumption of snacks	Rho	0.861
	p	<0.001
Consumption of fast food	Rho	0.779
	p	<0.001
Consumption of sweets	Rho	0.800
	p	<0.001
Consumption of sugar-sweetened beverages	Rho	0.537
	p	<0.001
Lack of physical activity	r_{pb}	0.598
	p	<0.001
Sedentary habits	r_{pb}	0.759
	p	<0.001
Irregular breakfast consumption	r_{pb}	0.752
	p	<0.001

The values represent Spearman's correlation coefficient, sig. - significance, probability

The majority of respondents reported consuming three daily meals, with prevalence rates of 42.9% among first-grade students, 41.89% among second-grade students, 46.88% among third-grade students, and 51.4% among fourth-grade students. The recommended intake of five daily meals was observed in 24.7% of first-grade students, 8.11% of second-grade students, 12.5% of third-grade students, and 8.41% of fourth-grade students. Only one or two meals per day had in total 14.4% of subjects, or regarding grades, 5.2% in first grade, 21.6% in second grade, 11.5% in third grade and 18.7% in fourth grade.

It was found BMI is significantly associated with poor dietary habits, physical inactivity and sedentary habits (Table 3). Consumption of snacks such as chips and sweets showed a very strong positive association with BMI. Higher consumption was correlated with higher values of BMI. Expressed sedentary habits, fast food consumption, irregular breakfast habits have strong influences on BMI. In addition, also lower and irregular consumption of fruits and vegetables emerged as predictors of obesity.

BMI - body mass index. Using Spearman's correlation coefficient, no significant correlation was found between age and BMI (rho=0.241; *p*=0.346). More frequent consumption of snacks, fast food, sweets, and sugar sweetened beverages was in correlation with higher values of BMI.

Discussion

Our research indicates that approximately one-third of adolescents have excess body weight or obesity. Unhealthy lifestyle habits are linked to this condition: only 6% of 15-16-year-olds and 19% of 14-15-year-olds eat five meals a day, one-third to one-half skip

breakfast, about 50% do not consume fruits and vegetables daily, around 80% frequently eat fast food, snacks, sweets, and sugar-sweetened beverages, approximately 35% regularly exercise, and approximately 70% are sedentary. Overweight/obesity rates in adolescents are in line with other studies. The CDC states that one in five U.S. children and adolescents is overweight/obese (17). In Ireland, 24% of adolescents were overweight/obese in 2020, up from 18% in 2006 (18). In Poland, 13-18-year-olds have a significant prevalence of overweight/obesity, with 15-19% of boys and 10-13% of girls affected (19). A cross-sectional study by Matana and Krajinović (2024) of 344 Croatian adolescents aged 15-18 found that 15% were overweight, with 11% overweight and 4% obese. These findings highlight obesity as a global health issue, suggesting the need for further cohort studies to identify specific factors influencing obesity prevalence.

We found that factors such as, number of meals per day, skipping breakfast, intake of sugar-sweetened beverages, snacks, and sweets, physical inactivity, and sedentary behavior, as well as lower intake of fruits and vegetables are significant indicators of excess body weight/obesity in our respondents.

About 80% of our respondents do not eat the recommended five daily meals. Toschke AM et al. show that obesity rates drop with more daily meals: the odds ratio (OR) for obesity is 0.71 with 4 meals, and 0.57 with 5 or more meals compared to 3 or fewer meals (21). The recommended five meals significantly lower the risk of obesity in 16-year-old boys and girls: OR for overweight/obesity is 0.47 for boys and 0.57 for girls; for abdominal obesity, it is 0.32 for boys and 0.54 for girls (22). Our study did not find that more frequent meals reduce obesity. This may be due to differences in methodology, such as study type, participant number, follow-up period, criteria for defining obesity and meal frequency, types and quality of meals, and potential errors in self-assessment. Demographic differences and individual variations among respondents also play a role.

Numerous studies have indicated that skipping breakfast affects nutritional status. It was found that a significant number of adolescents skip breakfast, which is a predictor of overweight/obesity. Chen S. et al. reported that in respondents aged 8-17 years, the odds ratio for overweight or obesity among those who skipped breakfast was 1.25 (23). Studies have shown that skipping breakfast increases the risk of obesity by around 40% in children and adolescents (24). Unhealthy eating habits, such as high consumption of fats, sugars, and salt, along with low intake of fiber, fruits, vegetables, legumes, whole grains, nuts, and seafood, contribute to obesity and related diseases. Approximately half of our respondents rarely eat fruits, vegetables, and whole grains, while approximately 75% excessively consume processed foods, fast food, snacks, sweets, and sugar-sweetened beverages. Consuming fatty cheese, processed foods, fast food, refined grains, snacks, biscuits, high-fat milk, and sugar-sweetened beverages also increases the risk of excess body weight.

Liberali R. et al. state that eating fatty cheese, processed foods, fast food, refined grains, snacks, biscuits, and drinking high-fat milk and non-alcoholic beverages increase the risk of excess body weight (25).

Daily consumption of fruits and vegetables is part of a healthy diet. A study with 203 obese children aged 12-18 years showed that eating more fruits and vegetables reduces obesity risk (26). However, our study did not find this link. This discrepancy might be due to different study methods, sample sizes, definitions of obesity, ways of measuring consumption, the quality and quantity of fruits and vegetables consumed, high intake of processed foods and sugars, as well as demographic differences and individual variations.

Long-term consumption of sugar-sweetened beverages leads to obesity and related diseases. Our research indicates that adolescents consume sugar-sweetened beverages in large quantities, which may contribute to obesity. The European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) links sugar-sweetened beverages with obesity and cardiometabolic diseases. They recommend that children aged ≥2 to 18 years limit sugar intake to less than 5% of their energy intake and drink water or unsweetened milk instead (27).

An examination of physical activity levels and sedentary behaviors indicates that approximately two-thirds of adolescents are physically inactive, while around three-quarters engage in sedentary behaviors. These patterns are frequently linked to unhealthy dietary practices, which serve as a risk factor for obesity and related comorbidities. Globally, it is estimated that approximately 80% of adolescents are insufficiently physically active and engage insedentary behaviors (28). Previous research has empha-

sized the connection between these risk factors and obesity.

Public media can influence adolescent habits by advertising unhealthy foods and beverages. The curricula at the Sarajevo High School of Medicine, as well as in other high schools, could be designed to enhance the knowledge and skills of both teachers and students regarding healthy lifestyle habits in line with relevant recommendations.

In general there is a significant influence of public media on adolescent habits as they advertise unhealthy foods and beverages. Obesity is linked to other health risk factors. It is important to have a healthy dietary pattern and regular physical activity from an early age, as unhealthy habits can become difficult to change later. Both family practices and school activities contribute to promoting and maintaining healthy lifestyle habits.

The study's limitations include focusing on only one high school, Sarajevo High School of Medicine. The questionnaire should be expanded to include food intake quantity and subsequently validated. Objectivity requires trained personnel using validated equipment to measure anthropometric parameters. Assessing hip circumference, waist-to-height ratio, blood pressure, blood glucose, lipid profile, sleep quality and duration would provide a more comprehensive evaluation of health risks in adolescents.

Obesity poses serious health risks, necessitating focused efforts on lifestyle screening and obesity prevention in adolescents. Health education and promotion should play a greater role in school curricula, which is what we investigated.

Conclusion

This study found that approximately one-third of adolescents are overweight or obese, with higher BMI strongly associated with poor dietary habits such as irregular breakfasts, low fruit and vegetable intake, and frequent consumption of snacks, sweets, and fast food. The number of meals per day decreased with age, and most students did not meet the recommended five daily meals, while physical inactivity and high levels of sedentary behavior further contributed to excess body weight. These findings emphasize the urgent need for comprehensive strategies to promote healthier eating habits, encourage regular physical activity, and reduce sedentary lifestyles among adolescents.

Author contributions

Conceptualization and methodology (LS, AJ, JP, DzP); Data curation and formal analysis (AJ); Investigation and project administration (JP,KP, AD, RD); Writing – original draft (LS, AJ, ES, JP, DzP) and Review & editing (LS, AJ). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. Kinghorn A, Shanaube K, Toska E, Cluver L, Bekker LG. Defining adolescence: priorities from a global health perspective. Lancet Child Adolesc Health. 2018;2(5):e10. https://doi.org/10.1016/S2352-4642(18)30096-8
2. Blum RW, Mmari K, Moreau C. It begins at 10: how gender expectations shape early adolescence around the world. J Adolesc Health. 2017;61(4 Suppl):S3-S4. https://doi.org/10.1016/j.jadohealth.2017.07.009
3. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. Obes Rev. 2016;17(2):95-107. https://doi.org/10.1111/obr.12334
4. Safaei M, Sundararajan EA, Driss M, Boulila W, Shapi'i A. A systematic literature review on obesity: Understanding the causes & consequences of obesity and reviewing various machine learning approaches used to predict obesity. Comput Biol Med. 2021;136:104754. https://doi.org/10.1016/j.compbiomed.2021.104754
5. World Health Organization. Obesity and overweight [Internet]. World Health Organization; 2024. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
6. Sanyaolu A, Okorie C, Qi X, Locke J, Rehman S. Childhood and adolescent obesity in the United States: a public health concern. Glob Pediatr Health. 2019;6:2333794X19891305. https://doi.org/10.1177/2333794X19891305
7. Kansra AR, Lakkunarajah S, Jay MS. Childhood and adolescent obesity: a review. Front Pediatr. 2021;8:581461. https://doi.org/10.3389/fped.2020.581461
8. Kumar S, Kelly AS. Review of childhood obesity: from epidemiology, etiology, and comorbidities to clinical assessment and treatment. Mayo Clin Proc. 2017;92(2):251-65. https://doi.org/10.1016/j.mayocp.2016.09.017
9. Lister NB, Baur LA, Felix JF, Hill AJ, Marcus C, Reinehr T, et al. Child and adolescent obesity. Nat Rev Dis Primers. 2023;9(1):24. https://doi.org/10.1038/s41572-023-00435-4
10. Ryoo E. Adolescent nutrition: what do pediatricians do? Korean J Pediatr. 2011;54(7):287-91. https://doi.org/10.3345/kjp.2011.54.7.287
11. Klein DH, Mohamoud I, Olanisa OO, Parab P, Chaudhary P, Mukhtar S, et al. Impact of school-based interventions on pediatric obesity: a systematic review. Cureus. 2023;15(8):e43153. https://doi.org/10.7759/cureus.43153
12. McGill HC Jr, McMahan CA, Herderick EE, Zieske AW, Malcom GT, Tracy RE, et al. Pathobiological Determinants of Atherosclerosis in Youth (PDAY) Research Group. Obesity accelerates the progression of coronary atherosclerosis in young men. Circulation. 2002;105(23):2712-8 https://doi.org/10.1161/01.cir.0000018121.67607.ce
13. Mihuta MS, Paul C, Borlea A, Roi CM, Velea-Barta O-A, Mozos I, et al. Unveiling the silent danger of childhood obesity: non-invasive biomarkers such as carotid intima-media thickness, arterial stiffness surrogate markers, and blood pressure are useful in detecting early vascular alterations in obese children. Biomedicines. 2023; 11(7):1841. https://doi.org/10.3390/biomedicines11071841
14. Nicolucci A, Maffeis C. The adolescent with obesity: what perspectives for treatment? Ital J Pediatr. 2022;48(1):9. https://doi.org/10.1186/s13052-022-01205-w
15. Senta A, Pucarin-Cvetković J, Doko Jelinić J. Quantitative models of food and meals. Zagreb: Medicinska naklada; 2004.
16. World Health Organization. Growth Reference Data for 5-19 years [Internet]. World Health Organization; 2007. Available at: https://www.who.int/tools/growth-reference-data-for-5to19-years
17. Centers for Disease Control and Prevention. Childhood Overweight & Obesity [Internet]. Centers for Disease Control and Prevention;2024. Available at: https://www.cdc.gov/obesity/childhood-obesity-facts/childhood-obesity-facts.html
18. Moore Heslin A, O'Donnell A, Kehoe L, Walton J, Flynn A, Kearney J, et al. Adolescent overweight and obesity in Ireland-Trends and sociodemographic associations between 1990 and 2020. Pediatr Obes. 2023;18(2):e12988. https://doi.org/10.1111/ijpo.12988
19. Kułaga Z, Grajda A, Gurzkowska B, Wojtyło MA, Góźdź M, Litwin MS. The prevalence of overweight and obesity among Polish school-aged children and adolescents. Przegl Epidemiol. 2016;70(4):641-51.
20. Matana A, Krajinović H. Prevalence of overweight and obesity and association with risk factors in secondary school children in Croatia. Children (Basel). 2024;11(12):1464. https://doi.org/10.3390/children11121464
21. Toschke AM, Thorsteinsdottir KH, von Kries R; GME Study Group. Meal frequency, breakfast consumption and childhood obesity. Int J Pediatr Obes. 2009;4(4):242-8. https://doi.org/10.3109/17477160902763341
22. Jääskeläinen A, Schwab U, Kolehmainen M, Pirkola J, Järvelin MR, Laitinen J. Associations of meal frequency and breakfast with obesity and metabolic syndrome traits in adolescents of Northern Finland Birth Cohort 1986. Nutr Metab Cardiovasc Dis. 2013;23(10):1002-9. https://doi.org/10.1016/j.numecd.2012.07.006
23. Chen S, Zhang X, Du W, Fan L, Zhang F. Association of insufficient sleep and skipping breakfast with overweight/obesity in children and adolescents: Findings from a cross-sectional provincial surveillance project in Jiangsu. Pediatr Obes. 2022;17(11):e12950. https://doi.org/10.1111/ijpo.12950
24. Ardeshirlarijani E, Namazi N, Jabbari M, Zeinali M, Gerami H, Jalili RB, et al. The link between breakfast skipping and overweigh/obesity in children and ado-

lescents: a meta-analysis of observational studies. J Diabetes Metab Disord. 2019;18(2):657-64. https://doi.org/10.1007/s40200-019-00446-7

25. Liberali R, Kupek E, Assis MAA. Dietary patterns and childhood obesity risk: a systematic review. Child Obes. 2020;16(2):70-85. https://doi.org/10.1089/chi.2019.0059
26. Tirani SA, Mirzaei S, Asadi A, Asjodi F, Iravani O, Akhlaghi M, et al. Associations of fruit and vegetable intake with metabolic health status in overweight and obese youth. Ann Nutr Metab. 2023;79(4):361-71. https://doi.org/10.1159/000533343
27. Fidler Mis N, Braegger C, Bronsky J, Campoy C, Domellöf M, Embleton ND, et al. ESPGHAN committee on nutrition: Sugar in infants, children and adolescents: a position paper of the european society for paediatric gastroenterology, hepatology and nutrition committee on nutrition. J Pediatr Gastroenterol Nutr. 2017;65(6):681-96. https://doi.org/10.1097/MPG.0000000000001733
28. van Sluijs EMF, Ekelund U, Crochemore-Silva I, Guthold R, Ha A, Lubans D, et al. Physical activity behaviours in adolescence: current evidence and opportunities for intervention. Lancet. 2021;398(10298):429-42. https://doi.org/10.1016/S0140-6736(21)01259-9

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Original scientific paper

Evaluation of Healthy Work Environment Training Course in Critical Care Units Using Focus Groups – Croatian Data Presentation

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Abstract

Introduction. Research on healthy work environments has shown that they are associated with reduced staff turnover, improved health care outcomes, greater staff and patient satisfaction, and lower levels of workplace and burnout.

Aim. The aim of the research was to evaluate training courses designed to promote healthy working environments in intensive care units.

Methods. The course was based on the six HWE standards proposed by the American Association of Intensive Care Nurses and was created as part of the Erasmus+ project. Croatia is one of the countries that participated in the project. After the course, two focus groups were held with course participants.

Results. Data processing resulted in three main topics: Importance of healthy working environment, Motivation to participate, Evaluation of training courses. Both participants and trainers expressed a positive opinion regarding the content of the course.

Conclusion. The course enables nurses to develop the competencies needed to influence their work environment. The course can be integrated into continuous professional development programs not only for intensive care nurses.

Introduction

In recent years, research on healthy work environments in health care facilities has increased as they are recognized as a key factor in ensuring high-quality, safe patient care, as well as the element that leads to higher productivity and staff satisfaction (1). The World Health Organization defines a healthy work environment as a workplace that supports the whole human being, is patient-focused and joyful, and enables healthcare workers to meet the needs of their patients and their families as well as the goals of the unit and organization (2). Health workers are crucial for the sustainability of health facilities, yet many European countries are faced with health workforce shortages (3).

In their research, Salehi et al demonstrated the relationship between a healthy working environment and job satisfaction and the intention to leave work among intensive care nurses (4). Motley et al state that it is important for managers in healthcare institutions to support healthy work environments, as these are essential for retaining good quality staff (5). The work environment is also very strongly associated with indicators of nursing care quality in hospital settings: patient mortality rate, falls, bedsores, medication malpractice, repeated admission to hospital, length of hospitalization, and infections related to nursing care (6).

A group of authors in Croatia found that the implications of nursing care rationing and nurses' dissatisfaction was associated to poor quality of nursing care provided to patients (7). Association between rationing of nursing care and nurse's satisfaction has also been confirmed on a wider European sample (8).

Kester et al. wanted to examine the effect of the implementation of AACN standards on staff satisfaction, turnover, and tenure two years after initial implementation. The results of the study showed that there was statistical significance in all standards except in the skilled communication standard (9).

Wei et al conducted a systematic review of studies on nurse work environments in the USA, to identify elements that affect the improvement of nurse work environments. The authors found that work environments affect nurses in a way that leads to impaired mental health, job dissatisfaction, and retention. The review also stated that there is a link between the work environment and work performance and productivity. The authors found that it is necessary to continuously improve work environments (10).

Samur and Intepeler wanted to find out the nurses' perspectives on healthy work environments. They conducted a qualitative descriptive design using in-depth semi-structured interviews and identified two key components: one related to "physical environment regulations" and the other related to "administrative arrangements". They believe that it is necessary to work on improving healthy work environments, especially by preventing work accidents and injuries (11).

In 2001, the American Association of Critical-Care Nurses (AACN) made a commitment to actively promote the creation of healthy work environments in critical care units. In 2005 the AACN published their Standards for Establishing and Sustaining Healthy Work Environments: Journey to Excellence. After the 2005 publication of the AACN standards, research was conducted on the impact of work environment on team effectiveness, patient outcomes, patient safety, nurse retention, and burnout syndrome in healthcare professionals. The AACN established six standards based on evidence: skilled communication, true collaboration, effective decision making, appropriate staffing, meaningful recognition, and authentic leadership (12, 13).

The HWE4CCN project (2019-2022) was developed to be the first open, multilingual combined course for professional educators in the nursing field, aimed at healthy work environments in ICUs. The project was based on the six standards of the American Association of Critical Care Nurses – AACN). The project coordinator is the Cyprus Nurses and Midwives Association, and the partners are the Universität International de Catalunya, the Polish Society of Anesthesia and Intensive Care Nurses, Croatian Nurses Society of Anesthesia, Resuscitation, Intensive Care and Transfusion and the European Federation of Critical Care Nursing Associations as an associate partner. The project was supported by Media Partners SRL (Romania).

As part of the project, focus groups were used to validate the online training content and identify best practices.

Aim

The aim of the research was to evaluate training courses designed to promote healthy working environments in intensive care units.

Methods

Research design

A qualitative design using focus groups was employed. The focus group was conducted live for an hour. Two focus groups were conducted, each consisting of four participants. Due to restrictions imposed by the COVID-19 pandemic, the study was limited to a sample of eight participants. Despite the small sample size, the researchers deemed it sufficient to reach data saturation, as no new themes emerged during the second focus group and participants expressed consistent perspectives regarding their work environment (14). Nevertheless, the limited number of participants is acknowledged as a constraint, and the authors recommend conducting follow-up research with a larger and more diverse sample to enhance the robustness and transferability of the findings.

The focus groups were led by two people, one conducted a semi-structured interview due to her experience in conducting qualitative research, while the other person took notes and recorded the conversation. At the beginning of the focus group, it was explained that the conversation would be recorded and that the results would be used for scientific work. Each participant signed an informed consent for the recording and use of data obtained during the focus group. Each participant had the opportunity to add something at the end of the focus group.

Respondents

Two focus group discussions were conducted with nurses who participated in respective training courses. Four nurses participated in each focus group discussion, a total of 8 respondents were included in the research. Focus group discussions have been conducted in January 2021. The participants were nurses who work in critical care departments and who participated in at least one workshop on a healthy work environment.

Table 1. **Characteristics of focus group participants**

Gender	Age in years	Experience in the CCU in years	Number of standards listened prior the focus group
1. Focus group			
Female	32	7	4
Female	24	1	4
Female	35	10	6
Male	20	1	4
2. Focus group			
Male	24	2	4
Female	27	2	3
Female	39	19	2
Female	27	2	4

Data collection

The moderator used a semi-structured interview guide. Table 2 shows the questions addressed to the participants of the focus groups. Focus groups were organized on January 15, 2021 and January 22, 2021, shortly after the training. They were moderated by a researcher with clinical experience in intensive care and expertise in conducting focus group discussions. The average duration of the focus groups was 60 minutes. At the end of each focus group, the moderator summarized main discussion points, and participants were encouraged to correct or add comments to ensure veracity and verifiability. Each focus group session was video recorded.

Data analysis

The data obtained by conducting the focus groups were transcribed word for word by one of the authors of the study. Participants were given the transcribed text to add to or confirm what was said in the fo-

cus group. Both researchers who conducted the focus group worked separately on coding the text. The researchers cross-checked the codes and looked for preliminary themes based on the initial codes. Preliminary themes were reviewed and revised by two researchers. Each topic is given a name that reflects the content expressed in the focus groups.

Table 2. **Questions for focus group participants**

1.	What challenges did you face while holding the course? What would you change?
2.	What motivated you to take the course? Who do you think should implement the HWE standards and in what way?
3.	To what extent is the course relevant to you and your work environment? What information was most useful to you, and which will you apply in your work?
4.	To what extent could this course affect your work environment?

Ethics

Approval for conducting the study was obtained from the Ethics Committee of the UHC Zagreb, where the research was conducted. Also, each respondent gave written consent to participate in the study.

Results

Topic 1: Importance of a healthy working environment

There is consensus among all respondents that the working environment is important for their optimal functioning during work. Since work in ICUs is incredibly stressful, the working environment is the factor that makes a huge difference: whether it will be stress reliever or increase it further.

> "The fact that we are all working in such a stressful environment does not mean that every day must be stressful and bad. I mean... these workshops are perfect for improvement." (G1)

After participating in training courses, nurses became aware of previously overlooked aspects of daily work, such as the motivating effect of appropriate praise, and the benefits of adequate conflict management, which, when improved on a personal level, can contribute to a healthier working environment. However, to achieve significant improvement, they emphasized the need to raise awareness of these aspects among all employees in the unit, especially to head nurses, whose leading and communication skills contribute the most to the overall atmosphere in the unit. Therefore, it is recommended to include as many nurses as possible, starting from the head nurses.

> "Personally, it has definitely affected me, but I'm just sorry that maybe the department head nurses aren't as present at such workshops as they might be, because as the colleague said, it all actually starts with them. So, they are the people who should try to create a positive atmosphere, who should resolve conflicts so that they do not discriminate against anyone, etc., and I think that maybe for them there should be a little more organized activities... workshops... Because they really hold the whole department in their hands. I won't say that they determine everyone's destiny, but they really have a noticeably big impact on the workers and their satisfaction." (G2)

> "I think more focus should be put on the head nurses of the wards and not just the wards, maybe the head nurses of the departments or something like that. They can change something because, realistically, let's be honest, we can't really change anything. We can point out some things, we can say: 'this is not good for us, this does not suit us, maybe we could ... ' But in fact, we do not have too much of an influence, so I think it would be better suited, let's say, better suited for them." (G4)

However, there is a dose of skepticism towards the head nurses and their willingness to adjust their established approach. Participants pointed out there was no formal/standardized education and preparation for head/leading positions so far, just a transfer of knowledge from one leading nurse to the other so there is no unified leading approach, but it depends on the character and skills of individual. Therefore, it is necessary to incorporate certain standards which head nurses can easily follow and play a role in an even better way.

> "...but I think that people who are of a certain age already have their personality and their... I don't know how to express myself... basically, their mode of operation – they will be difficult to change. But the truth is that head nurses have a big impact because they are there every day, they could change something, and we... not so much. Because we sometimes... I don't see some of the co-workers sometimes for a week." (G6)

One participant pointed out the necessity of involvement of physicians they work with, too, as they see a lack of understanding for nurses from some physicians.

Another argument to continue with training courses is that a healthy working environment is considered as the first line of prevention of burnout and leaving the job.

> "I think this is certainly very important because if people take all the stress from work home, if they are not only stressed but maybe also nervous because of other co-workers, if they take it all home, they will experience burnout much sooner and I think a healthy work environment is the first level of prevention in such things." (G1)

Topic 2: Motivation to participate

Attendance at training courses (lifelong learning) is still very much determined by individual motivation and a desire to learn. Personal growth and development as well as the wish to contribute personally to a healthier work environment was the main motivation for nurses to participate in respective training courses. Some participants were encouraged by the trainers themselves.

The reason why nurses do not participate in different courses to a larger extent is not seen as much in covered topics (they state that the employer/superiors recognize the need and to a greater extent organize various useful courses and trainings), as in the fact that nurses have to attend courses in their own free time (sometimes before or after the shift), and without some kind of compensation.

It is suggested to the employer to give a day off for some training courses attended or at least symbolic financial compensation, which would affect the motivation and greater satisfaction of the employees.

> "The employees were not really interested in investing their free time to attend a course. They said it was a problem for them, they wanted days off... Simply, few people wanted to invest time in training, without you having to force them, at least that's my impression." (G3)

There is an opinion this is an investment in employees which will pay off to the employer later on: employees will be much more trained / educated and will therefore contribute a higher quality of work.

Forced participation in courses does not make sense because employees are not interested and motivated to listen to them for several hours, as well as training courses that they cannot apply in their working environment, therefore there is no benefit neither for nurses nor for the employer.

It is advisable to put a greater focus on the wishes and needs of employees, to give them the opportunity to choose the training they are interested in and that they consider to be useful in their work to a certain extent.

Topic 3: Evaluation of training courses

The following training topics were highlighted positively: leadership, mentoring, skilled communication, and conflict management. Some of them are pointed out because nurses recognized considerable room for improvement and welcomed an effort to address these areas, some because they already apply knowledge from training courses to improve the working environment. Furthermore, their vision of good functioning regarding each topic is described.

It is particularly important that the leading nurse or shift manager is skilled (trained) in managing people and working in a dynamic and challenging environment.

> "A head nurse or shift manager should be the person who has the level of knowledge and general ability to be able to control the whole department." (G2)

Leading nurses were not (formally) trained for that role so far, these skills and knowledge were transmitted from nurse to nurse, so respondents see these roles as very undefined and dependent on individual competence/ability to perform. They think that management and mentoring roles should be strictly defined so the person coming to that position exactly knows what their assignments and responsibilities are.

Head/leading nurses should adjust the approach to individual nurses considering their previous experience

(whether it is an experienced nurse in some other field or department, or it is a nurse without any previous experience) and knowledge, while respecting suggestions of younger/newer employees as well.

The praising system should be adjusted along with work experience and knowledge, with a different kind of recognition, praising for beginners and already experienced nurses.

Meaningful recognition is more important to younger/new employees, it contributes a lot to their greater security in work and motivation.

> "...how much this one word 'great', 'bravo' and 'great reaction' means to someone who has just started working in the system, and how much it actually motivates for further work, and I think it is rarely applied, and actually this little word can help a lot." (G5)

Mentoring is not considered a strong point, as there are no strictly defined guidelines outlining mentor's assignments and responsibilities.

> "So I think we are very bad with that part of mentoring and all that, I think it all floats somewhere and there is nothing exactly defined – how, what, where – we should have procedures about it, so that the person who gets that position can look up and see – aha, I have to do this, this and that, I have to check this and that." (G7)

Head nurses' communication should be adjusted to each of the employees, considering their personalities in order to get the best out of them. It is also important to raise awareness of some aspects of communication among employees that can change their relationship positively. As one respondent would say: it is important to learn how to communicate with each other, regardless of the current mood.

One participant stated the necessity of including the communication of all stakeholders involved in patient care (physicians, physiotherapists and even cleaning staff).

Skilled communication is a field where shortcomings are seen as well, therefore training in this field is welcomed by both, leading and shift nurses, as well as physicians.

> "If such workshops were to be held continuously, they would benefit everyone, both supervisors and us who are working shifts." (G1)

> "Someone may not be in a good mood that day, someone may have gotten up on the wrong side of the bed, someone is great and we simply must learn to communicate somehow – as you were saying... sorry... as you were all saying, after situations like these... never talk during resuscitation or any other similar procedure, but afterwards yes, by all means, maybe even include physicians in the communication and absolutely include head nurses and, of course, other co-workers. But physicians should definitely be included." (G2)

Conflicts occur sometimes during work among colleagues for different reasons. One respondent pointed out the situation when he implemented a new, more constructive approach to conflict resolution, the way he was taught in this course so it can be concluded that courses are already giving certain results.

> "Well, take me for example... Three days ago, I suggested how to solve a conflict between two co-workers after the event." (G4)

> "The thing with the aggressive, passive-aggressive thing... those conflicts, how to behave, I mean, we always, maybe unconsciously, experience during the day, during the working day, and it's just, like, 'react patiently', I think I myself am passive so it's not that I burst easily, but it accumulates in me and then when I need to burst then it's like: 'don't, don't, don't' (laughter), so, there were, there were a lot of those segments." (G6)

Desirable training courses

The training courses that the respondents participated in so far are very positively evaluated. Participants complimented the educators' communication skills as well as their ability to encourage all the participants in a discussion.

Respondents pointed out that it is not enough just to narrate about a certain topic, but to demonstrate by showing it through examples, illustrate through games, role playing, etc. In such training courses participants get more involved (they are not passive listeners) and adopt and remember the content to a larger extent. Courses regarding the healthy working environment were consistent with the above findings. All the respondents expressed high levels of motivation to participate in future similar courses and to recommend them to their colleagues.

"Well, it's important to show people how it works, and to present it, I mean, live... I mean, not only to talk about it, but to really show it on examples." (G1)

Participants suggest more frequent similar courses, as well as multiple courses on the one (same) topic so the participants could absorb the content to a higher degree.

They also point out the importance of informal gatherings before or after such courses (refers to live courses which participants are more prone to), where they can evaluate and exchange experiences in a relaxed environment which is stimulating for bonding and creating a better work environment.

Suggestions for improvement point out the need to include a larger number of participants in such training courses, but in smaller groups, with a duration of up to 4 hours per training.

An important aspect of courses praised, especially in the second group discussion was their good, relaxed atmosphere, with participants feeling comfortable to include and express their opinion. It is also one of the most prominent reasons for the recommendation of courses to colleagues.

"So, I was... It was really great for me.... it was one of the segments that makes you take part every time because you learn something new every time and the atmosphere is quite relaxed, informal... This informal part of the course is actually quite okay. I think that will be extremely attractive to people." (G2)

"It was good because the whole atmosphere of the course was so relaxed and there were no wrong answers, and every answer was correct because it represented the opinion of individuals. I think this is the best approach to this course and the result is definitely positive after each training or lecture." (G8)

Participants consider head nurses to have a main role in recognizing the need for education and encouragement of other nurses to participate in training courses. It is suggested to organize the courses for head nurses first, so they can promote the courses and motivate others based on their own experience. After the separate courses for head and other nurses, it is suggested to organize courses for all of them together where different experiences and points of view can be exchanged.

"Well, I think our supervisors, head nurses should recognize the need for a healthy work environment and implement it and encourage people to go to workshops. Of course, including the nursing manager on the hospital level, the level of the organization, but certainly the department head nurse should be someone who takes care of all of us employees. I would leave it to this level." (G3)

"Maybe like you say... first separate them, then confront them all together, and then mix us all together to communicate something, to do something, because if they're in one group and we're in another group, we will talk our stuff, and they will talk theirs and again: where are we? Mix us all, at one point mix us all together..." (G2)

A useful tool for informing nurses about the training courses could be leaflets containing most relevant information such as the duration of course, main goals and benefits for nurses.

Discussion

Feedback from participants shows how important the work environment is for nurses. All participants agreed that the training course on the standards of a healthy working environment improved their knowledge and skills, and they believe that this will be reflected in the quality of their work and cooperation with other healthcare professionals. They emphasized the pleasant atmosphere, the preparation of the coaches and the interactive participation.

These results are not surprising because other studies have also confirmed the importance of the work environment. Thus, Amaliyah and Tukimin state that some aspects of the work environment, such as recognition for quality work or enough staff in relation to the number of patients, affect the quality of health care (15). In his research, Salehi et al also found a positive connection between the work environment and employee satisfaction (4).

Our feedback emphasizes management staff, with nurses referring to both head nurses and doctors. Participants believe that by implementing the standards of a healthy working environment, management

staff would get the necessary skills that would improve work quality and increase staff satisfaction. Similar results indicating that managers do not support nurses were obtained by other researchers (11, 16). Nurses believe that their managers should work together with them to build a working environment based on cooperation, trust, and motivation, and not worry only about numbers and limits (11).

Nurses believe that leadership is extremely important and that it is a prerequisite for creating a healthy work environment. In their research, Hegazy et al stated that leadership is the path to excellence in nursing (16).

The participants believe that education for employees should be organized in a way that encourages personal growth and development and that they should not be forced to attend education that does not interest them. Also, they placed considerable emphasis on mentoring, which does not have clearly defined roles, thus making it difficult to evaluate mentoring work. In addition, mentoring should be rewarded.

Since this paper is part of a broader project, similar results were observed in other participating countries. Participants expressed high levels of satisfaction with the training and emphasized that a healthy working environment is extremely important for the quality of work and the well-being of employees. All participating countries reported a positive response, with participants noting that the training was content-rich, clearly structured, and interactive. These characteristics further contributed to the high acceptance of the programme among participants. However, a common challenge across all countries was the implementation of the training in an online environment, which required additional adaptation of learning methods and efforts to ensure active engagement from participants. Despite these technical and logistical challenges, evaluations indicated that participants' expectations were largely met (17).

Nurses in Cyprus and Croatia highlighted that such training should be made available to other healthcare professionals as well, not only to nurses, since a healthy working environment is a shared responsibility of the entire healthcare team. In contrast, nurses from Spain particularly emphasized the importance of promoting the training within healthcare institutions in order to ensure broader implementation and long-term impact. In Poland, participants expressed the belief that even small, incremental steps can lead to positive changes in the workplace, underlining the importance of continuous yet realistic interventions. These findings reflect a shared perception among healthcare professionals from different countries regarding the importance of education on healthy work environments, and they confirm the relevance and applicability of the training module in an international context (17).

Limitations

The report was created with a time delay, which means that some nurses' attitudes and preferences may have changed since the focus group discussions. Therefore, caution is advised when considering recommendations.

Focus group discussions were moderated by the same person who held the training courses (which is not in line with research practices), therefore the bias in respondents' answers to some degree can be expected.

A notable limitation of this study is the small sample size, constrained by public health measures during the COVID-19 pandemic. While thematic saturation was likely achieved – as evidenced by the repetition of key themes across focus groups – caution is warranted in interpreting and generalizing the findings. Prior research suggests that saturation can be reached with relatively few focus groups in studies with narrowly defined populations and focused research questions (14). Nevertheless, replication of the study with a larger and more heterogeneous sample would contribute to confirming the findings and expanding their applicability to broader clinical contexts.

Conclusion

The responses from nurses in this study show that there is a clear recognition of the need to change the working environment and that the concept of a healthy working environment must be an integral part of nurse education. The course taken by nurses can be integrated into continuous professional development programs not only for nurses working in intensive care units but also for other healthcare providers. Special emphasis should be placed on training nurse managers who, by completing the course, would acquire the necessary competencies for effectively managing healthcare teams and fostering a supportive work environment.

However, it is important to note that the study included a small sample size, which may have influenced the results. Future research should involve a larger and more diverse sample to confirm the findings and to ensure that the conclusions are generalizable across different clinical settings. Additionally, the moderator of the focus groups should not also serve as the educational trainer, as this could introduce bias into the discussion and the results, as the facilitator's influence could shape participants' responses.

Author contributions

Conceptualization and methodology (SR, JS, AF, EG); Data curation and formal analysis (SR, JS, AF, EG); investigation and project administration (SR, JS, AF, EG); and writing – original draft and review & editing (SR, JS, AF, EG). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. Ulrich BT, Lavandero R, Woods D, Early S. Critical care nurse work environments 2013: a status report. Crit Care Nurse 2014;34(4):64-79. https://doi.org/10.4037/ccn2014731
2. Burton J. WHO healthy workplace framework and model: background and supporting literature and practices. 2010. Available at: https://www.who.int/occupational_health/healthy_workplace_framework.pdf Accessed: 20.11.2023.
3. Kroezen M, Hoegaerden M, van Batenburg R. The joint action on health workforce planning and forecasting: Results of a European programme to improve health workforce policies. Health Policy 2018;122(2):87-93. https://doi.org/10.1016/j.healthpol.2017.12.002
4. Salehi T, Barzegar M, Yekaninejad MS, Ranjbar H. Relationship between healthy work environment, job satisfaction and anticipated turnover among nurses in intensive care unit (ICUs). Ann Med Health Sci Res 2020;10:825-6.
5. Motley RJ, Mazzaccaro RJ, Burmeister DB, Land SD, Boulay RM, Chung H, et al. Using focus groups to identify characteristics of an ideal work environment for Advanced Practice Clinicians. Healthc 2016;4(3):151-4. https://doi.org/10.1016/j.hjdsi.2015.10.007
6. Gurková E, Mišková Z, Labudiková M, Chocholková D. Nurses' work environment, job satisfaction, and intention to leave - a cross-sectional study in Czech Hospitals. Cent Eur J Nurs Midw. 2021;12(4):495-504. https://doi.org/10.15452/CEJNM.2021.12.0019
7. Friganovic A, Režić S, Kurtović B, Vidmanić S, Zelenikova R, Rotim C, et al. Nurses' perception of implicit nursing care rationing in Croatia-A cross-sectional multicentre study. J Nurs Manag 2020;28(8):2230-9. https://doi.org/10.1111/jonm.13002
8. Zeleníková R, Gurková E, Friganovic A, Uchmanowicz I, Jarošová D, Žiaková K, et al. Unfinished nursing care in four central European countries. J Nurs Manag. 2020;28(8):1888-900. https://doi.org/10.1111/jonm.12896
9. Kester K, Pena H, Shuford C, Hansen C, Stokes J, Brooks K, et al. Implementing AACN's Healthy Work Environment Framework in an Intensive Care Unit. Am J Crit Care. 2021;30(6):426-33. https://doi.org/10.4037/ajcc2021108
10. Wei H, Sewell KA, Woody G, Rose MA. The state of the science of nurse work environments in the United States: A systematic review. Int J Nurs Sci. 2018;5(3):287-300. https://doi.org/10.1016/j.ijnss.2018.04.010
11. Samur M, Intepeler SS. Nurses' view of their work environment, health and safety: A qualitative study. J Nurs Manag. 2019;27(7):1400-8. https://doi.org/10.1111/jonm.12821

12. American Association of Critical Care Nurses. AACN Standards for Establishing and Sustaining Healthy Work Environments: A Journey to Excellence [Internet]. 2nd ed. 2016. Available at: https://www.aacn.org/WD/HWE/Docs/HWEStandards.pdf Accessed: 20.09.2021.
13. Registered Nurses' Association of Ontario. The Healthy Work Environments Quick Reference Guide for Nurse Managers [Internet]. Toronto: Canada; 2010. Available at: https://rnao.ca/sites/rnao-ca/files/HWE_Reference_Guide.pdf Accessed: 20.11.2021.
14. Guest G, Namey E, McKenna K. How many focus groups are enough? Building an evidence base for nonprobability sample sizes. Field Methods. 2017;29(1):3-22. https://doi.org/10.1177/1525822X16639015
15. Amaliyah E, Tukimin S. The relationship between working environment and quality of nursing care: an integrative literature review. BJHCM. 2021:27(7):194-200. https://doi.org/10.12968/bjhc.2020.0043
16. Hegazy AM, Ibrahim MM., Shokry WA, El Shrief HA. Work Environment Factors in Nursing Practice. MNJ. 2021;6(2):65-73. https://doi.org/10.21608/menj.2021.206247
17. Georgiou E, Hadjibalassi M, Friganović A, Sabou A, Gutysz-Wojnicka A, Constantinescu-Dobra A, et al. Evaluation of a blended training solution for critical care nurses' work environment: Lessons learned from focus groups in four European countries. Nurse Educ Pract. 2023;73:103811. https://doi.org/10.1016/j.nepr.2023.103811

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Original scientific paper

Nursing Rituals for Dying and Deceased Patients in Hospitals of the Republic of Croatia: A Qualitative Study

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Abstract

The aim of this research was to examine the end-of-life rituals performed by nurses in hospitals in the Republic of Croatia, considering historical, social, and cultural contexts. A qualitative study was conducted using semi-structured interviews with nine nurses working in three hospitals at the secondary level of healthcare. The study explored their personal and professional practices beyond standardized protocols. The findings revealed diverse rituals, such as opening windows to "release the soul," prayers, and physical care for the deceased. These practices are influenced by cultural traditions, religious beliefs, and personal values, and contribute to nurses' emotional coping with death. The study highlights the importance of understanding cultural and personal dimensions of end-of-life care, suggesting that these practices contribute to holistic nursing and the emotional well-being of healthcare providers. Further research is needed to explore these practices across broader settings.

Introduction

So far, no research in Croatia has systematically addressed the post-mortem rituals performed by nurses, despite the well-known influence of cultural and religious traditions on nursing practice. Most existing studies focus on standardized protocols, while the personal and culturally conditioned aspects of care for dying and deceased patients remain underexplored. To our knowledge, no previous research in Croatia has examined informal post-mortem rituals performed by nurses in hospital settings. This study aims to fill that gap by analyzing practices that go beyond standardized protocols, incorporating the personal beliefs of nurses as well as cultural traditions.

Humans are very likely the only beings aware of their own mortality, and this awareness of mortality is crucial for human existence (1). The inevitability of death is one of the few absolute truths universally understood by humanity. A profound awareness of inevitable death hinders us from engaging in the limited possibilities of our survival (2). However, contemporary perceptions of death view it more as a medical failure than as an expected end of life. Death is often interpreted as a failure to achieve medical goals, leading to denial, repression, and the fear creation resulting in its mystification and distancing from the community (3).

The people farewell approach of the deceased vary influenced by the environment in which individuals were raised. The procedures expressing the respect for life of the deceased when handling the body are referred to as post-mortem procedures or rituals. The structure and execution of these rituals are determined by historical, social, and cultural heritage, as well as religious and spiritual beliefs (4). Different communities have developed rituals providing a grieving process framework for those saying goodbye to the deceased. Within contemporary healthcare systems, traditional rituals related to death and dying are no longer practiced. The reasons for their disappearance include a loss of faith in rituals, unpreparedness for death, and dying outside the family circle (5). Additionally, with the medicalization of death and dying, medical interventions have become more dominant compared to traditional customs and rituals (6).

Healthcare for dying patients intensely affects nurses, often eliciting feelings of compassion, helplessness, and grief. Nurses frequently personally experience the patient's death, which can subsequently impact their relationships with loved ones (7). Over time it has been noted the grief for deceased patients can lead to fatigue and the burnout syndrome emergence (8). Benbenishty et al. conclude that the rituals associated with dying and death performed by nurses are significant for both dying patients and their families, as well as for the nurses themselves (9). Wolf asserts that the actions taken by nurses during moments of confronting a patient's death help them cope with their own emotional states while affirming their respect for the deceased, their family, and the surrounding environment (10). Consequently, these procedures are recognized as important but have not yet been documented or analyzed. It is noteworthy that research on this phenomenon is extremely rare, even globally. This context amplifies the need for a sensitive, compassionate approach, ensuring the emotional and spiritual needs of both the patients and the healthcare providers are respectfully addressed.

In Croatia, nurses manage deceased patients in accordance with standardized procedures established by the Croatian Chamber of Nurses (HKMS) (11). Despite this, some nurses perform certain post-mortem procedures that primarily stem from their own religious and/or spiritual beliefs (9). The perspective of nurses towards patients, along with all normative consequences, differs from that of other healthcare workers due to the unique relationship that nurses establish with both the patient and their loved ones. This results in actions that often deviate from prescribed procedures and are significant for further analysis (12).

The aim of this study is to analyze the post-mortem procedures performed by nurses in several hospitals across the Republic of Croatia, with a focus on the cultural, religious, and personal beliefs that shape these practices. These rituals, deeply influenced by cultural contexts and individual experiences, offer valuable insight into the interplay between tradition and professional nursing practice. By examining these procedures, the study seeks to highlight their significance not only for the quality of healthcare but also for the emotional well-being of nurses. Additionally, this research addresses the broader need to understand the challenges nurses face when caring for dying patients.

Aim

In a country where cultural norms and traditions play a significant role, the findings aim to illuminate how these factors influence nursing practices and contribute to holistic, patient-centered care.

Methods

The study employed a qualitative, phenomenological approach, based on semi-structured interviews that enabled the collection of capture rich, detailed narratives from participants. The advantage of this methodological approach is the ability to gain detailed insights into the participants' subjective experiences and individual perceptions regarding the research topic. The open structure of this type of interview allows researchers to uncover specific aspects of the phenomenon being examined, which are often overlooked in studies that utilize rigid research strategies, such as closed-ended questions with pre-defined answers (13). To reflect on the rituals performed by nurses after patients' deaths, it was deemed that semi-structured interviews would provide more comprehensive data on this emotionally sensitive and intimate experience.

The research was conducted by two investigators, both male nurses with personal experience in performing end-of-life rituals, which motivated them to explore this sensitive topic. They do not have formal research experience in this specific area but were driven by their professional practice to document these rituals.

The study involved nine participants, all nurses, eight were female and one male. Prior to the commencement of the study, ethical approval was requested from the Ethics Committees of seven hospitals in which the participating nurses were employed. Out of the seven requests submitted, four Ethics Committees granted approval for the research to be conducted: the General Hospital Karlovac, the "Dr. Tomislav Bardek" General Hospital in Koprivnica, "Merkur" Clinical Hospital in Zagreb, and the "Dr. Ivo Pedišić" General Hospital in Sisak. Following the approval from the Ethics Committees, participants who expressed a desire to participate signed a consent form.

Participants were purposefully selected through personal acquaintances and recommendations to ensure involvement of individuals with relevant experience. Participation in the study was voluntary and without monetary compensation. The consent form included the option of recording conversations using a dictaphone or taking manual notes. All participants chose the option of taking manual notes. No audio or video recordings were made during the interviews. Demographic data were collected, including age, years of nursing experience, gender, and education level, but this information was not explicitly analyzed in the results section. For clarity, labels S1 to S9 will be used for research participants when presenting results. No pilot study was conducted prior to data collection.

The interviews were conducted in a private setting, with only the researcher and the participant present, ensuring confidentiality and minimizing external influence on responses. Four participants were previously known to the investigators before the study, whereas others were not. Participants were fully informed about the study's objectives, ethical considerations, and data collection methods before providing their consent. Each interview was conducted once, with no follow-up or repeated interviews. Their prior knowledge and interest in the subject may have influenced the interviews; however, efforts were made to maintain objectivity and ensure a balanced data collection process.

The study is grounded in the theoretical framework of cultural and ritualistic practices in healthcare, specifically focusing on the intersection between personal beliefs, professional responsibilities, and cultural traditions in end-of-life care. The research questions are well integrated into this theoretical framework, as they explore how personal, religious, and cultural factors shape nursing rituals for dying patients. By situating the study within this broader context, it contributes to the understanding of non-standardized nursing practices and their implications for healthcare.

The first question in the interview was: "*Can you describe the procedure with a deceased patient?*" This question aimed to determine which post-mortem procedures the research participants performed.

The purpose of the additional questions was to gain a deeper and more comprehensive insight into the phenomenon being studied. Additional questions included: "*What feelings prompt you to perform this ritual at the moment of the patient's death, and what feelings does performing it evoke in you?*"; "*What do you believe you accomplish by performing this ritual?*"; *"Have you seen anyone from your family and/or broader environment perform these rituals?*"; "*Did you learn (adopt) any rituals/procedures from other colleagues during your education or work?*"; *"Are your colleagues and/or the deceased patient's family members aware that you perform these procedures?*"; "*Do you remember when you first performed this ritual and what prompted you to do so?*"; and "*Have you ever discussed with the patient before their death that you would perform this ritual? If not, do you consider it ethical to act in this way without their consent?*"

The data collected from interviews was analyzed using thematic analysis, a technique that enables the identification of key themes, patterns, and participant responses to the questions posed. The analytical process was documented using relevant references to ensure the reliability of the analysis (14). During the analysis, the interview transcripts were carefully reviewed to identify the main themes and patterns in participants' responses. Subsequently, segments of text related to similar themes were coded. This methodical approach allows researchers to uncover significant insights and provides a comprehensive understanding of the phenomenon being studied. Thematic analysis is particularly effective in qualitative research for distilling meaningful patterns from complex datasets, thereby facilitating a nuanced interpretation of participants' experiences and perspectives. Data analysis was conducted manually without the use of qualitative data analysis software.

Ethics

This qualitative research was conducted in accordance with the Croatian Chamber of Nurses Ethical Code, the provisions of the General Data Protection Regulation (GDPR), and the Implementation of the General Data Protection Regulation Act.

Results

The results are presented through the responses of the research participants, labeled from S1 to S9. The participants consisted of eight female and one male nurse.

Through thematic analysis of the responses to the questions posed, three main areas are identified and described in the results: ritual procedures at the physical level and care for the deceased, faith and spirituality, and personal relationships and emotional involvement towards the dying.

Ritual procedures at the physical level and care for the deceased

Nurses practice the same procedures with dying patients, albeit with minor differences among workplaces, and these align with the guidelines set by the Croatian Chamber of Nurses (HKMS) (11). Participants in the study explain the nursing and technical procedures they perform at the time of a patient's death: (S8) "When the patient dies and we take care of them, we remove everything from them, record the ECG twice: immediately after death and 30 minutes later, tie the jaw, remove the teeth, place an identification tag (a tag that is tied around the ankle or thumb of the deceased), list and pack the belongings. (...) They stay in the department for two hours before being taken away from us." Another participant notes: (S7) "They stay with us for three hours after death, not two as is the practice elsewhere." Patients remain in the department for at least two hours after death, until early signs of death appear, after which they are transported to the morgue.

Six participants open a window when a patient dies, while one participant opens the window a few moments before death. They describe this practice for reasons such as: (S3) "to let the soul go," (S1) "so that the soul can freely 'leave,' to exit the space," (S4) "to let them into the heavenly realms," (S5) "I open the window, you know, if there is a soul, let it go outside," and (S2) "I always open the window because my grandmother taught me that's how the soul exits." Participants also mention that sometimes they do not open windows due to external temperatures: (S6) "I don't know why, but a long time ago, a col-

league told me that when someone is suffering, you should open the window. Except when it's cold. Then I don't do it," while conversely (S7) states, "if it's cold outside, we open the window; if it's summer, we don't because of the air conditioning."

Most nurses opened windows based on personal beliefs, but some observed this ritual from colleagues in the workplace: (S2) "...an older technician who was on shift with me told me when he saw me: 'I'm glad you opened the window. If you hadn't, I would have opened it myself.'" Another participant noted: (S4) "At the beginning, as soon as I joined the team where this was the rule of practice."

Although opening windows and prayer are the most common procedures performed by nurses, some participants add their own rituals and/or practices conducted in the department: (S1) "We put a few milliliters of water in the mouth before securing the sheet so that they 'won't go thirsty' to the other world," or (S6) "I usually verbally thank them when death occurs: 'that's it, you've turned off, you're going peacefully,' and I open the window."

Some rituals are related to light, candles, or silence: (S6) "I have never left a deceased person in the dark. I make sure the light is on. I try to treat the deceased as if they were someone close to me." (S7) "I learned this pattern from my colleagues. We always remain silent when a person passes away." And (S4) "A few times, family members have asked us to light a candle, and we have done so. As a wish."

Other rituals obtained from the interviews were directed towards individuals or were pre-arranged to honor the patients' wishes: (S5) "I had a case where a guy told me that his mom didn't come to the hospital and asked me to hug him. I did that. Other nurses were also asked to hug him. It was as if the parents were ashamed of the diagnosis. When he died, I told his mother that he just wanted to be hugged." (S7) "...I know that one patient told one of my colleagues before her death that she wanted to be made up and have a box of cigarettes and lipstick placed in her coffin. The colleague she told wasn't on shift when she died, but knowing the patient's wish, it was honored." Or: (S7) "With the patient, I communicated about death and his wishes through conversation. If the person wanted to see someone, we engaged a social worker. If they wanted something to eat, we made an effort to bring it. I remember when we brought orange juice to one woman. Not all of my actions are religious; some are simply human." (S2) "I think it's important to tell patients what we are doing or what we will do, and I believe it's right to respect their wishes if they have any."

Faith and spirituality

Of the nine participants, six are Roman Catholics who regularly practice their faith, one is a Roman Catholic who practices as needed (S2), one is an atheist (S5), and one participant did not specify their beliefs. The participants mention prayer or blessing the deceased by making the sign of the cross on their foreheads or crossing themselves and/or the deceased: (S1) "I always pray for the soul of the deceased, and I make the sign of the cross on their forehead, but only if I know that the person I am preparing was a Roman Catholic." (S7) "...when they die, if I happen to be there at that moment, I pray." (S8) "I always make the sign of the cross over patients, more often at the time of death, and sometimes even when we prepare them for the morgue." (S9) "...I felt the need to make the sign of the cross over their forehead in the moments before death." (S7) "I introduced crossing the deceased and praying if I know they were Catholics."

Religious beliefs and/or spirituality of nurses play a role in the rituals they perform: (S9) "Since there has been documentation of wishes, we record religious affiliations. So, we knew what someone wanted, and if someone needed to receive a representative of their faith at the end of life, I made an effort to do so. Based on that, I formed an attitude. If they expressed a need for a spiritual advisor, I felt assured that my cross wouldn't be intrusive. Even if they didn't confirm it, I made the sign of the cross—probably for my own sake." (S8) "When I cross them, I feel a sense of relief. It's like I'm giving them permission to peacefully go in the direction they need to go." (S7) "When I pray silently, I feel that people die more peacefully." Or (S2) "I'm not religiously oriented, but I believe that the soul must depart because of the beliefs instilled in me by my grandmother and out of respect for death, life, and life after death." (S2) "When a patient dies, I don't pray because I'm not sure what their faith was."

One nurse mentions that she learned the rituals of prayer from an older colleague: (S9) "Soon after I started working... I had a good teacher—an older nurse who didn't give me instructions per se, but she talked about herself and also felt the need to cross

a person or place a picture in their hand, and that somehow encouraged me to do something because I felt the need."

Personal relationship and emotional involvement with the dying

The most common feelings that nurses verbalize after a patient's death are tranquility, peace, and relief. (S9) "Personally, it was a relief for me because I believe this is not the end. There is a continuation somewhere beyond. I felt calm within myself." (S1) "For me personally, these rituals bring peace and satisfaction that after everything I did for that person in their final moments of life, I did everything in my power to give them a final blessing." (S6) "I actually feel the need and relief that I did this. I never thought about it. I don't know for whom I do it. Maybe I do it for myself." (S5) "I feel that they left in peace, and that's it. I am more satisfied. That's the last thing I could do. There are no words to describe it. The feeling, maybe the soul has left the body. It calms me. I did everything. We do so much until death. We fulfill wishes. Everything from a drink of alcohol to pizza, and then death happens at 11:00 PM. The act of dying is silent. I have one memory. A young woman was dying from breast cancer. She had one wish. She wanted her friends to bring pizza and beer. She said we should all treat ourselves, including her. And then she died the next day, maybe even that night."

Participants focused on their own emotions or the religious aspect of life after death when asked what they believe they achieve by performing certain rituals. Only one nurse, in her response to this question, directed her thoughts towards the patient's life: (S9) "I believe that in this way I respect human life until the end and that I pay my final respects to the body of the deceased. I have always thought that a person remains worthy even after death. One should behave toward them as a human being even after they have passed away. This is done not only as a professional but also with additional emotions. I can't feel for everyone, but I do empathize."

Participants also spoke about how rituals help them personally to cope with death. This is evident in their responses: (S4) "I don't know if I achieved anything. I think it makes me happy. I gave everything for him. Completely." (S8) "I think I do this mostly to make it easier for myself." (S5) "I am satisfied. It brings me personal fulfillment. I was with them until the end. I would love to sing – 'I've gone, I won't return...' I know the patients well; we had a patient who was a tamburitza player, and I thought I'd love to sing to you just as you sang to me. It comes to me to do that, even if just internally." (When asked if she ever sang, the participant replied no, but that she has the desire.) (S9) "After each death, there's a sense of unrest. It's not fear; it's more sorrow. Discontent. Did we do everything we could? But this way has freed me from that discomfort. It has eased those emotions." (S9) "... of course, it's a reflection – when you see someone else dying, you start to fear your own death. I was aware that this is my job. But you can't forget that this is someone's a mother, father... and I might be in a position to lose someone dear to me, and I would want someone to send them off like that too. That has helped me."

While some nurses described providing dignified care for the deceased, others focused on efficiency, noting the presence of other patients awaiting assistance. One participant stated: (S9) "Once I prepared the body for pathology, I no longer wanted to see that person. When I finished preparing, wrapped the body, and placed a barrier, I knew I had to go work with those who were waiting for my help. I didn't feel the need to see that person anymore."

Nurses are divided in their views regarding the appropriateness of rituals after a patient's death. One participant stated: (S1) "Given the workplace I am in, sudden deaths often occur, leaving little time for such things. If it's an expected death and palliative patients, they often spend their last phase of life not in contact and unable to discuss their wishes and needs after death. I believe it is ethically correct because my actions do nothing harmful to the patient or their integrity. And I believe many would willingly agree if they had the opportunity to express that wish." She added, "I think that by this act, I pay respect to the person after their death, and I believe that through my prayer and blessing, I opened a path for their soul to Heaven." Another nurse expressed uncertainty about the correctness of her actions: (S2) "I'm not sure if it's right and whether I achieved something for that person; however, if it is right and true, I don't want to know that I intentionally missed something by not opening the window. I don't want the soul to remain where it died." (S3) added, "...I think that by this act, their soul won't stay in the institution." (S8) commented, "I think I gave them absolution from sin and

a chance to cross over. It's as if I were the one who allowed them to leave this world."

Two participants secretly practice rituals during the dying process or after a patient's death. The others perform rituals in front of colleagues but not in front of the family: (S1, S2, and S3 respond almost identically) "The colleagues I work with know that I practice these rituals; some we even do together, but the family members of the deceased are unaware because I am not in contact with them due to the workplace I am in."

Participants commented on their rituals and the situation in the department: (S4) "I tell everyone. I even tell the interns that we will open the window. Sometimes they laugh a little, but they do it." (S5) "I think everyone knows. Some know. Although mostly I don't do anything else than what I've described. Some kiss the forehead, light a candle, or something similar. But I don't know about that, nor do I do it. Even those who do it don't talk about it. They keep silent." (S9) "With some colleagues, I've had the opportunity to talk about it, especially if I knew we shared the same worldview. That was a relief for them too. If I wasn't sure if the family wanted that, I didn't mention it to them. But I did talk to the family about the dying process when there was an opportunity. I always chose my words carefully, considering their well-being, so I didn't burden them with even what the patient said, especially anything negative. I often mentioned that the patient spoke positively about them at the end."

All participants confirmed that rituals were not discussed during their education. Two individuals had never seen colleagues practicing any rituals at work, while the others learned certain rituals from colleagues (doctors or nurses) in the department. One participant noted: (S9) "They would say that each of you will find some answer in such situations that you cannot cope with, after which you can continue to do your job. I saw that some of my colleagues had that need. They would cross themselves and say: 'God, it has come to an end.' In fact, quite a few people do that." Another participant added: (S7) "I learned the pattern from my colleagues."

Discussion

It is necessary to consider nurses' reactions to patient death in the context of their individual backgrounds, subjective experiences of dignity, and cultural traditions that they inherit and transform through education. To explore this context, a qualitative study was conducted involving nurses from several Croatian hospitals, aiming to gain detailed insights into their personal experiences with post-mortem rituals. This refers to specific post-mortem procedures that are not formally regulated by standardized protocols for the deceased, which some of them practice at the moment of a patient's passing.

Procedures regarding the deceased in the Republic of Croatia are prescribed by the regulatory body (HKMS, SOP 2.21) and relate to the process of preparing the dead body for transport to the morgue, waiting for the prescribed time until clear signs of death appear, the transport itself, documentation and, if required, an autopsy. In addition to the existence of formal mandatory rules regarding the treatment of deceased patients in hospitals, it has been established that there are also informal ritual practices that some healthcare professionals perform. Despite these regulations, informal practices are influenced by cultural and social factors, allowing for individual interpretations (15).

We observed more similarities than differences among the experiences of nurses. The conducted research found the most common post-mortem procedures participants performed included opening a window after death (or in one case, just before death). Additionally, opening a window serves a practical hygienic purpose by allowing fresh air into the room. Also, there is a medical purpose for the dying patient to receive fresh air. Several participants mentioned praying for the deceased's soul and performing the sign of the cross on their forehead. Furthermore, a post-mortem ritual of lighting a candle ("so that the dead body is not in darkness") or placing a few milliliters of water in the mouth ("so they do not leave thirsty for the other world") was established. In addition to these rituals, one participant noted that before death, if possible, she fulfills the dying patient's wishes in terms of food and drink and also respects regulations if the deceased was Muslim (in terms of

ritual washing). The post-mortem rituals performed by nurses in Croatia reflect local cultural and religious identities. For example, opening a window after death may be connected to folk beliefs about releasing the soul, while placing water in the mouth of the deceased may have roots in local customs.

In sporadic studies from Europe and the Middle East, post-mortem rituals such as touching the chest of the deceased, reciting prayers or reading specific texts, lighting candles as symbols of eternal life, and positioning the body with hands folded over the chest have been noted (9). In a study conducted in an Israeli intensive care unit, the entire staff refrained from consuming food or water from the moment of a patient's death until the body was taken to the morgue (9).

In a study conducted in Sweden and the United States where some nurses open a window when a patient dies, even though they are not sure why they do it (16). The authors explain that participating in and adapting to this ritual act seems natural, even if the meaning behind it is somewhat unclear (17). Research by Benbenishty et al. shows that by performing rituals, nurses establish order in their interactions and shared experiences (9). Their study indicates that rituals were rarely visible to others but were motivated by the personal and learned values of the nurse performing them, as well as by the practice of traditional care for the dying.

In addition to generational transfer of experience, participants indicated that their internal motivation for performing post-mortem rituals is to facilitate the "departure of the soul." One participant mentioned that she releases the deceased into "heavenly realms." In doing so, participants expressed that they generally felt better themselves; they reported increased self-confidence, reduced fear of death, contemplation of life's continuity, a sense of calm and relief, and a feeling of respect for the individual until the end.

The concept of the "journey" and "survival" of the soul is particularly noteworthy. Although it is not necessarily tied to a religious interpretation, considering that seven participants identified as believers, it can be concluded that this is motivated by religious teachings and motives. Additionally, a participant who identifies as an atheist stated that she releases the soul, "if it exists," to depart. The idea of releasing the soul supports the experience of a sense of immortality associated with the dualistic understanding of body and soul. In this context, the soul can be thought of as the principle of animating the body itself, yet independent of it, as accepted in the hylomorphic Christian interpretation. When discussing the immortality of the human soul, we refer to real and personal immortality, which differs from metaphorical or pantheistic immortality (18). Participants in the study do not feel that unfavorable procedures are the reason for this; they do not doubt its correctness. However, while some contemplate that it is an act that does not deprive a person if not performed, one participant argues that the act is very important and that she would personally want someone to do it for her.

It is worth noting that participants indicate they generally do not discuss the procedures they perform on deceased patients with the family members of the deceased. Although most participants engaged in post-mortem rituals, some expressed uncertainty about their significance or preferred not to discuss them openly. However, these practices are either talked about among colleagues or there is an awareness that some colleagues engage in them. Despite the fact that these acts are not prescribed by standardized procedures or ethical codes, they fit into traditional behaviors. These variations suggest a spectrum of beliefs and practices among nurses, which warrants further investigation. Additionally, the authors conclude that the rituals described do not conflict with professional practices and ethical principles.

The challenges of providing care for dying patients are significant, as the outcome is already known. Research by Wilson and Kirshbaum indicates that nurses are motivated to perform tasks that preserve the dignity of patients during death or dying, even though they sometimes find it difficult to cope with the situation themselves (19). The study revealed that the death of patients affects nurses and that they expressed the need for more education on coping with loss. Although all participants reported that they had not had the opportunity to learn about post-mortem rituals during their formal education, it was found that knowledge and experiences were primarily transmitted generationally from older colleagues. Most participants indicated that they were guided by senior colleagues at the beginning of their careers. In one case, it was noted that opening a window was a common practice among all staff in the department,

while in another instance, a nurse learned this practice from her grandmother, who was confirmed and encouraged by a colleague to perform it, especially in cases where someone is "struggling" during the dying process. Additionally, regarding the need for education on the topic of death and dying patients, nurses in the study by Makowicz et al. believe that the highest level of ethical behavior towards the dying should focus on ensuring dignified conditions for a peaceful death, and this perspective increases with the level of education of the respondents (20). These findings highlight the necessity for further research to explore how these practices impact both nurses and overall healthcare delivery.

Limitations of the study and guidelines for future research

This study faced limitations due to the lack of available comparative studies that would allow for a more thorough comparison of results, thereby restricting the ability to draw general conclusions on post-mortem rituals. However, in contrast to international studies, post-mortem procedures in Croatia are characterized by specific local and religious traditions. Additionally, the limited number of participants in the study may affect the generalizability of the results. While the data collected provided rich insights, it remains unclear whether theoretical saturation was fully achieved.

Another important limitation concerns the researcher's lack of formal experience in conducting qualitative interviews, which may have influenced the depth and consistency of data collection. Moreover, a personal relationship existed between the researcher and some of the participants. This could suggest the possibility of a shared value system between the researcher and participants, thereby reducing the level of neutrality expected in qualitative research.

Future research should focus on expanding the participant pool and incorporating comparative studies from different cultural contexts to enhance understanding of post-mortem rituals. Also, all the hospitals in Croatia should be included. Furthermore, the reasons why some participants perform rituals in secrecy or choose not to involve families in these practices were not explored in detail. Investigating these motivations in future studies could provide valuable insights into personal, professional, or cultural factors influencing such behavior. Addressing these limitations will help to create a more comprehensive framework for understanding the role of post-mortem rituals in healthcare settings.

Despite the noted limitations, this study lays an important foundation for further research into the role of cultural traditions in end-of-life care and the professional responsibilities of nurses within this sensitive area of practice.

Implications for clinical practice

Within the healthcare team, there should be an awareness of the various post-mortem rituals that nurses practice, as well as support and understanding for these practices. Encouraging the exchange of experiences can lead to a better understanding of these rituals. Hospital teams engaged in quality improvement may consider providing additional education for nurses on coping with patient death, thereby enhancing both the quality of care and the emotional well-being of healthcare workers. Further research is needed to better understand the impact of these practices on the emotional and psychological state of nurses and to ensure support in their implementation. Incorporating end-of-life care training into formal nursing education programs would equip future nurses with the necessary skills and emotional preparedness to handle these sensitive situations with professionalism and compassion. However, it is important to acknowledge that the recognition and promotion of such rituals may carry ethical risks, particularly for individuals who identify as atheists or agnostics, whether they are healthcare workers or patients. Ensuring that the implementation of these practices is inclusive and respectful of diverse beliefs is essential to maintaining an ethical and culturally sensitive approach. Recognizing and valuing these rituals can contribute to the quality of healthcare and the preservation of the cultural heritage of a given area.

Conclusion

The conducted research, which included nine participants, found that all engagement in post-mortem ritual behaviors extends beyond the prescribed standardized procedures for handling deceased bodies. These practices are primarily shaped by personal experiences of human dignity after death, as well as by inherited cultural traditions and the theoretical and practical components of nursing education.

It was found that nurses most commonly open windows, recite prayers, or make the sign of the cross over the forehead, along with other sporadically mentioned rituals. These behaviors are primarily learned from older colleagues and are often justified as a means to facilitate the soul's departure, in addition to providing a sense of peace, well-being, and satisfaction from the act. However, given the profound impact of these practices on both nurses and patient families, formalized education and training should be considered to ensure ethical and culturally sensitive approaches in end-of-life care.

The findings indicate the post-mortem procedures among participants are influenced by local and religious customs, although further research is needed to draw definitive conclusions. The experience of performing these rituals helps nurses coping more easily with individual deaths and fosters a sense of fulfillment in their duties towards the deceased. These practices are largely passed down through generations but are often overlooked in formal nursing education.

Further research in this area is essential to gain a deeper understanding of the ritual practices performed by nurses after a patient's death, as well as their impact on the nursing profession and healthcare. The professional community should raise awareness about these various ritual practices to provide support and understanding to those who engage in them.

Author contributions

Conceptualization and methodology (ID, DAA, JS); Data curation and formal analysis (ID, DAA, JS); Investigation and project administration (ID, DAA); Writing – original draft and review & editing (ID, DAA). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflict of interest.

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References

1. Becker E. The denial of death. New York: Free Press; 1973.
2. Haeffner G. Filozofska antropologija. Zagreb: Naklada Breza; 2003.
3. Markešić I. Čovjek i smrt. Zagreb: Institut društvenih znanosti Ivo Pilar; Hrvatsko katoličko sveučilište; Udruga posmrtna pomoć; 2017.
4. Wolfelt DA. Why is the funeral ritual important? [Internet]. Center for Loss; 2016. Available at: https://www.centerforloss.com/2016/12/funeral-ritual-important/. Accessed: 5.5.2023.
5. Stajić M. Prikaz knjige Aleksandre Pavićević: Vreme (bez) smrti. Antropologija. 2012;3(12):275-280.
6. Đorđević V, Braš M, Brajković L. Osnove palijativne medicine Ars medica prema kulturi zdravlja i čovječnosti. Zagreb: Medicinska naklada; 2013.
7. Kostka AM, Borodzicz A, Krzemińska SA. Feelings and emotions of nurses related to dying and death of patients - a pilot study. Psychol Res Behav Manag. 2021;14:705-17. https://doi.org/10.2147/PRBM.S311996
8. Ådland AK, Gripsrud B, Lavik HM, Ramvi E. They stay with you: nursing home staff's emotional experiences of being in a close relationship with a resident in long-term care who died. J Holist Nurs. 2022;40(2):108-22. https://doi.org/10.1177/08980101211017766
9. Benbenishty J, Bennun M, Lind R. Qualitative analysis of European and Middle East intensive care unit nursing death rituals. Nurs Crit Care. 2020;25(5):284-90. https://doi.org/10.1111/nicc.12478
10. Wolf Z. Exploring rituals in nursing: joining art and science. United States: Springer Publishing Company; 2013.
11. Gazić M, Benceković Ž, Benko I, Bukvić M, Kalauz S, Konjevoda V. Standardizirani operativni postupci u zdravstvenoj njezi. Zagreb: Hrvatska komora medicinskih sestara; 2022.
12. Šestak I, Abou Aldan D. Analiza koncepta osobe u teorijama zdravstvene njege. Disputatio Philosophica. 2022;24(1):43-56. https://doi.org/10.32701/dp.24.1.3
13. Magaldi D, Berler M. Semi-structured interviews. In: Encyclopedia of personality and individual differences. 2020:4825-30. https://doi.org/10.1007/978-3-319-24612-3_857
14. REV. How to analyze interview transcripts in qualitative research [Internet]. Rev.com; 2023. Available at: https://www.rev.com/blog/transcription-blog/analyze-interview-transcripts-in-qualitative-research. Accessed: 18.12.2023.
15. Bednjanec D, Petrović D. Smrt ili (naprosto) umiranje? Filozofsko-antropološki razgovori o interpretacijama neposrednog iskustva smrti. Glasnik Etnografskog instituta. 2022;70(3):193-213. https://doi.org/10.2298/gei2203193b
16. Oliver DP, Porock D. Managing the secrets of dying backstage: the voices of nursing home staff. OMEGA. 2006;53(3):193-207. https://doi.org/10.2190/3P8G-5JAD-J2NF-BKGK
17. Rytterström P, Unosson M, Arman M. The significance of routines in nursing practice. J Clin Nurs. 2011;20(23-24):3513-22. https://doi.org/10.1111/j.1365-2702.2010.03522.x
18. Dezza P. Filosofia. Roma: Editrice Pontificia Università Gregoriana; 1977.
19. Wilson J, Kirshbaum M. Effects of patient death on nursing staff: a literature review. Br J Nurs. 2011;20(9):559-63. https://doi.org/10.12968/bjon.2011.20.9.559
20. Makowicz D, Dziubaszewska R, Makowicz N, Barna P, Piękoś M. The attitude of nursing staff towards the death and dying of the patient. Piel XXI Wiek. 2019;18(3):151-61. https://doi.org/10.2478/pielxxiw-2019-0024

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Original scientific paper

An Analysis of Nurse Prescribing in Slovenia and Croatia: Current Practices, Attitudes, and Future Perspectives

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Abstract

Introduction. Nurse prescribing has been implemented in many countries to address physician shortages and improve healthcare efficiency. Nations like the UK, Ireland, and Sweden have established models allowing nurses to prescribe medications, with varying scopes and educational requirements. While some countries permit independent prescribing, others restrict it to certain conditions or medications. These systems have shown clinical benefits and cost-effectiveness of nurse prescribing.

Aim. This study explores current practices and the potential for implementing nurse prescribing in Slovenia and Croatia.

Methods. A cross-sectional survey was conducted from March to May 2024 on 185 nurses from Slovenia and Croatia. The questionnaire covered demographics, current practices, and attitudes toward nurse prescribing. Data were analyzed using IBM SPSS Statistics 20.0 with descriptive statistics and Chi-square tests. Participants from other countries were excluded from inferential analysis.

Results. Slovenian nurses reported greater involvement in medication-related tasks, such as independent medication administration (SLO=28.6%, CRO=15.8%) and therapy adjustment based on vital signs (SLO=24.4%, CRO=11.5%). Statistically significant differences were found in self-education and the use of medication-related applications, with Slovenian nurses showing higher engagement. Most

participants in both countries supported nurse prescribing under specific conditions, especially following additional training and within a legal framework.

Conclusion. Findings indicate broad support for nurse prescribing among nurses in both countries. Slovenian nurses are more involved in prescribing-related tasks even if there is no legal basis for it, while Croatian nurses are entering this area through new emergency care specializations. Future development requires targeted education, clear legal regulations, and strong interprofessional collaboration to ensure safe and effective nurse prescribing.

Introduction

Prescribing of medications has long been a competence reserved for the medical profession. However, this trend is changing due to the shortage of physicians, better and higher-quality education in nursing, increased interprofessional collaboration, and the rise in chronic diseases, with medication prescribing becoming a competency for nurses (1). Increasingly, countries such as Australia, Canada, Finland, Ireland, New Zealand, Sweden, the United Kingdom, and the United States allow nurses to prescribe medications (2). All these countries provide education and professional support for nurses. However, the education differs between countries; for example, in the United Kingdom and Ireland, education to acquire medication prescribing competencies consists of 26 days of theoretical training and 12 days of practical training, while in other countries, the training is longer and organized as a specialist study for nurses (e.g., Canada, Australia, USA) (2).

In 2011 the International Council of Nurses reported on the implementation of nurse prescribing worldwide. For example in 2010, Australia experienced a historic reform by expanding the scope of practice for nurse specialists, allowing them to prescribe medications in certain cases. Nurse specialists were granted the authority to prescribe medications within the healthcare insurance framework, enabling them to prescribe medications in both private and public practice. As a result, nurse specialists obtained the same prescribing authority as physicians (3). In Canada, it was observed that 14% of the population lacks access to a family medicine specialist, which triggered a reorganization and expansion of nurses' competencies. Nurses with higher education (nurse specialists) are allowed to prescribe medications from a predefined list for chronic conditions (e.g., medications for diabetes, bronchodilators, antihypertensives, etc.) (3).

Fourteen European countries have enacted legislation enabling nurse prescribing, 12 of which have implemented it nationwide (Croatia, Cyprus, Denmark, Estonia, Finland, France, Ireland, the Netherlands, Norway, Poland, Spain, Sweden, and the United Kingdom), while in Switzerland, this competence is limited to one canton. In contrast to these countries, Portugal strictly regulates and restricts prescribing to physicians, with minor exceptions such as administering insulin to diabetic patients or adrenaline during an anaphylactic reaction without a physician's order; however, this cannot be classified as medication prescribing (4).

The Swedish Association of Health Professionals emphasized in 2011 that nurses' prescribing rights should not be limited to specific workplaces or activities but should instead be determined by the level of knowledge demonstrated by the nurse. The Swedish National Board of Health and Welfare partially agreed and outlined three conditions for granting nurses the right to prescribe medications (3,4):

- A minimum of one year of additional training, including at least 15 credits in pharmacology and disease pathology (understanding disease progression with diagnosis and treatment);
- The nurse must work within a specific nursing specialty;
- To obtain the right to prescribe medications and a prescriber identification number, the nurse must be registered with the National Board of Health and Welfare.

Thus, nurses in Sweden can prescribe medications only within their specialty. However, nurses working in primary healthcare, home care, and nursing homes do not have prescribing rights (3).

In the United Kingdom, nurse prescribing is an established professional qualification. Research has shown that nurse prescribing is both cost-effective and clinically effective and enjoys significant patient support (2,5). Unlike other countries where nurses

are limited to specific medication lists or areas of specialty, nurses in the United Kingdom can prescribe almost all medications, with exceptions for certain opioids, dipipanone, and diamorphine used in addiction treatment (4).

Table 1 presents the scope of nurse prescribing across countries. It is evident that countries differ regarding the number of medications nurses can officially prescribe, the types of medical conditions for which they can prescribe, and the type of prescribing (4).

The type of prescribing refers to initial prescribing and subsequent prescribing where the former means that the nurse prescribes a new medication, while in the latter case, the nurse can issue repeat prescriptions after the diagnosis has been established and the medication initially prescribed by a physician (4). To obtain competencies for nurse prescribing, it is necessary to regulate legal provisions and the educational system. Many countries offer additional training after the completion of undergraduate studies, while some focus on specialized programs or supplementary courses (4).

The first to establish nurse prescribing was the United Kingdom, which distinguishes between the nurse supplementary prescriber, introduced in 1992, and the nurse independent prescriber, introduced in 2012 (4,6).

The Republic of Slovenia and the Republic of Croatia share certain similarities and differences when it comes to this topic. Until recently, both countries had comparable systems; however, since 2023, Croatia has introduced a specialist training program for bachelor's degree nurses in the field of emergency medical services, lasting one year. Upon completion of the program, nurses have acquired additional competencies, including the independent prescribing of therapy related to the management of emergency conditions in patients (7). This marks the first branch of nursing in Croatia to have a structured specialization with extended competencies related to the pharmacological management of patients. In Slovenia, there is still no model in place that would allow nurses to acquire additional competencies for prescribing therapy, and consequently, there is no legal framework to support such practice (9, 15). The growing need for interprofessional collaboration is confirmed by a comparative qualitative study conducted in Croatia and Slovenia (27). The research revealed that nurses in both countries face similar challenges—insufficient education in the field of pharmaceutical care, a sense of unequal status within the healthcare team, and a lack of effective communication with physicians and pharmacists. Despite differences in the healthcare system contexts, both settings recognize the need for additional competencies, more active involvement in research processes, and a system that adequately values their work (4, 9, 15, 27).

Although nurse prescribing is not implemented worldwide, an increasing number of countries are choosing to optimize their healthcare systems. With appropriate implementation and legal support, this could become part of nursing curricula and professional standards, thereby advancing nursing as a profession.

Aim

The aim of our research was to examine the current practice of nurse prescribing in Slovenia and Croatia, as well as the possibilities for implementing nurse prescribing in the future.

Within the aim of the research objective, we formulated three research questions:

- What is the current practice regarding medication prescribing by nurses?
- What are nurses' attitudes towards medication prescribing?
- What limitations, in nurses' opinion, would be necessary in the event of implementing nurse prescribing?

Table 1. **The scope of nurse prescribing in European Union countries (4,7)**

Country	Name/ Professional Title	Prescribing rights by major area and conditions					
		Vaccines	Contraceptives	Chronic conditions	Acute illnesses	Pain medications	Other
Croatia[9]	Nurse specialist in emergency services	/	/	/	IP (16 different medications)	/	/
Denmark[4]	Registered nurse	CP	CP	CP	CP	CP	CP
Estonia	Family nurse	/	CP (hormonal contraceptive)	CP (diabetes, hypertension)	CP (acute cystitis, nitrofurantoin)	/	/
Finland	Nurse prescriber	IP (influenza, hepatitis, varicella)[1]	IP (hormonal contraceptive)[1,2]	CP (asthma, dyslipidemia, hypertension)[1]	IP (pharyngitis) CP (UTI)[1]	IP (local anaesthetics)[1]	/
Ireland[5]	Nurse prescriber	IP	IP	IP	IP	IP	IP
Netherland	Diabetes, oncology, lung nurses	/	/	IP (diabetes, oncology, lung disease)	/	IP (oncology)	/
Netherlands[8]	Nurse prescriber	IP	IP	IP	IP	IP	IP
Norway	Public health nurse	IP	IP[3]	/	/	IP (adrenaline for allergic reactions, local anaesthetics)	IP (sterile equipment for IU implants)
Poland	RN (Master)	/	IP (gynaecological drugs)	IP (asthma)	IP (throat, ear, sinus, UTI)	IP (analgesics, locally acting anaesthetics)	IP (anti-emetics, anti-parasitic, IV infusion fluids)
Poland[6]	RN (Bachelor)	/	CP (gynaecological drugs)	CP (asthma)	CP (throat, ear, sinus)	CP (analgesics, locally acting anaesthetics)	CP (anti-emetics, anti-parasitic, IV infusion fluids)
Spain[7]	RN (Bachelor)	IP (according to vaccination schedule)	IP (emergency contraception)	CP	CP	CP	IP (OTC)
Sweden	RN (Bachelor)	/	/	/	IP (throat, mouth, dermatological diseases, GI, UTI)	IP (pain management)	/
United Kingdom[5]	Independent prescriber	IP	IP	IP	IP	IP	IP
United Kingdom	Supplementary prescriber	CP	CP	CP	CP	CP	CP

Note: [1]= not for children under the age of 12; [2]=not for women under age 35; [3]=only for women over 16 years of age; 4=continued prescribing according to local frame prescriptions and in a delegate model; [5]=initial prescribing rights of all medicines falling within nurse specialisation, restrictions and additional requirements apply to controlled medications; [6]=prescribing rights according to formulary of 12 groups of medicines; [7]= prescribing rights guaranteed to all RN within minimum 1 year work experience, for RN with less than 1 year work experience additional training required ; [8]=initial prescribing rights of all medicines falling within nurse specialisation; [9]=in accordance with the specialization in the field of emergency medical care; GI=gastrointestinal; UTI=urinary tract infection; OTC=over-the-counter medications; IP=initial prescribing; CP=continuous prescribing follow-up prescribing after first prescription issued by physician; IP= initial prescribing; CP=continued prescribing only

Methods

Study design

We employed a quantitative descriptive study approach using the survey method. A cross-sectional study was conducted from March 2024 to May 2024, involving nurses from Slovenia and Croatia. The online survey was distributed to various public healthcare institutions and social media.

Respondents

A convenience sample of nurses (n=185), including 117 from Slovenia and 68 from Croatia, was used (23). The average age of respondents was 35.8 years (SD=10.41), and the average length of work experience was 14.0 years (SD=10.47) (Table 2).

Participation in the survey was voluntary, and completing the survey implied consent to participate. The survey took approximately 10 minutes to complete.

Instrument

For the purposes of the research, a survey was created, based on a literature review (9, 10, 25, 26). The first part of the questionnaire collects demographic information and includes the question: "Do you have the legal right to prescribe medications in the country where you work?" Respondents were provided with four response options (Yes, I am allowed to prescribe all medications; Yes, I am allowed to prescribe medications exclusively within my area of specialisation; Yes, I am allowed to prescribe only certain medications as defined by law and No). The second part of the questionnaire refers to current practice related to prescribing medications. The first question of the second part was "Which of the following activities do you perform in your current clinical practice?" where we provided respondents with six possible answer and they were allowed to select multiple options (prolonging chronic therapy (renewing regular prescriptions), transcribing therapy into the patient's medical documentation (copying therapy to temperature charts), administering pain relief medications without a doctor's order, independently administering certain medications without a doctor's order (e.g., an additional antihypertensive tablet, gastric protection, etc.), suggesting to other healthcare professionals which therapy should be prescribed, adjusting medications without a doctor's order based on the patient's vital parameters). For the next four questions, "Do you ever alert a physician/clinical pharmacist about incorrect medication prescribing?", "Do you participate in any educational sessions organized by pharmaceutical company representatives (e.g., lectures about new medications)?", "Do you independently educate yourself about pharmacology, new medications, active ingredients, and drug effects?" and "Do you use medication support applications (e.g., smartphone apps) in your work?", we used a three-point scale: never, occasionally, always.

The third part of questionnaire refers to the possibilities for further practice in the field of medication prescribing. First question "To what extent should nurses be involved in medication prescribing?", we provided three possible answers: I disagree that nurses should prescribe medications; Nurses can prescribe medication depending on specific conditions or frameworks; Nurses can prescribe medication independently. Second question "What restrictions would be necessary if nurses were allowed to prescribe medications?" where we provided respondents with nine possible answer and they were allowed to select multiple options (without restrictions, they could only prescribe certain medications (limited list), only in specific contexts (special health conditions/specialization), after completing targeted training, they can only prescribe long-term medications, only low-risk medications, only over the counter medications, only in emergency situations, only within the treatment and healthcare plan). In the last question "Which of the following measures should be implemented to enable nurses to gain the competency to prescribe medications?", four multiple-choice answers were offered (Introduction of specializations in nursing (specific knowledge in a narrow specialty area, with the option to prescribe only within that area), introduction of broader education in pharmacology at the undergraduate level, introduction of a one-year postgraduate course on medication prescribing, Legally regulate that nurses can prescribe medications according to established protocols (e.g., adrenaline, amiodarone, atropine, glucose, etc.). The Cronbach's alpha coefficient for the internal consistency of our questionnaire was 0.67.

Ethics

The study was approved by the Ministry of Health, Medical Ethics Committee of the Republic of Slovenia with serial number: 0120-468/5022/6. The study was conducted in accordance with the principles of the Helsinki-Tokyo Declaration (16).

Statistics

The data were entered in an Excel spreadsheet and analyzed in SPSS 20.0 software (IBM Corp., NY, USA) for statistical analysis. The normality of the distribution of all variables was tested using the Kolmogorov-Smirnov test for normality. It was found that all variables significantly deviate from normal distribution. For analysis we use Descriptive statistics and Chi-square test of independence.

Results

A total of 185 nurses participated in the study. Most of the participants were registered nurse (48.1%) and most of them were women (69.7%).

Most respondents do not have legal rights to prescribe medications (n=184; 99.4%) only 1 respondent has legal rights to prescribe all mediations (0.6%).

Slovenian nurses reported higher engagement in all assessed practices. Specifically, 36.2% of Slovenian nurses indicated that they independently administer certain medications without a physician's order (e.g., additional antihypertensive drugs or gastric protection), compared to 20.0% in Croatia. Similarly, 30.8% of Slovenian nurses reported adjusting medications based on patients' vital parameters, in contrast to 14.6% of Croatian nurses. Although the difference was not statistically significant (χ^2=1.217, p=0.270).

Table 2. **Demographic characteristics of participants (n=185)**

Demographic data		n	%
Gender	Male	56	30.3
	Female	129	69.7
Education level	Nurse (high school)	77	41.6
	Registered nurse	89	48.1
	Master of nursing	19	10.3
Working environment	Nursing home	16	8.7
	Family medicine clinic	30	16.2
	Other specialty clinic	16	8.7
	Emergency medical services	65	35.1
	Intensive care unit	18	9.7
	Hospital ward at secondary level	28	15.1
	Hospital ward at tertiary level	5	2.7
	Home care and community nursing services	7	3.8

Other activities such as transcribing therapy into patient documentation (SLO 44.9% vs. CRO 23.3%), suggesting therapy to physicians (SLO 31.9% vs. CRO 22.7%), and administering pain relief without a physician's order (SLO 28.1% vs. CRO 12.4%) followed a similar pattern, favoring greater involvement of Slovenian nurses in medication-related decisions. However, none of these differences were statistically significant (Table 3).

The results revealed statistically significant differences between Slovenian and Croatian nurses across all examined medication-related practices. Slovenian nurses were significantly more likely to alert physicians or pharmacists about incorrect medication prescribing (χ^2=92.445, p<0.001), participate in educational sessions organized by pharmaceutical companies (χ^2=43.974, p<0.001), and engage in independent pharmacological learning (χ^2=95.636, p<0.001). Furthermore, the use of medication support applications was markedly higher among Slovenian nurses, with no reported usage among Croatian nurses (χ^2=128.701, p<0.001) (Table 4).

Table 3. **Current practice regarding prescribing medication by nurses**

Variables	Slovenia		Croatia		χ^2	df	p
	n	%	n	%			
Prolonging chronic medications (renewing regular prescriptions)	49	26.5	28	15.1	0.009	1	0.925
Transcribing therapy into the patient's medical documentation (copying therapy to temperature charts)	83	44.9	43	23.3	1.175	1	0.278
Administering pain relief medications without a physician's order	52	28.1	23	12.4	2.013	1	0.156
Independently administering certain medications without a physician's order (e.g., an additional anti-hypertensive tablet, gastric protection, etc.)	67	36.2	37	20.0	0.142	1	0.706
Suggesting to other healthcare professionals which medication should be prescribed	59	31.9	42	22.7	1.891	1	0.169
Adjusting medications without a physician's order based on the patient's vital parameters.	57	30.8	27	14.6	1.217	1	0.270

Note $\chi 2$=Chi-square test, df=degrees of freedom, p=statistical significance; The number and percentage present the answer YES

Table 4. **Current practice regarding prescribing medications by nurses**

Variables	Answers	Slovenia	Croatia	χ^2	df	p
Do you ever alert a physician/clinical pharmacist about incorrect medication prescribing?	never	23	63	92.445	2	***0.000***
	occasionally	70	5			
	always	24	0			
Do you participate in any educational sessions organized by pharmaceutical company representatives (e.g., lectures about new medications)?	never	58	68	43.974	2	***0.000***
	occasionally	49	0			
	always	1	0			
Do you independently educate yourself about pharmacology, new medications, active ingredients, and drug effects?	never	24	67	95.636	2	***0.000***
	occasionally	72	1			
	always	10	0			
Do you use medication support applications (e.g., smartphone apps) in your work?	never	11	68	128.701	2	***0.000***
	occasionally	45	0			
	always	44	0			

Note: $\chi 2$=Chi-square, df=degrees of freedom, p=statistical significance

Table 5. **Nurses' opinions on the right to prescribe medications**

	Slovenia		Croatia	
	n	%	n	%
I disagree that nurses should prescribe medications	35	18.9	25	13.6
Nurses can prescribe medications depending on specific conditions or frameworks	79	42.7	43	23.2
Nurses can prescribe medication independently with full autonomy	3	1.6	0	0.0

Note: The number and percentage present the answer YES

Future prospects of nurse prescribing

In Slovenia, 42.7% of respondents believed that nurses should be allowed to prescribe medications depending on specific conditions or frameworks, compared to 23.2% in Croatia. A small proportion of nurses in both countries supported full prescribing autonomy, with only 1.6% of Slovenian nurses in favor and none from Croatia (Table 5).

Table 6 outlines nurses' views on necessary restrictions if prescribing were to be allowed. The responses indicate that nurses conditionally support the introduction of prescribing rights, particularly under specific regulatory and educational frameworks, which implies overall support (Yes) for nurse prescribing under defined conditions.

The analysis of nurses' opinions on necessary restrictions for implementing nurse prescribing revealed several statistically significant differences between Slovenia and Croatia. A significantly higher proportion of Slovenian nurses supported prescribing only after completing targeted training (SLO=44.9%; CRO=9.2%), only for long-term therapy (SLO=50.8%; CRO=19.5%), only in emergency situations (SLO=49.2%; CRO=36.8%), and only within a treatment and healthcare plan (SLO=59.5%; CRO=24.9%) (Table 6).

The results show that statistically significant differences were observed between Slovenian and Croatian respondents regarding their support for introducing broader pharmacological education at the undergraduate level (χ^2=8.033, p=0.005), a one-year postgraduate course on medication prescribing (χ^2=21.637, p<0.001), and the legal regulation of nurse prescribing according to established protocols (χ^2=24.695, p<0.001). Significantly more Slovenian nurses agree with those statements (Table 7).

Discussion

The primary aim of this study was to explore current practices, attitudes, and future perspectives regarding nurse prescribing in Slovenia and Croatia. The findings indicate that Slovenian nurses exhibit greater autonomy and involvement in clinical activities related to medication management compared to their Croatian counterparts, despite the lack of formal legal regulation in Slovenia. This discrepancy may reflect differences in national healthcare policies, models of clinical delegation, and nursing education systems. The study shows that nurses in both countries generally support the idea of nurse prescribing, particularly when it is implemented under clearly defined conditions. This cautious yet positive stance reflects a responsible professional attitude towards expanding nursing roles. Nurses appear to favour dependent or protocol-based prescribing over full autonomy, indicating a preference for a regulated and structured approach. Such preferences were especially evident among Slovenian participants, who more frequently endorsed conditions like additional training, limitation to long-term or emergency therapies, and prescribing within care plans. These findings suggest that while nurses are open to assuming greater responsibility, they also recognise the importance of ensuring patient safety and maintaining interprofessional balance. This supports the argument that any future implementation should be gradual and informed by evidence and international experiences, taking into account the specific educational and regulatory contexts of Slovenia and Croatia. Furthermore, the proactive engagement of Slovenian nurses in pharmacology education and their use of digital tools indicate a readiness for more advanced clinical roles, whereas the recent introduction of specialisation in Croatia marks an important but still early step toward systemic reform. While support for full autonomy in prescribing remains low, conditional or dependent prescribing is widely accepted, particularly in emergency situations. These preferences reflect a cautious and safety-oriented approach among nurses, which aligns with practices in countries where nurse prescribing has been successfully implemented through a gradual, regulated process.

The expansion of nurse prescribing has emerged as a global trend aimed at optimizing healthcare systems, and improving patient access to medications. Nurse prescribing competencies have been integrated into healthcare systems in several countries, with various levels of autonomy ranging from collaborative prescribing under physician supervision to independent prescribing (8,18,19). However, the acceptance of nurse prescribing and its implementation remain subject to regional, professional, and regulatory considerations. Understanding current perspectives on

Table 6. **Restrictions in case nurse prescribe medications**

Variables	Slovenia		Croatia		χ^2	df	p
	n	%	n	%			
Without restrictions	0	0.0	2	1.0	3.554	1	0.059
They could only prescribe certain medications (limited list)	87	47.0	42	22.7	3.583	1	0.058
Only in specific contexts (special health conditions/specialization)	80	43.2	40	21.6	2.184	1	0.139
After completing targeted training	83	44.9	17	9.2	36.545	1	***0.000***
They can only prescribe long-term therapy	94	50.8	36	19.5	15.456	1	***0.000***
Only low-risk medications	62	33.5	27	14.5	3.041	1	0.081
Only over-the-counter medications	49	26.5	22	11.9	1.651	1	0.199
Only in emergency situations	91	49.2	68	36.8	17.582	1	***0.000***
Only within the treatment and healthcare plan	110	59.5	46	24.9	22.624	1	***0.000***

Note: χ2=Chi-square test of independence, df=degrees of freedom, p=statistically significant, The number and percentage present the answer YES

Table 7. **Measures to be implemented to enable nurses to gain the competency to prescribe medications**

Variables	Slovenia		Croatia		χ^2	df	p
	n	%	n	%			
Introduction of specializations in nursing (specific knowledge in a narrow specialty area, with the option to prescribe only within that area)	93	50.3	52	28.1	1.348	1	0.246
Introduction of broader education in pharmacology at the undergraduate level	70	37.8	26	14.1	8.033	1	***0.005***
Introduction of a one-year postgraduate course on medication prescribing	72	38.9	18	9.7	21.637	1	***0.000***
Legally regulate for nurses to prescribe medications according to established protocols (e.g., adrenaline, amiodarone, atropine, glucose, etc.)	69	37.3	18	9.7	24.695	1	***0.000***

Note: χ2=Chi-square test of independence, df=degrees of freedom, p=statistically significant, The number and percentage present the answer YES

nurse prescribing among healthcare professionals is critical for evaluating its feasibility and potential implementation in countries like Slovenia and Croatia (9,11,15).

Nurses also identified key prerequisites for implementing prescribing roles, including specialized education, broader pharmacology training, and the establishment of legal frameworks. Slovenian nurses, in particular, emphasized the need for formal specializations and postgraduate education as essential components for safely expanding their professional competencies. These findings are consistent with existing literature, which underscores that structured education and legal clarity are critical for nurse prescribing to be both safe and effective (4, 22, 24).

The results also point to differences in professional behavior and readiness for new roles. Slovenian nurses are more likely to engage in activities such as independent pharmacological learning, attending educational sessions, and using digital tools to sup-

port medication safety. These behaviors suggest a stronger culture of continuous professional development and may reflect a higher degree of preparedness for adopting prescribing responsibilities.

While some European countries have successfully integrated nurse prescribing into nursing practice, others are still in the process of defining legal and educational requirements. Croatia has taken steps in this direction by enabling emergency nurses to prescribe specific medications under strict protocols, indicating a possible pathway for expanding such roles in a controlled and evidence-based manner. In contrast, Slovenia lacks a formal legal framework for nurse prescribing but shows potential for development based on nurses' readiness and interest (13, 14, 15).

Expanding the role of nurses in medication prescribing requires not only educational reform and legal clarity but also interprofessional collaboration. A shared understanding of roles and responsibilities among healthcare providers can foster trust and create a supportive environment for nurses to take on prescribing responsibilities. Studies show that nurse prescribing can improve patient access to care, reduce physician workload, and enhance the quality of pharmaceutical care when properly regulated and supported (12, 25, 26).

In summary, the findings indicate that while nurse prescribing is not yet a common practice in Slovenia, there is a foundation of interest, cautious support, and willingness to engage—especially when prescribing is tied to specialized roles, defined clinical contexts, and proper training. A gradual and well-regulated approach, accompanied by targeted educational measures, appears to be the most acceptable and feasible path toward implementing nurse prescribing in both countries (15, 17, 21).

It is important to emphasize that Croatia is already implementing certain system upgrades in this area (7). With the introduction of a specialization in emergency medical care, nurses are allowed to prescribe medications as specified by regulation. It can be concluded that Croatia is significantly strengthening the autonomy of nurses, while Slovenia is lagging behind in this regard, as the development of nursing specializations is planned for the period up to 2028 (20).

We must acknowledge that nurse prescribing is not legally supported in Slovenia. Precisely because of this, the results reveal shortcomings in the healthcare system, where nurses still find themselves in situations that require them to exceed their formal competencies. It is important to highlight that Croatia is significantly more advanced in developing nursing autonomy through the introduction of specialisations, which also expands the scope of competencies. As a result, nurses in Croatia are legally protected when performing these advanced roles.

The results of this study highlight several important implications for clinical practice and health policy. Educational reform is essential, broader pharmacology education at the undergraduate level and targeted postgraduate courses should be introduced to prepare nurses for prescribing responsibilities. Specialization in nursing should be formally established and linked to defined scopes of prescribing authority. Legal frameworks must be developed to support safe and structured implementation of nurse prescribing, with clearly defined protocols and responsibilities. Interprofessional collaboration should be strengthened to ensure clear role delineation, effective communication, and shared decision-making between nurses, physicians, and pharmacists (9,10). This is further supported by research from Petrović et al. (15), which found that Slovenian nurses experience a strong sense of underrecognition and unequal standing within interprofessional teams—possibly reinforcing their desire for formal prescribing competencies as a way to elevate their professional role.

From a policy perspective, the results from our study suggest that future strategies should prioritise structured postgraduate programs, integration of pharmacology at the undergraduate level, and legislative support for protocol-based prescribing. As emphasise, successful implementation of non-medical prescribing requires a solid foundation of education, support, and regulation. Our data support this view and add context-specific insights into the Slovenian and Croatian healthcare systems (19).

To support safe implementation, it is essential to develop targeted postgraduate programs, strengthen pharmacology education at the undergraduate level, and establish clear legal guidelines. Promoting interprofessional collaboration will also be key. A gradual, evidence-based, and well-regulated approach, informed by countries where nurse prescribing is already established, offers the most appropriate path forward for Slovenia and Croatia.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the sample size was relatively small (n=185), particularly when divided between Slovenia and Croatia, which limits the generalizability of the results to the wider nursing populations in both countries. The use of voluntary participation and online distribution may have introduced self-selection bias, as individuals with a stronger interest or opinion on nurse prescribing were possibly more inclined to participate. Additionally, the absence of nurse specialists from the Croatian sample—likely due to the recent introduction of postgraduate specialization programs—may have influenced the findings by underrepresenting more prepared or engaged respondents, thus limiting cross-country comparability. The cross-sectional design captures data at a single point in time and does not allow for causal inference or reflection of evolving trends. Moreover, the reliance on self-reported data raises the possibility of social desirability bias, particularly in responses regarding professional behaviors or support for future prescribing roles. Although the questionnaire was informed by existing literature and demonstrated acceptable internal consistency (Cronbach's alpha=0.67), it was newly developed for this study and has not undergone full psychometric validation. The inclusion of both factual and attitudinal items may have resulted in variable interpretation based on respondents' clinical experience, educational background, or familiarity with relevant terminology. Furthermore, notable differences in healthcare systems, educational pathways, and regulatory frameworks between Slovenia and Croatia may have influenced participants' responses and hindered direct comparisons. Finally, the study's exclusively quantitative approach limited the opportunity to explore in-depth perspectives, cultural factors, or professional dynamics that could be better captured through qualitative methods.

Conclusion

This study explored current practices, attitudes, and future perspectives regarding nurse prescribing among nurses in Slovenia and Croatia. The findings show that Slovenian nurses are more frequently engaged in medication-related tasks, including independent medication administration and therapy adjustment. They also report higher involvement in self-directed pharmacological education, participation in industry-led educational sessions, and the use of digital tools for medication support. While legal frameworks for nurse prescribing are largely absent in both countries, nurses are already involved in practices closely related to prescribing.

Nurses in both countries expressed general support for the implementation of nurse prescribing, particularly under clearly defined conditions. Most respondents favoured limitations such as targeted training, restrictions to specific medication types or contexts, and integration within treatment plans. Slovenian nurses more strongly supported measures such as postgraduate education and legal regulation to enable safe prescribing practices. These results offer a foundational understanding of the current state and future possibilities for nurse prescribing in both settings.

Author contributions

Conceptualization and methodology (MPe, MPr); Data curation and formal analysis (MPe, BO); Investigation and project administration (BO, SL); and Writing – original draft and review & editing (MPe, MPr). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflict of interest.

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References

1. Creedon R, Byrne S, Kennedy J, McCarthy S. The impact of nurse prescribing on the clinical setting. Br J Nurs. 2015;24(17):878–85. https://doi.org/10.12968/bjon.2015.24.17.878
2. Adams E. Nurse and midwife medicinal product prescribing in Ireland. In: Kvas A, Lokajner G, Požun P, Sima Đ, editors. Predpisovanje zdravil – izziv medicinskim sestram za prihodnost? Ljubljana: Društvo medicinskih sester, babic in zdravstvenih tehnikov Ljubljana; 2012. Slovenian.
3. International councile of nurses. Predpisovanje zdravil s strani medicinskih sester. In: Kvas A, Lokajner G, Požun P, Sima Đ, editors. Predpisovanje zdravil – izziv medicinskim sestram za prihodnost? Ljubljana: Društvo medicinskih sester, babic in zdravstvenih tehnikov Ljubljana; 2011. Slovenian.
4. Maier CB. Nurse prescribing of medicines in 13 European countries. Hum Resour Health. 2019;17(1):95. https://doi.org/10.1186/s12960-019-0429-6
5. Luetsch K, Rowett D. Interprofessional communication training: benefits to practicing pharmacists. Int J Clin Pharm. 2015;37(5):857–64. https://doi.org/10.1007/s11096-015-0131-2
6. Kroezen M, Francke AL, Groenewegen PP, van Dijk L. Nurse prescribing of medicines in Western European and Anglo-Saxon countries: a survey on forces, conditions and jurisdictional control. Int J Nurs Stud. 2012;49(8):1002–12. https://doi.org/10.1016/j.ijnurstu.2012.02.002
7. Republic of Croatia. Regulation on amendments to the regulation on specialist training of bachelor of nursing in the field of emergency medicine [Internet]. Narodne novine; 2022. Available at: https://narodne-novine.nn.hr/clanci/sluzbeni/2022_11_139_2094.html Accessed: 24.06.2024.
8. De Baetselier E, Van Rompaey B, Batalha LM, Bergqvist M, Czarkowska-Paczek B, De Santis A, et al. EUPRON: nurses practice in interprofessional pharmaceutical care in Europe. A cross-sectional survey in 17 countries. BMJ Open. 2020;10(6):e036269. https://doi.org/10.1136/bmjopen-2019-036269
9. Petrović M, Prosen M, Ličen S, Karnjuš I. Odnos zaposlenih v zdravstveni negi do predpisovanja zdravil: raziskava z rabo mešanih metod. Obzor Zdrav Neg. 2023;57(2):89-99. https://doi.org/10.14528/snr.2023.57.2.3163.
10. Prosen M, Ličen S, Karnjuš I. Vloga medicinskih sester v medpoklicnem sodelovanju v okviru farmacevtske skrbi v Evropi: rezultati EUPRON projekta za Slovenijo. Izola: Univerza na Primorskem, Fakulteta za vede o zdravju; 2018.
11. Nascimento WG, da Costa Uchoa SA, Coelho AA, de Sales Clementino F, Beserra Cosme MV, Bastos Rosa R, et al. Medication and test prescription by nurses: contributions to advanced practice and transformation of care. Rev Lat Am Enfermagem. 2018;26:e3062. https://doi.org/10.1590/1518-8345.2423.3062
12. Kroezen M, van Dijk L, Groenewegen PP, Francke AL. Nurse prescribing of medicines in Western European and Anglo-Saxon countries: a systematic review of the literature. BMC Health Serv Res. 2011;11:127. https://doi.org/10.1186/1472-6963-11-127
13. Bowskill D, Timmons S, James V. How do nurse prescribers integrate prescribing in practice: case studies in primary and secondary care. J Clin Nurs. 2013;22(13-14):2077-86. https://doi.org/10.1111/j.1365-2702.2012.04338.x
14. Heczkova J, Dilles T. Advanced nurses' practices related to pharmaceutical care in the Czech Republic. Nurs 21st Century. 2020;19(3):155–62. https://doi.org/10.2478/pielxxiw-2020-0021
15. Petrović M, Osmančević B, Ličen S, Karnjuš I, Prosen M. Oblikovanje modela medpoklicnega sodelovanja medicinskih sester na področju zagotavljanja farmacevtske skrbi: kvalitativna opisna raziskava. Obzor Zdrav Neg. 2021;55(2):92-101. https://doi.org/10.14528/snr.2021.55.2.3034. Slovenian.
16. World Medical Association. Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA. 2013;310(20):2191–4. https://doi.org/10.1001/jama.2013.281053
17. Ling DL, Lyu CM, Liu H, Xiao X, Yu HJ. The necessity and possibility of implementation of nurse prescribing in China: an international perspective. Int J Nurs Sci. 2018;5(1):72–80. https://doi.org/10.1016/j.ijnss.2017.12.011
18. Fong J, Buckley T, Cashin A. Nurse practitioner prescribing: an international perspective. Nurs Res Rev. 2015;5:99–108. https://doi.org/10.2147/NRR.S56188
19. Noblet T, Marriott J, Graham-Clarke E, Rushton A. Barriers to and facilitators of independent non-medical prescribing in clinical practice: a mixed-methods systematic review. J Physiother. 2017;63(4):221–34. https://doi.org/10.1016/j.jphys.2017.09.001
20. Sever M, Bregar B. Specializacije v zdravstveni negi: pogled študentov. Obzornik zdravstvene nege. 2015;49(1):26–43. https://doi.org/10.14528/snr.2015.49.1.49. Slovenian.
21. Debout C. Which education for which nursing competences in the future? Rev Infirm. 2004;(684):54–7.
22. Brown J, Stevens J, Kermode S. Supporting student nurse professionalisation: The role of the clinical teacher. Nurse Educ Today. 2012;32(5):606–10. https://doi.org/10.1016/j.nedt.2011.08.007
23. Goertzen MJ. Introduction to quantitative research and data. Library Technology Reports. 2017;53(4):12–18.

24. Martinkova J. Farmakologie: pro studenty zdravotnických oborů. Praha: Grada; 2019. Czech.
25. De Baetselier E, Van Rompaey B, Dijkstra NE, Sino CG, Akerman K, Batalha LM, et al. The NUPHAC-EU Framework for Nurses' Role in Interprofessional Pharmaceutical Care: Cross-Sectional Evaluation in Europe. Int J Environ Res Public Health. 2021;18(15):7862. https://doi.org/10.3390/ijerph18157862
26. De Baetselier E, Dijkstra NE, Batalha LM, Carvalho Ferreira PA, Filov I, Grøndahl VA, et al. Cross-sectional evaluation of pharmaceutical care competences in nurse education: how well do curricula prepare students of different educational levels? BMC Nurs. 2024;23(1):96. https://doi.org/10.1186/s12912-023-01646-6
27. Osmančević B, Karnjuš I, Ličen S, Prosen M. Perspektiva medicinskih sestara o njihovoj ulozi u farmacevtskoj skrbi: Uporedba između Slovenije i Hrvatske. Sestrinski glasnik. 2021;26(2):115-9. https://doi.org/10.11608/sgnj.26.2.5. Croatian.

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Original scientific paper

The Relationship Between Physical Activity and the Quality of Chest Compressions During Cardiopulmonary Resuscitation

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Abstract

Introduction. Cardiopulmonary resuscitation is a critical intervention in cardiac arrest, and the quality of chest compressions may be related to the physical fitness of the person performing them.

Aim. This study aimed to examine the relationship between physical activity level and the quality of chest compressions during simulated cardiopulmonary resuscitation, while also considering potential gender differences.

Methods. The study included 34 out-of-hospital emergency medical service employees who completed a socio-demographic questionnaire and the International Physical Activity Questionnaire to determine their physical activity level. Participants performed chest compressions on a simulated manikin for eight minutes, with parameters measured every two minutes. Parameters analyzed included compression depth, chest recoil, frequency of compression and overall quality of chest compressions.

Results. A statistically significant positive correlation was found between physical activity level and the quality of chest compressions ($p<0.001$). Participants with higher physical activity levels achieved better results in overall compression quality ($p=0.001$), compression depth ($p=0.009$), and frequency ($p=0.003$). No statistically significant differences were found for chest recoil ($p=0.470$). Gender had no significant effect on overall compression quality, depth, or frequency; however, female partici-

pants achieved significantly better results in chest recoil (p=0.034).

Conclusion. Physical activity level was significantly associated with the quality of chest compressions, while the effect of gender was limited to specific parameters such as chest recoil. These findings underscore the relevance of physical fitness among emergency medical service personnel in improving CPR performance.

Introduction

Cardiopulmonary resuscitation (CPR) is a vital procedure for survival in individuals experiencing cardiac arrest. According to the Resuscitation Council UK, the annual incidence of out-of-hospital cardiac arrest (OHCA) is approximately 55 cases per 100,000 population, with a survival rate to hospital discharge of around 9% (1). Globally, the average incidence of OHCA in adults is similar, yet the overall survival rate remains low, with an average of just 7% (2). In such critical situations, timely and high-quality CPR is essential to maintain blood flow and oxygen supply to vital organs until emergency medical services arrive or more advanced interventions can be applied.

The basic components of CPR include chest compressions and artificial respiration. The quality of these measures is closely associated with resuscitation outcomes. The European Resuscitation Council guidelines recommend a compression rate of 100–120 compressions per minute and a depth of 5–6 cm, with full chest recoil between compressions (3). Performing CPR in accordance with these guidelines requires not only proper technique but also considerable physical strength and endurance—particularly during prolonged efforts.

Previous studies have suggested that the physical fitness of emergency medical service (EMS) personnel may be associated with their ability to maintain high-quality chest compressions over time. Nayak et al. (2020) observed that individuals with higher levels of physical activity maintained compression quality more consistently, while less active individuals showed signs of fatigue earlier (4). Similarly, Ock et al. (2011) reported a significant decline in compression quality after just a few minutes of CPR, with effectiveness decreasing to only 28% after five minutes (5). These findings highlight the relevance of physical preparedness in sustaining CPR performance.

While some authors have explored gender-related differences in CPR performance, results remain inconclusive. For example, Ochoa et al. (1998) found no significant differences between male and female participants in overall CPR quality, suggesting that gender alone may not be a decisive factor (6).

Although the relationship between physical activity and CPR performance has been increasingly addressed in international research, no such studies have, to our knowledge, been conducted in the Republic of Croatia. This highlights the need for locally relevant data on this topic.

Aim

The aim of this study was to examine the relationship between the level of physical activity and the quality of chest compressions during cardiopulmonary resuscitation among emergency medical service personnel, while also considering potential gender differences.

Methods

The study was designed as a cross-sectional study. A total of 34 employees from the out-of-hospital emergency medical service participated in the research. Inclusion criteria allowed for participants aged between 18 and 65 years; however, the final sample included individuals aged between 20 and 62 years. The average age of participants was 38.4 years (SD=11.6), and the average length of work experience in emergency medical services was 11.2 years (SD=7.9). The sample included professionals from various occupational backgrounds, including nurses (n=18), drivers (n=10), and physicians (n=6).

Participation was voluntary, and informed consent was obtained from all participants prior to inclusion. The study was conducted between June 1 and July 18, 2024. The researcher was present during individual data collection to provide standardized instructions and technical support. While the researcher had access to participants' performance during testing, no documents or records linking individual identities to performance data were retained. The final dataset contained only anonymized identification codes ("Participant N"), ensuring confidentiality.

All participants had completed formal cardiopulmonary resuscitation training in accordance with national regulations (Official Gazette No. 12/2025), which is a mandatory requirement for working in the emergency medical service. Given their professional roles and years of experience, all participants had previously encountered CPR situations in real-life emergency settings.

Data were collected in two phases. In the first phase, participants completed a structured socio-demographic questionnaire developed for the study, which included questions on age, gender, height, weight, occupation, and years of work experience. They also completed the International Physical Activity Questionnaire (IPAQ – long version, 2006), validated in Croatian by Pedišić et al. (2011) (7). This instrument categorized participants into low, moderate, or high physical activity levels; however, for the purposes of statistical analysis, raw IPAQ scores (MET-minutes/week) were used to preserve accuracy.

In the second phase, participants performed an eight-minute CPR session on a simulation manikin (Resusci Anne QCPR, Laerdal Medical, Stavanger, Norway) connected to the Laerdal QCPR application (version 6.2.10). This system enabled automated measurement of chest compression parameters, including depth (in millimeters), rate (compressions per minute), proper chest recoil (percentage), and overall CPR performance (percentage). Participants could stop the simulation at any point if they experienced fatigue or were unable to continue. Prior to testing, all participants received standardized instructions based on the European Resuscitation Council guidelines.

Descriptive statistics included a categorization of CPR performance into three levels—Basic ability (0–49%), Intermediate ability (50–74%), and Advanced ability (75–100%). However, all inferential statistical analyses were conducted using continuous (raw) performance scores to maintain measurement precision and sensitivity.

Ethics

Approval for the study was obtained from the Ethics Committee of the Teaching Institute of Emergency Medicine of Istria County (Ref. No.: 2163-5-1-336/24). The study was conducted according to ethical principles while maintaining the anonymity of the participants. All participants provided a written consent for the use of the data collected via questionnaires exclusively for the purposes of this research.

Statistics

The collected data was analyzed using IBM SPSS Statistics software, version 22. The normality of the distribution of the continuous variables was tested using the Kolmogorov-Smirnov test and the Shapiro-Wilk test, both of which showed significant deviations from a normal distribution. The data were then analyzed using descriptive statistics, the Kruskal-Wallis test and the chi-square test (χ^2). A linear mixed model (LMM) was used to assess the impact of physical activity level on the quality of chest compressions across the measurement intervals. The results were interpreted using F-values and p-values, with the significance level set at $p<0.05$.

Results

A total of 34 emergency medical service personnel participated in the study. Of these, 19 were male (55.9%) and 15 female (44.1%). Participants were categorized into three levels of physical activity based on IPAQ: low (n=10; 29.4%), moderate (n=12; 35.3%), and high (n=12; 35.3%) (Table 1).

Table 1. **Distribution of participants by gender and physical activity level**

Gender	Low activity	Moderate activity	High activity	Total
Male	6	6	7	19
Female	4	6	5	15
Total	10	12	12	34

Note: There is no statistically significant difference in gender distribution across physical activity levels (χ^2=0.476, p=0.788).

Relationship between physical activity and chest compression quality

The Linear Mixed Model (LMM) analysis showed a statistically significant positive relationship between physical activity level (measured continuously using total MET-minutes/week) and chest compression quality over time (F=1272.954; p<0.001). Estimates indicated that compression quality improved steadily across the four 2-minute intervals, with the increase plateauing slightly between the third and fourth interval (Table 2).

Table 2. **Estimates from the Linear Mixed Model (LMM) for chest compression quality**

Time Interval	Estimate	Standard Error	t-value	*p-value*
1st	0.507	0.124	4.09	*<0.001*
2nd	0.606	0.147	4.12	*<0.001*
3rd	0.687	0.168	4.09	*<0.001*
4th	0.693	0.169	4.10	*<0.001*

Note: Estimates reflect progressive improvement in compression quality across time intervals. The trend stabilizes from the third interval onward.

Estimated marginal means by activity group

To improve interpretability, estimated marginal means (EMMs) were calculated for each activity level at each time point (Table 2a). These values show how performance varied across groups.

Table 2a. **Estimated marginal means for compression quality by activity level**

Time Interval	Low Activity	Moderate Activity	High Activity
1st	45.7	62.1	78.4
2nd	47.3	64.9	82.0
3rd	49.2	66.8	84.2
4th	49.0	67.1	84.5

Note: High activity participants maintained consistently higher predicted CPR quality across all time points.

Post-hoc comparisons of compression quality by physical activity level

The Kruskal-Wallis test indicated significant differences in chest compression quality between physical activity groups at all time intervals. Mann-Whitney post-hoc tests identified pairwise differences, especially between low and high activity participants, and to a lesser extent between moderate and high groups (Table 3).

Overall compression quality and specific parameters

Overall CPR quality was calculated as the arithmetic mean across all four time intervals. Kruskal-Wallis and Mann-Whitney tests showed significant differences between groups in quality, depth, and frequency, but not in chest recoil (Table 4).

Correlation between physical activity and chest compression quality

Spearman's correlation analysis confirmed a strong and statistically significant positive relationship between overall physical activity level, measured in MET-minutes per week, and average chest compression quality (ρ=0.79, p<0.001). This result suggests that individuals with higher levels of physical activity tend to perform higher-quality chest compressions during CPR.

Gender differences on chest compression quality

While gender did not significantly affect overall CPR quality, depth, or frequency, a statistically significant difference was found for chest recoil, where female participants performed better (Table 5).

Discussion

The results of this study indicate a statistically significant positive association between physical activity level and the quality of chest compressions during cardiopulmonary resuscitation (p<0.001). Participants with higher activity levels generally maintained better compression quality throughout the eight-minute simulation, while those with lower activity levels showed a more noticeable decline in performance after the first minute. This pattern is reflected in the estimated marginal means (EMMs), which increased steadily until the third interval and

Table 3. **Kruskal-Wallis and Mann-Whitney post-hoc tests for time intervals**

Time	Group Comparison	Median (Low-Mod-High)	Mean Rank	χ^2 (KW)	*p* (KW)	U (MW)	*p* (MW)
1st	Low - Moderate	46.0 - 66.5 - 81.0	9.70-18.00-23.50	14.71	<0.001	24.5	0.007
	Moderate - High					37.0	0.036
2nd	Low - Moderate	43.0 - 68.0 - 83.0	9.55-17.63-24.00	15.30	<0.001	23.0	0.005
	Moderate - High					36.5	0.030
3rd	Low - Moderate	48.0 - 70.5 - 85.0	11.35-16.29-23.83	10.48	0.005	36.5	0.046
	Moderate - High					30.0	0.021
4th	Low - Moderate	50.0 - 71.0 - 84.0	12.40-15.92-23.33	8.53	0.014	42.0	0.068
	Moderate - High					28.0	0.018

Note: Significant differences were observed between most group pairs. Differences between low and moderate in the fourth interval approached significance (*p*=0.068).

Table 4. **Group comparison of performance parameters (with medians and post-hoc tests)**

Parameter	Median (L-M-H)	Mean Rank (L-M-H)	χ^2	*p* (KW)	Significant Comparisons (MW)
Chest compression quality	44.5 - 62.0 - 82.0	10.2 - 16.58 - 24.50	14.63	<0.001	Low-Mod (p=0.011), Mod-High (p=0.041)
Compression depth	51.0 - 64.0 - 73.5	12.3 - 16.83 - 22.50	9.31	0.009	Low-High (p=0.014)
Compression frequency	42.5 - 67.0 - 74.0	10.4 - 18.33 - 22.58	11.70	0.003	Low-Mod (p=0.019), Mod-High (p=0.047)
Chest recoil	66.5 - 65.0 - 68.0	17.0 - 15.58 - 19.83	1.51	0.470	None

Note: The high physical activity group outperformed others in all parameters except chest recoil, which did not significantly differ between groups.

Table 5. **Chest compression performance by gender**

Parameters	Gender	Below Average (%)	Above Average (%)	Chi-square test (χ^2)	*p*
Compression depth	Female	40.0	60.0	1.449	*0.229*
	Male	21.05	78.95		
Compression frequency	Female	40.0	60.0	0.035	*0.851*
	Male	36.84	63.16		
Chest recoil	Female	26.67	73.33	4.480	*0.034*
	Male	63.16	36.84		

Note: Above/below average classification based on median split. Only chest recoil showed a statistically significant gender difference in favor of female participants.

then plateaued, with the highest predicted values consistently observed in the high activity group across all time points. In contrast, the low activity group consistently displayed lower mean ranks and median values across all intervals.

Post-hoc comparisons further revealed that differences in compression quality were statistically significant between physical activity groups at nearly all intervals. The strongest differences were observed between the low and high activity groups, with some significant differences also found between moderate and high activity participants. These results support the idea that higher physical activity levels are associated with the ability to maintain higher compression quality over time.

These findings are in line with current recommendations suggesting frequent rotation of team members performing compressions to minimize fatigue and

help maintain CPR quality (8). Similar observations were reported by Nayak et al. (4), while Ippolito et al. (9) did not find significant differences in overall CPR quality by activity level but did observe variation in compression depth. This suggests that certain CPR components may be more closely related to physical fitness than others.

Our findings also correspond with the results of Oermann et al. (10), who reported that nursing students with higher physical activity levels achieved better compression rate and depth during simulations. Likewise, Krarup et al. (11) found that professional EMS teams involved in regular physical conditioning performed CPR at higher quality levels than volunteers without such training. These results indicate that physical activity may be associated with improved CPR performance, even in non-professional settings.

Additional insights come from McDonald et al. (12), who showed that individuals with greater muscle mass and higher BMI were more likely to achieve adequate compression depth, regardless of gender. In our study, gender did not have a statistically significant effect on compression depth or frequency. Interestingly, female participants performed significantly better in chest recoil (p=0.034). This finding was consistent across intervals and was statistically significant when data were aggregated. This may reflect greater precision or control among female participants, as proper chest recoil requires full release of pressure between compressions—an action that is likely more dependent on technique than physical strength.

These findings are consistent with previous research by Ochoa et al. and Jaafar et al. (6,13), which suggests that women may demonstrate greater accuracy in certain CPR components. When controlling for variables such as BMI and physical fitness, gender alone does not appear to be a major factor influencing overall CPR quality (14,15).

Vaillancourt and Stiell (16) similarly highlighted the relevance of physical preparedness, noting that lay responders with lower fitness levels experienced a noticeable decline in CPR performance within the first few minutes. Ahn et al. (17) emphasized the importance of team coordination and structured task rotation, showing that planned switching of roles can help maintain compression quality—even among physically fit responders.

The practical implications of these findings point to the potential benefits of training programs that include physical conditioning components, particularly those targeting endurance and upper body control. Structured rotation protocols—particularly during prolonged resuscitation—may help compensate for fatigue-related declines in performance, especially among less physically active responders. While the design of this study does not allow for conclusions about causality, the observed associations support the relevance of physical fitness in CPR-related performance.

Despite the significance of the findings, several limitations must be acknowledged. The sample size was relatively small (N=34), which may limit the generalizability of results. Physical activity levels were assessed via the self-reported IPAQ questionnaire, which may introduce response bias. Additionally, other potentially important variables—such as age, BMI, and prior CPR experience—were not included in the analysis. Finally, while manikin-based simulations offer controlled environments for measuring CPR quality, they do not fully replicate the stress and variability of real-life cardiac arrest situations.

Future studies should involve larger, more diverse samples and incorporate objective fitness metrics. Research should also examine the role of age and body composition, as well as the combined effects of fatigue, stress, and environmental conditions on CPR performance. Longitudinal designs could provide insight into the long-term impact of physical training on resuscitation outcomes.

Overall, these results align with a growing body of evidence associating physical activity with CPR quality. They highlight the importance of physical preparedness among EMS personnel and suggest that combining physical and technical training components may help improve the quality of resuscitation efforts in both professional and lay responder settings.

Conclusion

The results of this study show that a high level of physical activity significantly improves the quality of chest compressions during cardiopulmonary resuscitation. Participants with a high level of physical activity were able to maintain the quality of compressions over a longer period, while participants with a lower level of activity experienced a more rapid decline in performance. These results underline the importance of the physical fitness among emergency medical service personnel in ensuring the effectiveness of CPR, especially during prolonged resuscitation efforts.

Although gender was not a determining factor in the overall quality of chest compressions, differences were observed in certain parameters such as chest recoil, where women performed better.

Author contributions

Conceptualization and methodology (DT, BO, KI); Data curation and formal analysis (DT, KI); Investigation and project administration (DT); and Writing – original draft and review & editing (DT, BO, KI). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. Resuscitation Council UK. Epidemiology of Cardiac Arrest [Internet]. Resuscitation Council UK; 2021. Available at: https://www.resus.org.uk/library/2021-resuscitation-guidelines/epidemiology-cardiac-arrest-guidelines Accessed: 24. 1. 2025.
2. Ong MEH, Perkins GD, Cariou A. Out-of-hospital cardiac arrest: prehospital management. The Lancet. 2010;81(4):402-11. https://doi.org/10.1016/S0140-6736(18)30316-7
3. Perkins GD, Graesner JT, Semeraro F, Olasveengen T, Soar J, Lott C, et al. European Resuscitation Council Guidelines 2021: Executive summary. Resuscitation. 2021 Apr;161:1-60. https://doi.org/10.1016/j.resuscitation.2021.02.003
4. Nayak VR, Babu A, Unnikrishnan R, Babu AS, Krishna HM. Influence of Physical Activity of the Rescuer on Chest Compression Duration and its Effects on Hemodynamics and Fatigue Levels of the Rescuer: A Simulation-based Study. Indian J Crit Care Med. 2020 Jun;24(6):409-13. https://doi.org/10.5005/jp-journals-10071-23457
5. Ock SM, Kim YM, Chung JH, Kim SH. Influence of physical fitness on the performance of 5-minute continuous chest compression. Eur J Emerg Med. 2011 Oct;18(5):251-6. https://doi.org/10.1097/MEJ.0b013e328345340f
6. Ochoa FJ, Ramalle-Gómara E, Lisa V, Saralegui I. The effect of rescuer fatigue on the quality of chest compressions. Resuscitation. 1998 Jun;37(3):149-52. https://doi.org/10.1016/s0300-9572(98)00057-4
7. Pedišić Ž, Jurakić D, Rakovac M, Hodak D, Dizdar D. Pouzdanost hrvatske verzije upitnika International Physical Activity Questionnaire (IPAQ) - Long Form. Kinesiology [Internet]. 2011;43(2):185-91. Available at: https://hrcak.srce.hr/75475 Accessed: 15. 4. 2024.
8. Gianotto-Oliveira R, Gianotto-Oliveira G, Gonzalez MM, Quilici AP, Andrade FP, Vianna CB, et al. Quality of continuous chest compressions performed for one or two minutes. Clinics (Sao Paulo). 2015 Mar;70(3):190-5. https://doi.org/10.6061/clinics/2015(03)07
9. Ippolito M, Cortegiani A, Ferraro OE, Borrelli P, Contri E, Burkart R, et al; MANI-CPR Investigators. Physical activity and quality of cardiopulmonary resuscitation: A secondary analysis of the MANI-CPR trial. Am J Emerg Med. 2021 Dec;50:330-4. https://doi.org/10.1016/j.ajem.2021.08.039
10. Oermann MH, Kardong-Edgren SE, Odom-Maryon T. Effects of monthly practice on nursing students' CPR psychomotor skill performance. Resuscitation. 2011;82(4):447-53. https://doi.org/10.1016/j.resuscitation.2010.11.022

11. Krarup NH, Terkelsen CJ, Johnsen SP, Clemmensen P, Olivecrona GK, Hansen TM, et al. Quality of cardiopulmonary resuscitation in out-of-hospital cardiac arrest is hampered by interruptions in chest compressions: a nationwide prospective feasibility study. Resuscitation. 2011;82(3):263-9. https://doi.org/10.1016/j.resuscitation.2010.11.003
12. McDonald CH, Heggie J, Jones CM, Thorne CJ, Hulme J. Rescuer fatigue under the 2010 ERC guidelines, and its effect on cardiopulmonary resuscitation (CPR) performance. Emerg Med J. 2012;29(9):664-9. https://doi.org/10.1136/emermed-2012-201610
13. Jaafar A, Abdulwahab M, Al-Hashemi E. Influence of Rescuers' Gender and Body Mass Index on Cardiopulmonary Resuscitation according to the American Heart Association 2010 Resuscitation Guidelines. Int Sch Res Notices. 2015 Nov 18;2015:246398. https://doi.org/10.1155/2015/246398
14. Jamjoom M, Bakr AA, Alahmadi E, Alsulami R, Alhawsa N, Turkistani Z, et al. The association of chest compressor's physical activity level with the quality of continuous chest compressions during a stimulated cardiac arrest in an education center. Saudi J Er Med. 2023;4(2):105-11. https://doi.org/10.24911/SJEMed/72-1674858076
15. Amacher SA, Schumacher C, Legeret C, Tschan F, Semmer NK, Marsch S, et al. Influence of Gender on the Performance of Cardiopulmonary Rescue Teams: A Randomized, Prospective Simulator Study. Crit Care Med. 2017 Jul;45(7):1184-91. https://doi.org/10.1097/CCM.0000000000002375
16. Vaillancourt C, Stiell IG. Cardiac arrest care and emergency medical services in Canada. Can J Cardiol. 2004;20(11):1081-90.
17. Ahn C, Lee J, Oh J, Song Y, Chee Y, Lim TH, et al. Effectiveness of feedback with a smartwatch for high-quality chest compressions during adult cardiac arrest: a randomized controlled simulation study. PLoS One. 2017;12(3):e0169046. https://doi.org/10.1371/journal.pone.0169046

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Original scientific paper

SARC-F as a Case-Finding Tool for Sarcopenia in Older Adults

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Abstract

Introduction. Sarcopenia is defined as a progressive decrease of skeletal muscle mass associated with aging. It is associated with an increased risk of adverse outcomes, such as falls, fractures, physical disability, and death. Early detection of sarcopenia in older adults is of utmost importance as it has been shown to be crucial for providing appropriate interventions, primarily in terms of physical exercise and nutrition, to maintain a quality of life. Sarcopenia screening is crucial for public health given its significant prevalence and adverse outcomes.

Aim. The aim of the research was case-finding for sarcopenia in individuals aged 65 and older and to determine whether there are differences in the prevalence of sarcopenia according to the SARC-F questionnaire in three groups of participants.

Methods. A total of 138 individuals aged 65 and older of both sexes participated in the research. There were three groups of participants: residents in a retirement home, outpatients in an orthopaedic clinic, and community-dwelling individuals (general group). SARC-F questionnaire (Strength, Assistance with Walking, Rising from a Chair, Climbing Stairs, and Falls) was used as a highly recommended tool for screening.

Results. The results showed that participants with an indication for sarcopenia were significantly older, with a mean age of 80.7 years (SD = 7.65) compared to 75.1 years (SD = 5.97) in the no indication group ($t = 4.76$; $p < 0.001$). In terms of residential setting, participants with an indication for sarcopenia were more likely to reside in nursing homes (36.5%) compared to those without an indication (12.0%). Conversely, participants without an indication were from the general population (62.7%) more frequently than

those with an indication (41.3%). The proportion of participants from clinical settings was similar between the groups (22.2% vs. 25.3%).

Conclusion. Age is the only significant risk factor when assessing the sarcopenia risk in this research. Individuals at risk of sarcopenia were significantly older than those not at risk, with an average age difference of approximately five years. According to the results of this research, each additional year of age increases the odds of sarcopenia by approximately 12%. Retirement home residents are at the highest risk of sarcopenia. When it comes to the significant public health consequences caused by sarcopenia in the community, further similar research is necessary with an emphasis on an interdisciplinary approach to the disease.

Introduction

Sarcopenia was first mentioned in 1989 (1, 2, 3) and defined as a "decrease of muscle mass associated with aging". This definition has been improved and changed several times, and sarcopenia is now defined as a "progressive decrease of skeletal muscle mass associated with aging". Sarcopenia was included in the International Classification of Diseases (4, 5) in 2016, which confirmed the seriousness of this geriatric syndrome.

The increasing life expectancy as well as aging of the global population requires special attention from each country's health and public health strategies to benefit the health of older population. Sarcopenia prevention could reduce the financial, social and health burden often associated with an aging population. Screening for sarcopenia should be a public health priority to reduce the prevalence and the adverse outcomes of sarcopenia (3). Negative outcomes, such as falls, reduced mobility and functionality, can jeopardise the independence as well as the quality of life in older individuals to a great extent (2, 6). The SARC-F questionnaire is one of the most commonly used tools when screening for sarcopenia (7). Validation of the SARC-F questionnaire is in the centre of interest of many scientists (8), and some of them consider it a valid tool not only for sarcopenia screening but also for future mortality related to sarcopenia (9). Recently, there has been increasing research into possibilities of new assessment instruments related to screening for sarcopenia such as anthropometric measurements, Ishii Test and Mini Sarcopenia Risk Assessment (MSRA) questionnaire, a new test designed by Thai researchers – Taiwan Risk Score for Sarcopenia (TRSS), Sarcopenia Scoring Assessment Model (SarSA-Mod), and others. More specific tests are used in research to make predictions about the development of sarcopenia, such as Sarcopenia Quality of Life (SARQoL) questionnaire and fracture risk assessment questionnaires (8). Although these tests show high validity and make a good choice for screening for sarcopenia, the European Working Group on Sarcopenia in Older People 2 (EWGSOP2) assessment algorithm recommends the SARC-F questionnaire as a valid and validated tool for screening for risk of sarcopenia (10). Some authors who have researched the connection between sarcopenia and recovery of orthopaedic and trauma patients recommend a pre-operative treatment of sarcopenia patients, especially of the respiratory muscles since they have found a correlation between sarcopenia and the duration of hospitalisation and increased mortality (11, 12). Older individuals who live alone are more independent in daily activities; they have a higher level of physical activity and are generally more independent than individuals living in retirement homes who can be more likely to suffer from sarcopenia. This has been confirmed by the research conducted by De Oliveira et al. (2021), which presented a high likelihood of developing sarcopenia in institutionalized elderly (13). Research conducted in Japan among older individuals living alone showed that prevalence of sarcopenia was most closely associated with physical activity (14). Independent living implies autonomy in instrumental activities of daily living such as shopping, going to the bank, etc. A higher risk of sarcopenia has been noted in orthopaedic patients (15) and could be associated with pain and restrictions in motion. Older patients after hip surgery are particularly predictive, as confirmed by several studies (16, 17), as well as patients with osteosarcopenia (18).

Aim

The aim of this study was case-finding for sarcopenia in individuals aged 65 and older and to determine whether there are differences in the prevalence of sarcopenia according to the SARC-F questionnaire in three groups of participants. An additional aim was to determine the significant predictors associated with sarcopenia indication.

Methods

Study design

The research was carried out in the House of St Francis - a home for the elderly and disabled in Zagreb, in the Department of Orthopedics and Traumatology at the Dubrava University Hospital, and in respondents' homes.

The research period was from June 2024 to March 2025.

Respondents

The research was carried out on 138 individuals from Zagreb aged 65 and older of both sexes.

The sample was a convenience sample.

The participants were divided into three groups: the first group consisted of residents of the House of St Francis – a home for the elderly and disabled (Nursing Home Group), the second group was comprised of outpatients in the Department of Orthopedics and Traumatology at the Dubrava University Hospital (Clinical Group), and the third group was a General Group. The General Group consisted of respondents who lived independently and did not have any fractures in the past year. There were 32 participants in the first group, the Nursing Home Group, of whom 25 (78.12%) were women and 7 (21.87%) were men. In the second group, the Clinical Group, there were 33 participants, of whom 26 were women (78.78%) and 7 were men (21.21%). In the third group studied, the General Group, there were 73 participants, 50 of whom were women (68.49%) and 23 men (31.50%). They were informed about the purpose and aims of the research prior to completing the questionnaire. Anonymity of the respondents was guaranteed. They completed the questionnaire voluntarily, confirmed their participation by a written consent, and gave a written consent for their data to be used for the purpose of the research. The participants had the possibility withdraw from the research at any time.

The exclusion criteria for the research were: individuals younger than 65, immobile patients, people with dementia, and individuals who had an extremity fracture in the past year.

Instruments

The aim of the SARC-F questionnaire is to identify people at risk of sarcopenia (19). The questionnaire consists of five questions examining the following items: Strength, Assistance in walking, Rising from a chair, Climbing stairs, Falls (Table 1). The respondent is asked how much difficulty he/she has when performing the abovementioned components of various activities, e.g. "How many times have you fallen in the last year?". The possible answers are: "None", "Some" and "A lot or unable". Individual answers are awarded the following points: "None" = 0 points; "Some" = 1 point; "A lot or unable" = 2 points. The points awarded for the answers in the last question about the number of falls in the past year are: "None" – 0 points; 1 to 3 falls – 1 point; 4 and more falls – 2 points. The highest possible score in the questionnaire is 10, which is the worst result, while the best result is 0 points. If a respondent gets four or more points, he/she is considered to be at a risk of sarcopenia and, according to the guidelines of the European Working Group on Sarcopenia in Older People (EWGSOP), should be included in further assessments to confirm the diagnosis or not (2).

To assess the internal consistency of the SARC-F questionnaire in the present sample, Cronbach's α was calculated (Table 2). The scale demonstrated acceptable internal reliability with a Cronbach's α of 0.765. Item-level analysis showed that removing the Strength (α = 0.713), Assistance in walking (α = 0.693), Rising from a chair (α = 0.700), or Climbing stairs (α = 0.702) items would result in only a slight decrease in overall reliability, indicating that those

items contribute meaningfully to the scale's consistency. The item-rest correlations for these items ranged from 0.561 to 0.612, indicating moderate associations with the total score. In contrast, removal of the Falls item increased the α to 0.787, and its lower item-rest correlation (0.312) suggests that this item was less consistent with the rest of the scale in this sample.

Table 1. **SARC-F questionnaire (19)**

Component	Question	Scoring
Strength	How much difficulty do you have in lifting and carrying 4.5 kg?	None = 0 Some = 1 A lot or unable = 2
Assistance in walking	How much difficulty do you have walking across a room?	None = 0 Some = 1 A lot or unable = 2
Rising from a chair	How much difficulty do you have transferring from a chair to bed?	None = 0 Some = 1 A lot or unable = 2
Climbing stairs	How much difficulty do you have climbing a flight of 10 stairs?	None = 0 Some = 1 A lot or unable = 2
Falls	How many times have you fallen in the past year?	None = 0 Some = 1 A lot or unable = 2

Table 2. **Internal consistency statistics for the SARC-F screening tool**

	Cronbach's α	
	0.765	
Item Reliability Statistics	**If item dropped**	**Item-rest**
Strength	0.713	0.561
Assistance in walking	0.693	0.612
Rising from a chair	0.700	0.597
Climbing stairs	0.702	0.589
Falls	0.787	0.312

Procedure

Prior to completing the SARC-F questionnaire, the respondents were informed about the purpose of the questionnaire, and they had the opportunity to ask questions to avoid any doubts. The participants completed the questionnaire independently, but in cases when they could not fill in the questionnaire on their own, the answers were entered by the interviewers or researchers.

Ethics

For the purpose of this research, consent was obtained from the Ethics Committee of the University of Applied Health Sciences (registered under the number: 251-379-10-23-02), from the City Office for Social Protection, Health, War Veterans and People with Disabilities (registered under the number: 251-09-12--/2-23-2, and from the Dubrava University Hospital (registered under the number: 251-379-12-24-05). The respondents filled in and signed an adult information consent to participate in the research in which safety of personal data collected in the research is guaranteed.

Statistics

Descriptive statistics were used to summarize the characteristics of the sample, including gender, age, and residential setting, stratified by sarcopenia indication. The assumption of normality for t-tests was evaluated using the Shapiro-Wilk W test and visual inspection of density plots. Differences between groups were assessed using independent t-tests or non-parametric Mann-Whitney U test for continuous variables and chi-square tests for categorical variables. For significant chi-square tests involving more than two groups, post hoc pairwise chi-square comparisons with Bonferroni correction were conducted. For posterity, before performing the main analysis, internal consistency of the SARC-F scale was evaluated using Cronbach's α. Item reliability was assessed by calculating the change in Cronbach's α if individual items were removed and examining item-rest correlations. To analyse potential differences in proportion of subjects with sarcopenia between groups, binomial logistic regression model was used to correct for age and gender.

Model 1 included age as the sole predictor. Model 2 added gender, female vs. male with males as a reference category, as an additional predictor. Model 3 further included residential setting, general and clinical setting vs. nursing home with the nursing home group as the reference category. Model fit was evaluated using the deviance, Akaike Information Criterion

(AIC), and McFadden's R^2. Improvement in model fit between nested models was tested using likelihood ratio tests. Statistical significance was set at $p < 0.05$ for all tests. Logistic regression results were reported as log odds ratios their standard errors, and odds ratios (OR).

Results

Table 3 presents the descriptive characteristics of the study sample, including age, gender distribution, and residential setting (group), stratified by presence or absence of sarcopenia indication.

Table 3. **Descriptive parameters of the sample by sarcopenia indication**

	Yes (n = 63)	No (n = 75)	Overall (n = 138)
Gender			
Male	13 (20.3%)	24 (32.0%)	37 (26.6%)
Female	50 (79.4%)	51 (68.0%)	101 (73.2%)
Age			
Mean (SD)	80.7 (7.65)	75.1 (5.97)	77.7 (7.31)
Median [Min, Max]	80.0 [66.0, 95.0]	75.0 [65.0, 87.0]	76.5 [65.0, 95.0]
Group			
General	26 (41.3%)	47 (62.7%)	73 (52.9%)
Nursing home	23 (36.5%)	9 (12.0%)	32 (23.2%)
Clinical	14 (22.2%)	19 (25.3%)	33 (23.9%)
Prevalence within group			
General	35.6%	64.4%	-
Nursing home	71.9%	28.1%	-
Clinical	42.4%	57.6%	-

Of the 138 participants, 63 had an indication for sarcopenia (indication group) and 75 had no indication for sarcopenia (no indication group). Overall, 73.2% of participants were female, with a higher proportion in the indication group (79.4%) compared to the no indication group (68.0%), though this difference was not statistically significant ($\chi^2 = 2.25$; $p = 0.133$). Participants with an indication for sarcopenia were significantly older, with a mean age of 80.7 years (SD = 7.65) compared to 75.1 years (SD = 5.97) in the no indication group ($t = 4.76$; $p < 0.001$). The prevalence of sarcopenia indication was 71.9% among nursing home residents, 42.4% among clinical participants, and 35.6% in the general population. The overall distribution of residential setting across groups was statistically significant ($\chi^2 = 11.97$; $p = 0.003$). Post hoc chi-square pairwise comparisons with Bonferroni correction revealed a significantly higher proportion of nursing home residents among those with sarcopenia indication compared to the general population group ($p_{Bonferroni} = 0.004$). No statistically significant differences were observed between the clinical setting and either of the other two groups after adjustment ($p_{Bonferroni} > 0.05$).

Table 4 presents the result of three binomial logistic regression models predicting the likelihood of sarcopenia indication. Model 1 tested the effect of age on sarcopenia indication. Model 2 added gender as a predictor, and Model 3 further included residential setting, with nursing home group being the reference group. Model fit improved very slightly from Model 1 to Model 3, with the deviance decreasing from 170 to 165 and McFadden's R^2 increasing from 0.109 in Model 1 to 0.134 in Model 3, indicating virtually no improvement in explanatory power. Expectedly, the differences in fit between models were not statistically significant (Model 1 vs. Model 2: $\chi^2 = 2.80$, $p = 0.091$; Model 2 vs. Model 3: $\chi^2 = 1.99$, $p = 0.371$).

Table 4. **Fit measures for three models and model comparisons**

Model Fit Measures	Model 1	Model 2	Model 3
Deviance	170	167	165
AIC	174	173	175
R^2 (McFadden)	0.109	0.124	0.134
Model Comparisons	χ^2	df	*p*
Model 1 vs. Model 2	2.80	1	0.094
Model 2 vs. Model 3	1.99	2	0.371

According to Table 4, in all models, age was a significant predictor of sarcopenia indication, with each additional year of age increasing the odds of sarcopenia indication by approximately 12% (Model 1: OR = 1.12, $p < 0.001$; Model 2: OR = 1.13, 10 $p < 0.001$; Model 3: OR = 1.11, $p = 0.003$). In Model 2, the effect of gender was not significant, and this effect remained non-significant in Model 3. In Model 3, the odds of sarcopenia indication were lower in the General Group compared to nursing home residents (OR = 0.49, $p = 0.177$) and in the Clinical Group compared to nursing home residents (OR = 0.68, $p = 0.524$), but these differences were not statistically significant (Table 5). Overall, age was the only consistent and significant predictor across all models. This result is not surprising with regard of the average age in the three groups which showed that the highest average age of the participants was in the Nursing Home group, namely 84.7 (SD 6.99), whereas the average age of the participants in the General Group was 75.8 years (SD 6.10) and in the Clinical Group 75.0 years (SD 5.79). The lowest age of the participants was 65 (in the General Group) while the highest age was 95 (in the Nursing Home group).

Discussion

This research examined prediction of sarcopenia in three groups: the Nursing Home Group, a group of outpatients in the Department of Orthopedics and Traumatology (Clinical Group), and a group of community-dwelling members as the General Group. The results are based on the data from the SARC-F questionnaire, age, gender, and comparison between the groups. Individuals at risk of sarcopenia scored 4 or more points on the SARC-F questionnaire. The results showed that individuals at risk of sarcopenia were significantly older in comparison with those who were not at risk. Among those at risk of sarcopenia, the youngest participant was 66.0 years old and the oldest was 95.0 years old.

When it comes to residential setting, participants with an indication for sarcopenia were more likely to reside in nursing homes compared to those without an indication. Moreover, older individuals and nursing homes residents had the highest likelihood of having an indication for sarcopenia. Participants with an indication for sarcopenia were, on average, about five years older than those without such indication (80.7 vs. 75.1 years) and were more likely to live in nursing homes (36.5% vs. 12%). It can be concluded that the Nursing group, the group with the oldest participants, is physically least active and in need of help in some activities of daily living, such as shopping, cooking, cleaning up, etc. Conversely, individuals without an indication of sarcopenia were more com-

Table 5. **Specific model results for three tested models**

Model Coefficients	Estimate	SE	Z	*p*	OR
Model 1					
Age	0.117	0.028	4.17	< 0.001	1.12
Model 2					
Age	0.119	0.028	4.21	< 0.001	1.13
Female vs. Male	0.713	0.434	1.64	0.10	2.04
Model 3					
Age	0.104	0.032	3.27	0.001	1.11
Female vs. Male	0.643	0.440	1.46	0.14	1.90
General vs. Nursing Home	-0.712	0.528	-1.35	0.18	0.49
Clinical vs. Nursing Home	-0.385	0.604	-0.64	0.52	0.68

Note: Estimates represent the log odds of "sarcopenia indication = Yes" vs. "sarcopenia indication = No."

monly drawn from the general population, likely due to their younger age and higher levels of functional mobility in daily activities.

Logistic regression confirmed that age was the only significant predictor of sarcopenia indication, with each additional year of age increasing the likelihood by about 12%. No significant difference was found in the incidence of sarcopenia between male and female respondents, which suggests that gender did not play a significant role in this sample. A possible cause for this result was a small proportion of men in the sample.

It can therefore be concluded that neither gender nor residential setting were significant predictors, although there is a noticeable trend toward higher occurrence of sarcopenia in nursing home residents, which can be explained by their age. It is important to highlight that, in this study, residents of nursing homes were generally older than individuals living in the community. Understandably, those with greater mobility and independence tend to remain in their own homes for as long as possible. This may partially explain the higher prevalence of sarcopenia risk among nursing home residents and older age.

Research using the SARC-F questionnaire was conducted in Poland on a sample of 73 community-dwelling participants (78.1% of whom were women) of ≥65 years of age. The average age of the participants was 77.8 years, and the results showed that 19% of the entire group were at a risk of sarcopenia (9), which is a considerably lower result than in the community-dwelling group in our research (the General Group).

The average age of community-dwelling participants in the research conducted by Patel et al. (2024) was 79.8 years, and the result indicated that older age was associated with sarcopenia in both sexes (20) which was confirmed by our research showing that the oldest group of respondents (M = 80.4) had the highest sarcopenia prediction.

Research using the SARC-F questionnaire carried out on Turkish population older than 65 showed an even lower degree of risk of sarcopenia. A study demonstrated the result of 12.7% of risk (21), and the prevalence of sarcopenia in another study ranged from 1.9% to 9.2% (22). One of the possible explanations of such a low result is the age of the respondents, who were relatively young in comparison with respondents in other studies, and whose average age was 74.6 ± 6.6 years with less prevalent comorbidities such as heart failure, chronic kidney failure, etc. (22).

Diagnostic accuracy of the following four sarcopenia screening tools was compared in a retirement home in China: the Mini Sarcopenia Risk Assessment full version (MSRA-7) and the short version (MSRA-5), the SARC-F, and the SARC-F combined with calf circumference (SARC-CalF). It is interesting that the mean age of participants was 81.6±3.3 years (range 74-93 years), which is on average higher than the mean age of residents in the retirement home in this research, but the former group of participants had a lower prevalence of risk of sarcopenia, ranging from 31.4% to 38.3% when using different diagnostic criteria (23).

Similar results were found in another research in nursing homes in China. The respondents' median age was 85 years, and the prevalence of SARC-F-defined sarcopenia was 9.8% (24).

A very high risk of sarcopenia was found in the research conducted in nursing home residents across 12 sites in South Australia. The average age of the respondents was 87.7 years, and 72.6% of them were female. As many as 89.5% of respondents were at a risk of sarcopenia. It is interesting that diabetes was cited as a significant risk factor of sarcopenia (25).

Limitations

One limitation of this research was the use of a convenience sample. Additionally, the gender distribution within the sample could have been more balanced, particularly by increasing the proportion of male participants.

The practical implications of this research include the implementation of sarcopenia risk assessment among the elderly, both in nursing homes and in community-dwelling populations. This involves not only using the SARC-F questionnaire as an initial screening tool but also incorporating further diagnostic steps in accordance with the protocol of the European Working Group on Sarcopenia in Older People (EWGSOP) (2), which has not been adopted in Croatia yet.

The benefit of this approach is that individuals who are not only at risk of sarcopenia but also those already affected can be identified in a relatively short

period, allowing for timely interventions. In this context, improving nutrition is particularly important, especially considering that many elderly individuals are malnourished. Interventions should include increased protein intake and regular physical exercise.

Conclusion

Age is the only significant risk factor when assessing the sarcopenia risk in this sample. Moreover, each additional year of age increases the odds of sarcopenia by approximately 12%. Individuals at risk of sarcopenia were significantly older than those not at risk, with an average age difference of approximately five years. Nursing home residents had the highest risk of sarcopenia, while lower risk levels were observed among the general population and orthopaedic clinic outpatients. According to this research, gender is not a significant predictor for the risk of sarcopenia.

When it comes to the significant public health consequences caused by sarcopenia in the community, further similar research is necessary since there is insufficient data on sarcopenia in Croatia and there is still no systematic monitoring of this illness.

Author contributions

Conceptualization (AMĆ, MF, IJ, MT, EP); Investigation (MT, MF, AMĆ, KT, VB); Methodology (IJ, LFT, TNJZ); Writing – Original Draft (AMĆ, MT, TNjZ, EP); Writing – Review & Editing (AMĆ, MT, IJ, MF). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. Rosenberg IH. Sarcopenia: origins and clinical relevance. The Journal of nutrition. 1997 May 1;127(5):990S-1S https://doi.org/10.1093/jn/127.5.990S
2. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T, Landi F, et al. European Working Group on Sarcopenia in Older People. Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. Age Ageing. 2010 Jul;39(4):412-23. https://doi.org/10.1093/ageing/afq034
3. Cruz-Jentoft AJ, Sayer AA. Sarcopenia. The Lancet. 2019 Jun 29;393(10191):2636-46. https://doi.org/10.1016/S0140-6736(19)31138-9
4. Cao L, Morley JE. Sarcopenia is recognized as an independent condition by an international classification of disease, tenth revision, clinical modification (ICD-10-CM) code. J Am Med Dir Assoc. 2016 Aug 1;17(8):675-7. https://doi.org/10.1016/j.jamda.2016.06.001
5. Anker SD, Morley JE, von Haehling S. Welcome to the ICD-10 code for sarcopenia. J Cachexia Sarcopenia Muscle. 2016 Dec;7(5):512-4. https://doi.org/10.1002/jcsm.12147
6. Liška F. The Benefits of Virtual Reality in Preventing Falls in Older Adults: Literature Review. Croat Nurs J. 2023; 7(2):153-60. https://doi.org/10.24141/2/7/2/5
7. Franić M, Njegovan Zvonarević T, Pulić E, Mojsović Ćuić A, Feher Turković L, Telebuh M, et al. Procjena rizika razvoja sarkopenije – upitnik SARC F. Journal of applied health sciences. 2024;10(1):49-56. https://doi.org/10.24141/1/10/1/5
8. Bahat G, Erdoğan T, İlhan B. SARC-F and other screening tests for sarcopenia. Curr Opin Clin Nutr Metab Care. 2022 Jan 1;25(1):37-42. doi: https://doi.org/10.1097/MCO.0000000000000801
9. Ida S, Kaneko R, Imataka K, Okubo K, Shirakura Y, Azuma K, et al. Verification of the predictive validity for mortality of the SARC-F questionnaire based on a meta-analysis. Aging Clin Exp Res. 2021 Apr;33:835-42. https://doi.org/10.1007/s40520-020-01585-1
10. Piotrowicz K, Głuszewska A, Czesak J, Fedyk-Łukasik M, Klimek E, Sánchez-Rodríguez D, et al. SARC-F as a case-finding tool for sarcopenia according to the EWGSOP2. National validation and comparison with other diagnostic standards. Aging Clin Exp Res. 2021 Jul;33(7):1821-1829. https://doi.org/10.1007/s40520-020-01782-y
11. Gewiess J, Kreuzer S, Eggimann AK, Bertschi D, Bastian JD. Definitions and adverse outcomes of Sarcopenia in older patients in orthopedic and trauma care: a scoping review on current evidence. Eur J Trauma Emerg Surg. Oct;50(5):2039-51. https://doi.org/10.1007/s00068-024-02541-8

12. Yang Y, Sun M, Chen WM, Wu SY, Zhang J. Adverse postoperative outcomes in elderly patients with sarcopenia. BMC geriatrics. 2024 Jun 27;24(1):561. https://doi.org/10.1186/s12877-024-05066-2
13. de Oliveira Neto L, de Oliveira LP, Agrícola PM, de Oliveira Tavares VD, Gomes IC, Sales MC, et al. Factors associated with sarcopenia in institutionalized elderly. Journal of Public Health. 2021 Dec;43(4):806-13. https://doi.org/10.1093/pubmed/fdaa122
14. Tanimoto Y, Watanabe M, Sun W, Sugiura Y, Tsuda Y, Kimura M, et al. Association between sarcopenia and higher-level functional capacity in daily living in community-dwelling elderly subjects in Japan. Arch Gerontol Geriatr. 2012 Sep 1;55(2):e9-13. https://doi.org/10.1016/j.archger.2012.06.015
15. Park JW, Kim HS, Lee YK, Yoo JI, Choi Y, Ha YC, et al. Sarcopenia: an unsolved problem after hip fracture. J Bone Miner Metab. 2022 Jul;40(4):688-695. https://doi.org/10.1007/s00774-022-01334-6.
16. Hida T, Ishiguro N, Shimokata H, Sakai Y, Matsui Y, Takemura M, et al. High prevalence of sarcopenia and reduced leg muscle mass in Japanese patients immediately after a hip fracture. Geriatr Gerontol Int. 2013 Apr;13(2):413-20. https://doi.org/10.1111/j.1447-0594.2012.00918.x
17. Yeung SS, Reijnierse EM, Pham VK, Trappenburg MC, Lim WK, Meskers CG, Maier AB. Sarcopenia and its association with falls and fractures in older adults: a systematic review and meta-analysis. J Cachexia Sarcopenia Muscle. 2019 Jun;10(3):485-500. https://doi.org/10.1002/jcsm.12411
18. Kirk B, Zanker J, Duque G. Osteosarcopenia: epidemiology, diagnosis, and treatment—facts and numbers. Journal of cachexia, sarcopenia and muscle. 2020 Jun;11(3):609-18. https://doi.org/10.1002/jcsm.12567
19. Malmstrom TK, Morley JE. Sarcopenia: the target population. J Frailty Aging 2013; 2: 55-6. https://doi.org/10.14283/jfa.2013.8
20. Patel HP, Boswell E, Laskou F, Westbury LD, Bevilacqua G, Bloom I, et al. Detection of Sarcopenia in Community-Dwelling Older Adults Using the SARC-F Questionnaire: Findings From the Southampton Longitudinal Study of Ageing (SaLSA). JCSM Communications. 2024 Jul;7(2):164-72. https://doi.org/10.1002/rco2.108
21. Bahat G, Oren MM, Yilmaz O, KiliÃ C, Aydin K, Karan MA. Comparing SARC-F with SARC-CalF to screen sarcopenia in community living older adults. The Journal of nutrition, health and aging. 2018 Nov 1;22(9):1034-8. https://doi.org/ 10.1007/s12603-018-1072-y
22. Sacar DE, Kilic C, Karan MA, Bahat G. Ability of SARC-F to find probable sarcopenia cases in older adults. The Journal of nutrition, health and aging. 2021 Jun 1;25(6):757-61. https://doi.org/ 10.1007/s12603-021-1617-3
23. Yang M, Lu J, Jiang J, Zeng Y, Tang H. Comparison of four sarcopenia screening tools in nursing home residents. Aging clinical and experimental research. 2019 Oct;31:1481-9. https://doi.org/10.1007/s40520-018-1083-x
24. Yang M, Jiang J, Zeng Y, Tang H. Sarcopenia for predicting mortality among elderly nursing home residents: SARC-F versus SARC-CalF. Medicine. 2019 Feb 1;98(7):e14546. https://doi.org/ 10.1097/MD.0000000000014546
25. Thompson MQ, Jadczak AD, Yu S, Tucker GR, Visvanathan R. Sarcopenia risk in nursing home residents using SARC-F: FIRST study findings. Geriatrics & Gerontology International. 2022 Mar;22(3):206-12. https://doi.org/ 10.1111/ggi.14327

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Original scientific paper

Assessing Quality of Life Among Emergency Department Nurses

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Abstract

Aim. The aim of this research was to assess the quality of life (QoL) of nurses working in emergency departments in Rijeka and Zagreb. In addition, the study examined how demographic and work-related factors such as gender, age, education level, and place of employment are associated with variations in quality of life.

Methods. A cross-sectional study was conducted in July and August 2024 using a non-probabilistic random sampling method. A total of 99 nurses (54.5% female, 45.5% male; mean age = 34.1 years, SD = 8.9) participated by completing an anonymous online survey. The World Health Organization Quality of Life Questionnaire (WHOQOL-BREF) was used to evaluate four domains of QoL: physical health, psychological health, social relationships and environmental. Statistical analysis included descriptive statistics, the Kolmogorov-Smirnov test, Mann-Whitney U test, Kruskal-Wallis test, and, where appropriate, post hoc analyses. Statistical significance was set at $p < 0.05$.

Results. The overall mean quality of life score was 57.0, indicating a moderate level of well-being. The highest scores were observed in the domain of social relationships (M = 65.4), and the lowest in physical health (M = 50.8). Statistically significant differences were found between age groups, particularly in psychological health and social relationships, with younger participants (< 25 years) reporting higher scores. Nurses with secondary education reported higher QoL in psychological and social domains than those with higher degrees. The respondents from Rijeka scored higher in the environmental domain than those from Zagreb.

Conclusion. This study highlights moderate QoL among emergency nurses and identifies demographic and contextual differences across key domains. The findings suggest a need for targeted interventions to improve physical health, support work-life balance, and promote equity based on age, gender, and work environment. Enhancing the well-being of emergency department nurses is essential for sustainable healthcare systems and quality patient care.

Introduction

Nurses constitute the largest group of healthcare professionals and play a vital role in maintaining the efficiency and quality of healthcare services. Their ability to deliver high-quality care is strongly influenced by factors such as working conditions, quality of life, and job satisfaction (1, 2). Among all healthcare environments, the emergency department presents particularly challenging conditions due to its unpredictable, high-pressure, and dynamic nature. Nurses working in these settings are frequently exposed to time-sensitive procedures, trauma cases, and emotionally charged situations, all of which contributes to increased physical and psychological strain (3, 4).

Emergency nursing is commonly associated with irregular shift work, including night shifts, weekends, and holidays, which disrupt circadian rhythms and make it difficult for nurses to maintain a consistent personal life. These schedules often restrict participation in family and social activities, leading to negative consequences for nurses' physical, psychological, and social well-being (5,6). In addition, work-related stress, heavy workloads, insufficient staffing, and lack of institutional support are consistently cited as major contributors to emotional exhaustion, burnout, and workforce attrition (2, 7).

Quality of life among nurses is influenced by an interplay of physical health, mental well-being, material conditions, social relationships, and personal perceptions of life satisfaction (8). While subjective and objective indicators are interrelated, individual perception is essential for understanding how nurses experience their professional and personal lives. Previous research shows conflicting results: some studies indicate that younger nurses and those with higher education report better physical health and stronger social support networks, while others suggest that older, more experienced staff demonstrate greater psychological resilience and work-life balance (6, 9).

However, current research on nurses' QoL in emergency settings remains limited and inconsistent. Many studies focus on general hospital staff, use small or non-representative samples, or do not account for intersecting variables such as age, gender, and educational background. These methodological limitations, combined with varying institutional and cultural contexts, may partly explain the contradictions in the findings. Importantly, there is a lack of studies specifically examining these issues within the Croatian healthcare system, especially in high-intensity units such as emergency departments. This gap underscores the need for localized, context-sensitive research to explore how demographic and workplace factors influence nurses' quality of life in Croatia.

Despite financial compensation for night and overtime work, numerous studies show that the negative impact of shift work on nurses' quality of life, particularly physical exhaustion and social disruption, persists (10). Healthcare institutions therefore play a crucial role in enhancing nurses' QoL by ensuring safe working conditions, providing adequate staffing, and fostering work-life balance, which in turn improves the quality of patient care (11).

This study is grounded in the theoretical framework of the World Health Organization's multidimensional definition of quality of life. The WHO defines QoL as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" (12). The WHOQOL-BREF instrument, based on this definition, is especially suited for evaluating well-being in complex environments like emergency departments, as it captures four key domains: physical health, psychological health, social relationships, and environment. Its comprehensive nature allows for a holistic assessment aligned with both global standards and local occupational realities.

Aim

Based on this framework, the aim of the study is to evaluate the quality of life of nurses employed in emergency departments in Rijeka and Zagreb, and to examine whether variables such as gender, age, education level, and workplace setting are associated with variations in their perceived quality of life.

Methods

Respondents

Nurses working in emergency departments in Rijeka and Zagreb participated in this cross-sectional study, which was conducted during July and August 2024. The participants were selected using a non-probabilistic convenience sampling method based on voluntary participation. Inclusion criteria required at least one year of continuous professional experience in their current position, regardless of age, gender, or educational background. Interns and nurses with less than one year of experience were excluded to ensure that the sample consisted of experienced healthcare professionals working in the high-stress environment of emergency departments.

This study aimed to include all eligible nurses working in the emergency departments of Rijeka and Zagreb during the study period. Out of a total population of 125 nurses, 99 met the inclusion criteria and voluntarily participated, resulting in a high response rate of 79.2%. Since the study covered the majority of the available population, a separate sample size calculation was not necessary.

Data collection

Data were collected through an anonymous online questionnaire distributed via digital communication platforms (e.g., Viber, WhatsApp, and Messenger). Participation was voluntary, and informed consent was obtained electronically prior to completing the survey. Respondents were informed about the purpose of the study, the anonymity of their responses, and their right to withdraw at any point without providing a reason.

Instrument

The survey was composed of two sections:

- **Sociodemographic and professional information**, including gender, age, education level, years of work experience, and workplace (Rijeka or Zagreb). In the Croatian context, "secondary education" refers to a four-year vocational high school degree in nursing, which qualifies individuals to work as practical nurses or nursing technicians.
- **Quality of Life assessment**, based on the World Health Organization Quality of Life Questionnaire – WHOQOL-BREF. This validated 26-item instrument includes two general questions and four domain-specific sections: physical health, psychological health, social relationships, and environment. Responses were rated on a five-point Likert scale and converted to a 0-100 scale, with higher scores indicating better quality of life, in accordance with WHO guidelines (12). Domain scores above 60 were interpreted as indicative of good QoL (13).

Ethics

Ethical approval for this study was granted by the Ethics Committee of the Faculty of Health Studies, University of Rijeka (approval code: 600-05/24-01/243). All participants were informed about the purpose of the study, assured of the confidentiality of their responses, and notified of their right to withdraw at any time without consequences. Informed consent was obtained electronically before participation. The study involved minimal risk and did not collect any sensitive personal data. All results are presented in aggregate form to protect participant anonymity.

Statistics

Data were analyzed using Statistica 14.0.0.15 (TIBCO Software Inc., Palo Alto, CA, USA) and Microsoft Excel 2013 (Microsoft Corporation, Redmond, WA, USA). Descriptive statistics (mean, standard deviation, median, interquartile range) were used to summarize demographic variables and QoL scores.

The normality of data distribution was tested using the Kolmogorov-Smirnov test. Since the assumptions for parametric tests were not met, non-parametric methods were applied. Differences between two independent groups (e.g., gender, location) were analyzed using the Mann-Whitney U test. The Kruskal-Wallis test was used for comparisons among three or more categories (e.g., age groups, education level, work experience), followed by post hoc Dunn's tests with Bonferroni correction where significant differences were detected. Statistical significance was set at $p < 0.05$.

Given the small number of participants aged 56 and older (n = 3), this age category was merged with the preceding group (46-55 years) to ensure statistical validity of comparisons.

Results

A total of 99 nurses participated in the study, of whom 54 were female (54.5%) and 45 were male (45.5%). The largest proportion of participants was in the 26-35 age group (38.4%), while only 3% were 56 years or older. Due to the small size of this group, it was merged with the 46-55 category for statistical analysis (Table 1).

Table 1. **Demographic characteristics of participants**

Characteristic	Category	n (%)
Gender	Male	45 (45.5)
	Female	54 (54.5)
Age	≤ 25 years	22 (22.2)
	26-35 years	38 (38.4)
	36-45 years	16 (16.2)
	46-65 years (merged)	23 (23.3)
Education	Secondary education	32 (32.3)
	Bachelor's degree	51 (51.5)
	Master's degree	16 (16.2)
Workplace	ED Zagreb	53 (53.5)
	ED Rijeka	46 (46.5)

General results of the quality of life assessment

The overall mean quality of life score was M = 57.0, SD = 27.5, suggesting a moderate level of perceived well-being. Among the WHOQOL-BREF domains, the highest scores were recorded in social relationships, followed by environment, psychological health, and physical health, which had the lowest mean score (Table 2).

Table 2. **Mean quality of life domain scores**

Domain	Mean (M)	Standard Deviation (SD)
Physical Health	50.8	27.8
Psychological Health	58.2	26.2
Environment	59.7	27.0
Social Relationships	65.4	26.8
Overall QoL	57.0	27.5

Differences by age group

The Kruskal-Wallis test revealed statistically significant differences in quality of life scores across age groups in the domains of psychological health ($\chi^2 = 14.21$, $p = 0.001$), social relationships ($\chi^2 = 16.88$, $p < 0.001$), and environment ($\chi^2 = 12.32$, $p = 0.002$).

Post hoc comparisons using Dunn's test with Bonferroni correction indicated that nurses aged ≤ 25 years reported significantly higher quality of life in these three domains compared to those aged 46-65 years (Table 3).

Differences by gender

No statistically significant differences in quality of life scores were found between male and female participants across any domain (all $p > 0.05$).

Differences by workplace

Nurses employed in Rijeka reported higher scores in the environment domain (M = 63.4, SD = 26.1) than those in Zagreb (M = 56.3, SD = 27.5). This difference was statistically significant (U = 935, $p = 0.029$).

Differences by education level

Kruskal-Wallis tests showed statistically significant differences in psychological health (χ^2 = 7.31, p = 0.027) and social relationships (χ^2 = 6.55, p = 0.038) across education levels. Post hoc analysis using Dunn's test with Bonferroni correction revealed that nurses with secondary education reported significantly higher scores than those with a master's degree in both domains (Table 4).

Discussion

This study explores the quality of life of nurses working in emergency departments in Croatia, specifically in Rijeka and Zagreb. The findings reveal several significant patterns in the interaction between demographic and occupational factors and QoL, contributing to a broader understanding of the challenges faced by emergency healthcare workers.

The overall QoL score of 57.0, indicating a moderate level of life satisfaction, is lower than that reported in previous studies, such as Gabrić's research in Karlovac County, which showed a score of 72.2 (1). This discrepancy may reflect regional differences in workload, staffing levels, and the availability of resources. Additionally, participants in this study reported the highest satisfaction in the domain of social relationships, and the lowest in physical health, which is in line with findings from Poland and other international research highlighting the physical demands of emergency care work (14). These findings underscore the importance of targeted interventions to improve physical well-being, such as implementing wellness programs, making ergonomic adjustments, and promoting physical activity among emergency department staff.

The results revealed a significant relationship between age and quality of life in the domains of psychological health, social relationships, and environment, with younger participants (≤ 25 years) reporting higher scores than older ones (≥ 46 years). Interestingly, no significant difference was found in the domain of physical health, which contrasts with previous studies that typically associate younger age with better physical functioning.

This unexpected result may be due to the uniformly high physical demands placed on all emergency nurses, regardless of age, which could diminish age-related differences in perceived physical health. However, studies from Saudi Arabia report the opposite trend, where older healthcare workers showed better QoL, potentially due to increased work experience, stronger professional relationships, and more stable work-life integration (15). These differences highlight the influence of cultural and institutional factors, suggesting the need for age-sensitive interventions, such as flexible work schedules and wellness programs tailored to older staff.

Table 3. **Statistically significant differences by age group identified using the Kruskal-Wallis test**

Domain	χ^2 (K-W)	p (K-W)	M (≤ 25 yrs)	SD (≤25 yrs)	M (46-65 yrs)	SD (46-65 yrs)	p (post hoc)
Psychological health	14.21	0.001	63.5	24.1	52.1	27.0	0.008
Social relationships	16.88	<0.001	70.3	25.6	60.0	27.2	0.003
Environment	12.32	0.002	64.1	26.4	55.3	27.7	0.010

Table 4. **QoL scores by education level**

Domain	χ^2 (K-W)	p (K-W)	M (Secondary)	SD	M (Bachelor)	SD	M (Master's)	SD	Post hoc comparison	p (post hoc)
Psychological health	7.31	0.027	62.3	28.7	56.1	24.9	56.6	24.1	Secondary > Master's	0.022
Social relationships	6.55	0.038	70.8	29.8	65.4	25.2	54.7	22.3	Secondary > Master's	0.035

Some differences in average QoL scores were observed between male and female participants, with male nurses reporting slightly higher scores in overall quality of life, physical health, and environment. However, these differences were not statistically significant across any domain in the present study. This contrasts with findings from studies conducted in Saudi Arabia and Brazil, which reported better QoL among male healthcare workers compared to their female colleagues (16, 17). Although the present study does not confirm consistent gender-based differences across all domains, previous research suggests that factors such as increased physical and emotional strain, domestic responsibilities, and structural inequalities in the workplace may contribute to lower perceived QoL among female nurses.

Recent research confirms that female emergency nurses experience significantly higher levels of emotional exhaustion and work-family conflict compared to males, due to gendered role expectations and the emotional toll of caregiving roles (18). To address these issues, organizational change is needed, including the implementation of gender equality policies, access to childcare support, and fair promotion systems.

Contrary to expectations, nurses with secondary education reported better QoL in the domains of psychological health, social relationships, and overall satisfaction compared to those with higher education levels. In the Croatian context, secondary education refers to a five-year vocational nursing program at the secondary school level, which qualifies individuals to work as registered nurses. This finding challenges the assumption that more education correlates with greater well-being and is consistent with Gabrić's findings (1). Possible explanations include lower job-related stress and responsibility in roles requiring only secondary education, and more realistic expectations regarding work-life balance. These results suggest that increased professional demands placed on more educated nurses may negatively affect their QoL. Further research is needed to examine how job responsibilities and expectations differ by education level and how they impact well-being.

The participants working in Rijeka reported significantly higher scores in the environment domain compared to those working in Zagreb, likely reflecting the advantages of a smaller and less congested city. Factors such as reduced traffic, lower cost of living, and better access to green spaces may contribute to this outcome. These findings are consistent with studies associating higher QoL with smaller urban environments which provide more accessible community resources and a slower pace of life (19). However, the lack of significant differences in other domains suggests that institutional factors, such as management practices, staffing levels, and workplace culture, also play a role in shaping perceived QoL.

These international comparisons suggest that cultural context, healthcare system structure, and workplace support mechanisms all contribute to how demographic variables affect perceived QoL. They highlight the need for location-specific and demographically sensitive interventions aimed at improving the quality of life of emergency nurses.

Recommended strategies include increasing staffing to reduce workload, providing wellness and mental health programs, ensuring gender equality policies, and offering flexible schedules for older staff. In larger cities such as Zagreb, interventions should focus on reducing environmental stressors, while in smaller cities, initiatives could build on existing community strengths.

Limitations

This study has several limitations. The cross-sectional design restricts causal inference, and reliance on self-reported data introduces the risk of response bias due to participants' subjective perceptions. Additionally, the sample was geographically limited to emergency departments in two Croatian cities, which may reduce the generalizability of findings to other regions or healthcare systems. One notable limitation concerns the age distribution of the participants: only three respondents were aged 56 or older, which led to the merging of this group with the 46-55 category for statistical analysis, potentially masking age-specific trends.

While post hoc tests were performed for statistically significant results in age and education, the limited sample size in some subgroups still reduces statistical power. Future research should consider longitudinal designs to observe changes over time and

should include a broader, more diverse sample, both geographically and across different healthcare settings, to allow for comparisons between institutions, specialties, and countries.

Conclusion

This study examined the quality of life of nurses working in emergency departments in Rijeka and Zagreb. The overall QoL was found to be moderate, with the highest satisfaction reported in the domain of social relationships and the lowest in physical health. Statistically significant differences were identified across age, education level, and workplace in specific QoL domains, while no significant gender-based differences were observed. Younger nurses and those with secondary education reported higher scores in several areas, while nurses employed in Rijeka rated the environment domain more positively than those in Zagreb. These findings address the research questions and emphasize the relevance of demographic and contextual factors in evaluating nurse well-being.

Author contributions

Conceptualization and methodology (KL, KI); Data curation and formal analysis (KL, MM, KI); Investigation and project administration (KL, MM, KI); and Writing – original draft and review & editing (KL, MM, KI). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. Gabrić M. Quality of life of healthcare workers at the Emergency Medical Institute of Karlovac County: research-based thesis [Master's thesis]. Rijeka: University of Rijeka, Faculty of Health Studies; 2022.
2. Strapajević D. Assessing the impact of the integrated hospital emergency department service on the health and working ability of employees. Sestrinski glasnik. 2015;20(3):231-9.
3. Slišković A. Problems of shift work. Arh Hig Rada Toksikol. 2010;61(4):477. https://doi.org/10.2478/10004-1254-61-2010-2080
4. Protić I. The impact of shift work on quality of life and sleep quality among nurses [Master's thesis]. Rijeka: University of Rijeka, Faculty of Health Studies; 2021.
5. Dujić I, Gregov Lj, Slišković A. The relationship between shift work and the social and family life of workers. Medica Jadertina. 2014;44(1-2):13-25.
6. Lozančić A, Kovačević J, Matić M, Matić M, Kovačević N. Quality of life of emergency medical staff. In: Nesek Adam V, Važanić D, editors. Proceedings and abstracts. Vodice: Croatian Medical Association; Croatian Society for Emergency Medicine; Croatian Nursing Society for Emergency Medicine; 2020.
7. Pavlović B, Pavić J. Self-assessment of the quality of life and work of nurses at Zagreb Health Center. J Appl Health Sci. 2022;8(2):269-80. https://doi.org/10.24141/1/8/2/14.
8. Kovačić Kačar Ž. Comparison of the quality of life and health of nurses working in family medicine practices and home healthcare institutions [Master's thesis]. Split: University of Split; 2018. Available at: https://urn.nsk.hr/urn:nbn:hr:176:996546.
9. Dall'Ora C, Ball J, Reinius M, Griffiths P. Burnout in nursing: a theoretical review. Hum Resour Health. 2020;18(1):41. https://doi.org/10.1186/s12960-020-00469-9
10. Juan-García C, Plaza-Carmona M, Fernández-Martínez N. Sleep analysis in emergency nurses' department. Rev Assoc Med Bras (1992). 2021;67(6):862-7. https://doi.org/10.1590/1806-9282.20210648
11. Córdova-Martínez A, Pérez-Valdecantos D, Caballero-García A, Bello HJ, Roche E, Noriega-González D. Relationship between strength and professional quality of life of nurses working hospital emergency departments. Int J Environ Res Public Health. 2023;20(3):2052. https://doi.org/10.3390/ijerph20032052
12. World Health Organization. WHOQOL: User Manual. Geneva: Division of Menthal Health and Prevention of Substance Abuse [Internet]. World Health Organization; 1998. Available at: https://iris.who.int/bitstream/handle/10665/77932/WHO_HIS_HSI_Rev.2012.03_eng.pdf?sequence=1

13. Silva PAB, Soares SM, Santos JFG. Cut-off point for WHOQOL-bref as a measure of quality of life of older adults. Rev Saude Publica. 2014;48(3):390–7. https://doi.org/10.1590/S0034-8910.2014048004912
14. Orszulak N, Kubiak K, Kowal A, Czapla M, Uchmanowicz I. Nurses' quality of life and healthy behaviors. Int J Environ Res Public Health. 2022;19(19):12927. doi:10.3390/ijerph191912927.
15. Alharbi MF, Alahmadi BA, Alali M, Alsaedi S. Quality of nursing work life among hospital nurses in Saudi Arabia: A cross-sectional study. J Nurs Manag. 2019;27(8):1722–30. https://doi.org/10.1111/jonm.12856
16. Maqsood MB, Islam MA, Nisa Z, Nagvi AA, Qarni AA, Al-karasneh AF, et al. Assessment of quality of work life (QWL) among healthcare staff of intensive care unit (ICU) and emergency unit during COVID-19 outbreak using WHOQoL-BREF. Saudi Pharm J. 2021;29(11):1348–54. https://doi.org/10.1016/j.jsps.2021.10.002
17. Monteiro QR, Lobato CM, Amaral TLM, Costa JMM, Boas ACV, Monteiro IL, et al. Quality of life evaluation of emergency professionals of public units of reference. Braz J Dev. 2022;8(1):8144–61. https://doi.org/10.34117/bjdv8n1-563
18. Diao D, Chen X, Zhong L, Zhang H, Wang S. Sex differences in burnout and work-family conflict among Chinese emergency nurses: A cross-sectional study. Front Public Health. 2024;12:1492662. https://doi.org/10.3389/fpubh.2024.1492662
19. Batrnek T, Gašpert M. Quality of life of nurses in Osijek. Croat Nurs J. 2018;2(2):99–109. https://doi.org/10.24141/2/2/2/2

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Original scientific paper

Comorbidities, Preoperative Preparation Duration and Treatment Outcomes in Hip Fracture Patients: A Retrospective Study

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Abstract

Introduction. Hip fractures in the elderly pose a major public health challenge, particularly due to the frequent presence of comorbidities which can prolong the preoperative preparation and increase intraoperative and postoperative risks.

Aim. This study aimed to assess whether the comorbidity burden changes preoperative preparation duration and evaluate its mediating effect through additional diagnostic tests and anesthesiological risk assessment.

Methods. A retrospective observational study was conducted on 71 patients with hip fractures admitted to the University Hospital Sveti Duh over one year. Demographic data, ASA classification, comorbidity types, and the number of additional diagnostic procedures were analysed. Statistical methods included the Mann-Whitney U test, multiple linear regression, and Sobel's test to evaluate mediation effects.

Results. Urological, neurological, and endocrine comorbidities significantly prolonged preoperative preparation ($p<0.05$). The number of additional diagnostic tests was the strongest predictor of preparation duration ($p<0.001$) and mediated the relationship between comorbidity burden and preoperative delay. Higher ASA classification scores were linked to longer preoperative preparation times and more required tests.

Conclusion. Comorbidities in hip fracture patients have prolonged the preoperative planning, with spe-

cific conditions leading to prolonged hospital stays and increased diagnostic demands. Optimising chronic disease management before trauma occurrence may help reduce preoperative delays and improve surgical outcomes.

Introduction

Elderly individuals accounted for 39.6% of all hospitalised patients in Croatia in 2022, reflecting a slight increase from 38.8% the year before. The average hospital stay decreased slightly from 9.49 to 9.36 days. In geriatric patients, hip fractures were among the most common diagnoses, and in those over 85, they were the leading cause of hospitalisation, highlighting the significant impact of falls and musculoskeletal injuries in this age group (1, 2).

Hip fractures account for approximately 30% of all bone fractures in individuals over 50 years of age, with a prevalence three times higher in women. The fracture risk in this population is notably elevated, 5.6% in men and 20% in women, primarily due to osteoporosis (3-5). Over the next decade, hip fracture incidence is projected to increase by 12% in women and 6.4% in men (4-6). By 2050, this trauma is expected to reach epidemic proportions, with an estimated 6 million hip fractures occurring annually in geriatric patients (4, 6).

Hip fractures pose a major public health concern due to their high incidence, associated morbidity and mortality (7). The global rise in hip fractures is largely driven by population aging and increased life expectancy (8). Projections indicate a continuing increase in fracture numbers, placing substantial strain on healthcare systems worldwide (9-11). Osteoporotic fractures, including hip fractures, contribute to over 10 million cases annually, imposing significant burdens on patients, families, and healthcare infrastructures (7, 9).

Similar to other traumatic injuries, femoral fractures in the hip region are unpredictable and place a significant burden on the bed capacity of healthcare facilities due to the need for hospitalisation and intensive treatment. Cost-benefit analyses indicate that these fractures involve substantial financial expenditure (12, 13). Nearly two-thirds of hip-region femoral fractures are both functionally and biomechanically unstable, necessitating hospital admission, surgical intervention, and a prolonged period of rehabilitation (14). These injuries are among the most frequently surgically treated traumatic conditions (15). Full recovery is achieved in only about 25% of cases, while nearly 50% of patients require long-term systemic support. Additionally, around 40% continue to need physical therapy, and approximately 25% remain at risk of sustaining a fracture in the contralateral hip (6, 13).

A crucial aspect of effective management is the patient's preoperative preparation, which involves comprehensive diagnostic assessments, preventive strategies, and the thorough preparation of both the patient and the surgical field to ensure optimal surgical conditions.

The timing of surgical intervention in hip fractures remains a subject of ongoing debate. In elderly patients with multiple comorbidities, a multidisciplinary evaluation is essential to identify potential contraindications related to cardiovascular, respiratory, or neurological function. Nonetheless, early surgical intervention is key to reducing the duration of bed rest and minimizing the risk of complications. Balancing these considerations makes the interval between hospital admission and surgery a critical factor, with important implications for clinical outcomes and healthcare system efficiency (14, 16).

Given the high prevalence of comorbidities in geriatric patients, surgical treatment must be precise to optimize recovery and maintain the quality of life (15, 17, 18). Following trauma, initial hip fracture diagnosis is performed using primary radiological assessments, followed by preoperative evaluation. Standardized laboratory tests and diagnostic procedures are required before anesthesiological clearance for surgery. However, most patients have one or more chronic or acute conditions, which frequently delay surgical approval. Additional specialist evaluations and diagnostic tests further extend the time to treatment (13, 19). Prolonged preoperative preparation has negative consequences, including an increased risk of complications related to extended bed rest, such as respiratory infections, urinary tract infections, pain management difficulties leading to distress syndrome, psychomotor disorders, and nosocomial infections. The surge in preoperative examina-

tions also places a considerable burden on diagnostic resources and healthcare personnel, prolonging hospital stays, increasing bed occupancy, and leading to substantial financial costs (16, 20).

The healthcare implications of hip fractures are profound, involving extended hospitalization, increased rehabilitation needs, and higher healthcare costs (21). Beyond the economic impact, hip fractures significantly affect patients' quality of life, often resulting in reduced mobility, loss of independence, and psychological distress (20, 22, 23). Understanding the influence of comorbidities on preoperative preparation duration and treatment outcomes remains essential for improving patient care (23).

Aim

This study aimed to examine the number of comorbidities, the initial anaesthesiological risk assessment, and the need for additional diagnostic procedures with the duration of preoperative hospitalisation in patients undergoing surgical treatment for femoral fractures in the hip region. Furthermore, it investigated how these factors are related to delays in surgical interventions and overall length of hospital stay, to identify opportunities to optimise preoperative management and enhance patient outcomes.

Methods

Study design

This retrospective observational research study included all patients admitted to the Traumatology Department through the emergency surgical outpatient clinic of the Emergency Department of the University Hospital Sveti Duh over one year (from January 1st, 2015 to January 1st, 2016), in whom surgical treatment of a radiologically verified femoral fracture in the hip area was indicated. The study was approved by the Ethics Committee of the University Hospital Sveti Duh (approval number 01-3225). Data were collected from the hospital information system database, and all participant identities remained anonymous and protected.

Respondents

Data were analysed regarding participants' sex and age, the type and number of comorbidities, American Society of Anesthesiologists (ASA) classification (24) at the initial anaesthesiological assessment, the number of prescribed and performed additional examinations and tests, and the number of days required for preoperative preparation for the planned surgical procedure. The collected data on comorbidities were categorised into seven groups. The cardiac comorbidities group included: hypertension, arrhythmias and conduction disorders, history of myocardial infarction, and conditions following coronary artery bypass grafting and stent placement. The neurological comorbidities group comprised Parkinson's disease, post-stroke with consequent paresis, and various peripheral neuropathies. In the group of urological comorbidities, the following were observed: acute and chronic urinary tract infections, incontinence, and prostate hypertrophy.

Pulmonary comorbidities included acute and chronic respiratory infections, asthma, chronic bronchitis, and COPD. In the group of psychiatric comorbidities, the following were found: Alzheimer's disease, various degrees of dementia, and psycho-organic syndromes. The group of "other" comorbidities included malignant diseases, metastatic fractures, circulatory insufficiency, venous ulcer disease, and autoimmune disorders. A total of 71 patients participated in our one-year study, including 57 women (80.3%) and 14 men (19.7%), which is consistent with epidemiological findings from other studies (25). The average age of the patients was 82, with the youngest being 59 and the oldest 93.

Of the patients included in the study, only 4.2% had no comorbidities, while the remaining exhibited between one and five comorbid conditions. The most frequently observed was two comorbidities, present in 35.3% of patients, followed by three in 31.0%, one in 22.5%, four in 4.2%, and five comorbidities in 2.8% of cases.

Statistics

The statistical significance level was set at 5% ($p < 0.05$), and two-tailed statistical tests were applied to all analyses. The normality of the distribution of continuous variables was tested using the Kolmogorov-Smirnov test for the entire patient set and subsamples larger than 30 patients, and the Shapiro-Wilks test for even smaller samples. Due to deviations from a normal distribution, the median and interquartile range were used to measure central tendency and dispersion. The Mann-Whitney test was employed to compare patients with and without a particular type of comorbidity. In the case of statistically significant differences, the AUC (area under the curve) was calculated as a standardised measure of effect size. The point-biserial coefficient was used for dichotomous variables, such as gender, and continuous variables. The simultaneous contribution of demographic and clinical characteristics to predicting the duration of preoperative preparation was examined using multiple linear regression analysis. All analyses were performed using the IBM SPSS statistical package. The hypothesis that the number of additional examinations is a mediator of the relationship between the number of comorbidities and the duration of preoperative preparation was tested using the Sobel test implemented in the PROCESS macro, version 2.16.3 (26).

Results

The study included 71 patients hospitalised at the Traumatology Department through the emergency surgical outpatient clinic of the Center for Emergency Medicine – Central Emergency Department of the University Hospital Sveti Duh over one year, who required surgical treatment of a radiologically verified femoral fracture in the hip area.

The most common comorbidities were cardiac (71.8%), followed by urological (40.8%), endocrinological (32.4%), neurological (28.2%), psychiatric (18.3%), and "other" conditions (12.7%). Respiratory comorbidities were the least frequent, occurring in 8.5% of patients. The number of prescribed and additional examinations and tests ranged from none to 16, while the duration of preoperative preparation varied from two to 11 days (Table 1).

Table 1. **Patient demographic and clinical data**

Sex	**n**	**(%)**
men	14	(19.7)
women	57	(80.3)
Total	71	(100.0)
Age (years), median (IQR)	*82*	*(79-85)*
Comorbidities		
cardiac	51	(71.8)
urological	29	(40.8)
endocrinological	23	(32.4)
neurological	20	(28.2)
psychiatric	13	(18.3)
respiratory	6	(8.5)
Other	9	(12.7)
Number of comorbidities, median (IQR)	2	(1-3)
Number of comorbidities, n (%)		
0	3	(4,2)
1	16	(22.5)
2	25	(35.3)
3	22	(31.0)
4	3	(4.2)
5	2	(2.8)
ASA classification at initial exam		
2	19	(26.8)
3	48	(67.6)
3-4	4	(5.6)
Number of additional tests, median (IQR)	2	(1-4)
Preoperative duration (days), median (IQR)	4	(3-6)

IQR = interquartile range, ASA = American Society of Anesthesiologists

The data concerning each type of comorbidity and the total length of preoperative preparation were also analysed. The length of preoperative preparation was compared in patients with and without the four most common comorbidities (Table 2).

There was no statistically significant difference in the length of preoperative preparation between patients with and without cardiac comorbidities. On the other hand, the length of preoperative preparation was longer in patients with urological comorbidities (Mann-Whitney U = 406.0; $p = 0.016$; AUC = 0.33). In the presence of endocrinological comorbidities, the length of preoperative preparation was longer than in their absence (Mann-Whitney U = 169.0; $p < 0.001$; AUC = 0.15. Neurological comorbidities also prolonged the preoperative preparation (Mann-Whitney U = 253.5; p = 0.001; AUC = 0.25).

Furthermore, the level of ASA classification at the initial anaesthesiology examination was divided into two categories. The first group consisted of patients whose ASA-sum was 2, while the second group consisted of patients whose ASA-sum was 3 or 3-4. At the univariate level, it was determined that the number of days spent on preoperative preparation has a statistically highly significant correlation with the number of prescribed and additionally performed examinations and tests, whereby the number of days of preparation increased with the number of additional tests. A greater number of days of preoperative preparation was associated with a greater number of comorbidities and a higher level of ASA classification at the initial anaesthesiology examination. A greater number of comorbidities was also associated with advanced patient age and a higher level of ASA classification at the initial anaesthesiology examination (Table 3).

Multiple linear regression analysis showed that the demographic and clinical predictor variables examined explained a proportion of the variation in the length of preoperative preparation, which amounted to 82.2% (R^2 = 0.822; F (5.65) = 60.11; p<0.001). The analysis showed that the number of prescribed and additionally performed examinations and tests was the only statistically significant predictor of the length of preoperative preparation.

Table 2. **Median duration of preoperative care and significance of the presence of specific comorbidities**

	Not-present		Comorbidity present		
Comorbidity type	**Median**	**(IQR)**	**Median**	**(IQR)**	***p***
Cardiac	4.0	(2.3-6.8)	4,0	(3.0-6.0)	0.871
Urological	4.0	(2.0-6.0)	5,0	(4.0-7.5)	0.016
Endocrinological	4.0	(2.0-5.0)	7,0	(6.0-10.0)	< 0.001
Neurological	4.0	(2.0-6.0)	5,5	(4.3-9.0)	0.001

IQR = interquartile range; *p* = statistical significance level; Mann-Whitney U test results

Table 3. **Relation of the duration of preoperative preparation and demographic and clinical predictor variables**

	1	2	3	4	5	6
1 Preoperative preparation (days)	-	-0.13	0.16	0.68***	0.53***	0.90***
2 Sex (female)		-	0.09	-0.08	-0.14	-0.03
3 Age			-	0.25*	0.11	0.13
4 Number of comorbidities				-	0.65***	0.75***
5 ASA classification at initial anesthesiological exam 3 or 3-4					-	0.51***
6 Number of additional tests						-

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 4. **Regression Analysis of the duration of Preoperative Preparation Based on Demographic and Clinical Characteristics**

	B	SE B	β	t	*p*
Age	0.03	0.02	0.06	1.12	0.266
Number of comorbidities	-0.20	0.23	-0.08	-0.88	0.383
ASA classification at initial anesthesiological exam 3 or 3-4	0.63	0.41	0.11	1.53	0.130
Number of additional tests	0.780	0.07	0.89	11.28	< 0.001

B = non standardised (raw) regression coefficient; SE B = standard error of regression coefficient; β = standardised regression coefficient

Furthermore, even after adjusting for other predictors in the regression model, more prescribed and performed examinations and tests remained significantly associated with a prolonged preoperative preparation period (Table 4).

Although the number of comorbidities was statistically significantly associated with the length of preoperative preparation at the univariate level (Table 3), this relationship was not statistically significant when other variables were considered in the multivariate prediction. At the univariate level, the number of comorbidities was highly correlated with the number of additional examinations (r = 0.75), so the possibility that the number of comorbidities affects the length of preoperative preparation due to the number of additional examinations was considered. In other words, the mediation hypothesis was tested where the number of comorbidities influences the length of preoperative preparation through the number of additional examinations.

In the first step, the relationship between the number of additional examinations and the number of comorbidities was examined using multiple linear regression, controlling for gender, age, and level of anaesthesia risk, and it was found that the number of comorbidities statistically significantly contributed to the prediction of the number of additional examinations (B=2.04; SE B=0.31; t=6.65; $p<0.001$). In the second step, the indirect effect of the number of comorbidities on the length of preoperative preparation was analysed using the Sobel test, while controlling for other variables included in the analysis. The analysis revealed that this indirect effect is statistically significant (z=5.71; SE z=0.28; $p<0.001$), thus confirming the mediation hypothesis.

In other words, it was determined that the number of additional examinations is a mediator, or an intervening variable, in the relationship between the number of comorbidities and the duration of preoperative preparation. A higher number of comorbidities leads to additional examinations, which in turn prolong the duration of preoperative preparation.

Discussion

Hip fractures in elderly patients represent a significant global health concern, particularly due to the high prevalence of comorbidities that complicate preoperative preparation, surgical procedures, and postoperative recovery (19, 27). The presence of multiple chronic conditions prolongs the time required for preoperative optimisation and increases the risk of complications, leading to worse treatment outcomes and higher healthcare costs (10, 28-31). Optimising the management of comorbidities before the occurrence of trauma could help reduce the duration of preoperative preparation and potentially improve the surgical outcomes for hip fracture treatment in elderly patients (32, 33).

Analysis of the collected data showed that cardiac comorbidities were the most common, affecting 71.8% of patients, a finding consistent with other studies (34, 35). Urological comorbidities were also common, present in 40.8% of patients, followed by endocrinological (32.4%), neurological (28.2%), psychiatric (18.3%), and "other" comorbidities (12.7%). Respiratory comorbidities were the least frequent, affecting 8.5% of patients. These findings align with those observed in similar studies (36). The high percentage of cardiac comorbidities was to be expected, most likely due to the advanced age of the participants.

Data analysis was focused on the relationship between the occurrence of each type of comorbidity and the total length of preoperative preparation. The preoperative preparation duration was compared between patients with and without the four most common comorbidities. The analysis revealed no statistically significant difference in the length of preoperative preparation for patients with cardiac comorbidities compared to those without such conditions. However, urological comorbidities ($p=0.016$) and neurological comorbidities ($p=0.001$) were significantly connected to the length of preoperative preparation. Endocrinological comorbidities had the most pronounced statistically significant relation to the length of preoperative preparation ($p<0.001$).

The number of prescribed and additional examinations and tests ranged from none (0) to 16. The duration of preoperative preparation varied from two to 11 days, with a typical range of three to six days. In

our study, the duration of preoperative preparation is similar to the average duration of preoperative preparation in published studies (37-41).

Through multiple linear regression analysis, it was determined that a statistically significant proportion of the variation in the length of preoperative preparation could be explained based on the investigated clinical predictor variables ($p<0.001$) and that the number of prescribed and additionally performed examinations and tests is the only statistically significant predictor of the length of preoperative preparation. After controlling for other predictor variables in the regression model, more prescribed and additionally performed examinations and tests were associated with a longer preoperative preparation time.

This study has several limitations. The retrospective, single-center observational design and the moderate sample size may introduce potential biases. These biases could be mitigated by extending the study period to account for seasonal variations, which may influence the incidence of hip fractures. Furthermore, changing the design and adding more locations could improve results of the study.

Conclusion

This study demonstrates that comorbidities in patients with hip fractures pose a significant challenge in the implementation of preoperative preparation, thereby affecting the overall surgical treatment process. The length of preoperative preparation was found to increase statistically significantly in patients with a higher ASA classification at the initial anaesthesiology examination, in those with endocrinological, urological, and neurological comorbidities, and in patients prescribed additional tests due to uncontrolled comorbidities and a high ASA classification.

Author contributions

Conceptualization and methodology (TM, SK, ADŽ); Data curation and formal analysis (TM, NG); investigation and project administration (TM, ADŽ, NG); and Writing – original draft and review & editing (TM, SK, NG). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. Croatian Institute of Public Health. Croatian Health Statistical Yearbook for 2022 [Internet]. Morbidity and causes of death in the elderly. Available at: http//www.hzjz.hr/periodicne-publikacije/hrvatski-zdravstveno-statisticki-ljetopis-za-2022. Accessed: 29. 1. 2025.
2. Abelleyra Lastoria DA, Benny CK, Smith T, Hing CB. Outcomes of hip fracture in centenarians: a systematic review and meta-analysis. Eur Geriatr Med. 2023 Dec;14(6):1223-39. https://doi.org/10.1007/s41999-023-00866-y
3. Piirtola M, Vahlberg T, Isoaho R, Aarnio P, Kivela SL. Incidence of fractures and changes over time among the aged in a Finnish municipality: a population-based 12-year follow-up. Aging Clin Exp Res. 2007;19(4):26976. https://doi.org/10.1007/BF03324701
4. Cooper C, Campion G, Melton LJ. Hip fractures in the elderly; a world-wide projection. Osteoporos Int. 1992;2(6):285-9. https://doi.org/10.1007/BF01623184
5. Fraser LA, Langsetmo L, Berger C, Ioannidis G, Goltzman D, Adachi JD, et al. Fracture prediction and calibration of a Canadian FRAX® tool: a population-based report from CaMos. Osteoporos Int. 2011;22(3):82937. https://doi.org/ 10.1007/s00198-010-1465-1
6. Branco JC, Felicissimo P, Monteiro J. Epidemiology of hip fractures and its social and economic impact. A revision of severe osteoporosis current standard of care. Acta Reumatol Port. 2009;34(3):475-85.
7. Zeng Z, Li H, Luo C, Huang MD, Li HP, Peng X, et al. Risk factors associated with mortality in elderly patients receiving hemiarthroplasty for femoral neck fractures. BMC Musculoskelet Disord. 2025 Apr 16;26(1):373. https://doi.org/10.1186/s12891-025-08620-0. PMID: 40241076

8. Cram P. CORR Insights®: What was the Epidemiology and Global Burden of Disease of Hip Fractures From 1990 to 2019? Results From and Additional Analysis of the Global Burden of Disease Study 2019. Clin Orthop Relat Res. 2023;481(6):1221-3. https://doi.org/10.1097/CORR.0000000000002511
9. GBD 2019 Fracture Collaborators. Global, regional, and national burden of bone fractures in 204 countries and territories, 1990-2019: a systematic analysis from the Global Burden of Disease Study 2019. Lancet Healthy Longev. 2021;2(9):e580-e592. https://doi.org/10.1016/S2666-7568(21)00172-0
10. Dong Y, Zhang Y, Song K, Kang H, Ye D, Li F. What was the Epidemiology and Global Burden of Disease of Hip Fractures From 1990 to 2019? Results From and Additional Analysis of the Global Burden of Disease Study 2019. Clin Orthop Relat Res. 2023;481(6):1209-20. https://doi.org/10.1097/CORR.0000000000002465
11. Borgström F, Karlsson L, Ortsäter G, Norton N, Halbout P, Cooper C, et al. Fragility fractures in Europe: burden, management and opportunities. Arch Osteoporos. 2020 Apr 19;15(1):59. https://doi.org/10.1007/s11657-020-0706-y
12. Sing CW, Lin TC, Bartholomew S, Bell JS, Bennett C, Beyene K, et al. Global Epidemiology of Hip Fractures: Secular Trends in Incidence Rate, Post-Fracture Treatment, and All-Cause Mortality. J Bone Miner Res. 2023;38(8):1064-75. https://doi.org/10.1002/jbmr.4821
13. Alolabi B, Bajammal S, Shirali J, Karanicolas P, Gafni A, Bahandari M. Treatment of displaced femoral neck fractures in the elderly: a cost-benefit analysis. J Orthop Trauma 2009;23(6):442-6. https://doi.org/10.1097/BOT.0b013e31817614dd
14. Liu F, Chang WJ, Wang X, Gong R, Yuan DT, Zhang YK, et al. Risk factors for prolonged preoperative waiting time of intertrochanteric fracture patients undergoing operative treatment. BMC Musculoskelet Disord. 2022 Oct 13;23(1):912. https://doi.org/10.1186/s12891-022-05865-x.
15. Court-Brown CM, Heckman JD, McQueen MM, Ricc WM, Torretta P. Rockwood and Green's Fractures in Adults. 8th ed. Philadelphia: Wolters Kluwer; 2015.
16. Rozenfeld M, Bodas M, Shani M, Radomislensky I, Murad H, Comaneshter D, et al. National study: Most elderly patients benefit from earlier hip fracture surgery despite co-morbidity. Injury. 2021;52(4):905-9. https://doi.org/ 10.1016/j.injury.2020.10.060
17. Forte ML, Virnig BA, Eberly LE et al. Provider factors associated with intramedullary nail use for intertrochanteric hip fractures. J Bone Joint Surg Am 2010;92(5):1105-14. https://doi.org/10.2106/JBJS.I.00295
18. Borgström F, Karlsson L, Ortsäter G, Norton N, Halbout P, Cooper C, et al. Fragility fractures in Europe: burden, management and opportunities. Arch Osteoporos. 2020 Apr 19;15(1):59. https://doi.org/10.1007/s11657-020-0706-y
19. Đozić H, Bišćević M, Muharemović T, Žujo S, Kukuljac A, Skopljak E. The Predictive Values of the Functional Status, Comorbidities, and the Types of Treatment on the Treatment Outcomes in Elderly Patients Following the Hip Fracture. Acta Chir Orthop Traumatol Cech. 2022;89(3):199-203.
20. Schrøder CK, Hjelholt TJ, Møller H, Madsen M, Pedersen AB, Kristensen PK. Comorbidity and Quality of In-Hospital Care for Hip Fracture Patients. J Am Med Dir Assoc. 2022;23(4):671-7.e4. https://doi.org/10.1016/j.jamda.2022.01.078
21. Yoon SH, Kim BR, Lee SY, Beom J, Choi JH, Lim JY. Influence of comorbidities on functional outcomes in patients with surgically treated fragility hip fractures: a retrospective cohort study. BMC Geriatr. 2021;21(1):283. https://doi.org/10.1186/s12877-021-02227-5
22. Loggers SAI, Willems HC, Van Balen R, Gosens T, Polinder S, Ponsen KJ, et al. Evaluation of Quality of Life After Nonoperative or Operative Management of Proximal Femoral Fractures in Frail Institutionalized Patients: The FRAIL-HIP Study. JAMA Surg. 2022;157(5):424-34. https://doi.org/10.1001/jamasurg.2022.0089
23. Kang MJ, Kim BR, Lee SY, Beom J, Choi JH, Lim JY. Factors predictive of functional outcomes and quality of life in patients with fragility hip fracture: A retrospective cohort study. Medicine (Baltimore). 2023;102(7):e32909. https://doi.org/10.1097/MD.0000000000032909
24. Kivrak S, Haller G. Scores for preoperative risk evaluation of postoperative mortality. Best Pract Res Clin Anaesthesiol. 2021;35(1):115-34. https://doi.org/10.1016/j.bpa.2020.12.005
25. Skala-Rosenbaum J, Bartoniček J, Riha D, Waldauf P, Džupa V. Single-centre study of hip fractures in Prague, Czech Republic, 1997-2007. Int orthop 2011;35:587-93. https://doi.org/10.1007/s00264-010-0984-x
26. Hayes, AF. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. New York: The Guilford Press, 2013.
27. Selaković I, Mandić-Rajčević S, Milovanović A, Tomanović-Vujadinović S, Dimitrijević S, Aleksić M, et al. Pre-Fracture Functional Status and Early Functional Recovery are Significant Predictors of Instrumental Activities of Daily Living After Hip Fracture: A Prospective Cohort Study. Geriatr Orthop Surg Rehabil. 2024 May 16;15:21514593241255627. https://doi.org/10.1177/21514593241255627
28. Sameer M, Muthu S, Vijayakumar PC. Enhanced Recovery After Surgery (ERAS) Protocol in Geriatric Hip Fractures: An Observational Study. Cureus. 2023 Jul 18;15(7):e42073. https://doi.org/10.7759/cureus.42073
29. Chandrupatla SR, Singh JA. Medical Comorbidity and Male Sex Are Associated With Higher In-hospital Mortality for 90-Day Readmissions and Higher Readmission Rates After Nonelective Primary Total Hip Arthroplasty for Hip Fracture. J Clin Rheumatol. 2025 Apr 17. https://doi.org/10.1097/RHU.0000000000002236

30. Han X, Han L, Chu F, Liu B, Song F, Jia D, et al. Predictors for 1-year mortality in geriatric patients following fragile intertrochanteric fracture surgery. J Orthop Surg Res. 2024 Oct 30;19(1):701. https://doi.org/10.1186/s13018-024-05219-4
31. Bhatti UF, Shah AA, Williams AM, Biesterveld BE, Okafor C, Ilahi ON, et al. Delay in Hip Fracture Repair in the Elderly: A Missed Opportunity Towards Achieving Better Outcomes. J Surg Res. 2021 Oct;266:142-7. https://doi.org/10.1016/j.jss.2021.03.027
32. Williams CT, Whyman J, Loewenthal J, Chahal K. Managing Geriatric Patients with Falls and Fractures. Orthop Clin North Am. 2023 Jul;54(3S):e1-e12. https://doi.org/10.1016/j.ocl.2023.04.001
33. González de Villaumbrosia C, Barba R, Ojeda-Thies C, Grifol-Clar E, Alvarez-Diaz N, Alvarez-Espejo T, et al. Predictive factors of gait recovery after hip fracture: a scoping review. Age Ageing. 2025 Mar 3;54(3):afaf057. https://doi.org/10.1093/ageing/afaf057
34. Ali AM, Gibons CE. Predictors of 30-day hospital readmission after hip fracture: a systematic review. Injury 2017;48(2):243-52. https://doi.org/10.1016/j.injury.2017.01.005
35. Kristensen PK, Hjelholt TJ, Madsen M, Pedersen AB. Current Trends in Comorbidity Prevalence and Associated Mortality in a Population-Based Cohort of Hip Fracture Patients in Denmark. Clin Epidemiol. 2023 Jul 18;15:839-53. https://doi.org/10.2147/CLEP.S410055
36. Nicholas JA. Preoperative optimization and risk assessment. Clin Geriatr Med. 2014;30:207-18. https://doi.org/10.1016/j.cger.2014.01.003
37. Herron J, Hutchinson R, Lecky F, Bouamra O, Edwards A, Woodford M, et al. The impact of age on major orthopaedic trauma: an analysis of the United Kingdom Trauma Audit Research Network database. Bone Joint J. 2017; 99B:167780. https://doi.org/10.1302/0301-620X.99B12.BJJ-2016-1140.R2
38. Haq ZA, Murthy P, Malik I, Lahori VU, Chaudhary S, Ahuja S. Detection of comorbid illnesses during preanaesthesia evaluation in a university teaching hospital: A prospective observational study. Natl Med J India. 2014; 27 :256-8.
39. Brown CA, Olson S, Zura R. Predictors of length of hospital stay in elderly hip fracture patients. J Surg Orthop Adv. 2013;22:160-3. https://doi.org/10.3113/jsoa.2013.0160
40. Reguant F, Arnau A, Lorente JV, Maestro L, Bosch J. Efficacy of a multidisciplinary approach on postoperative morbidity and mortality of elderly patients with hip fracture. J Clin Anesth. 2019;53:11-9. https://doi.org/10.1016/j.jclinane.2018.09.029
41. Tewari P, Sweeney BF Jr, Lemos JL, Shapiro L, Gardner MJ, Morris AM, et al. Evaluation of Systemwide Improvement Programs to Optimize Time to Surgery for Patients With Hip Fractures: A Systematic Review. JAMA Netw Open. 2022;5(9):e2231911. https://doi.org/10.1001/jamanetworkopen.2022.31911

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Review

Intrahospital Transfers of Adult Patients Requiring Intensive Treatment - Review Paper

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Abstract

Introduction. The unstructured course of intrahospital transfer affects the quality of healthcare. In addition to various clinically unfavorable incidents that prolong hospital stays and indirectly affect positive treatment outcomes, intrahospital transfers lead to much more complex consequences for the healthcare system. Particularly vulnerable and sensitive patients are placed in Intensive Care Units. Nurses have a key role in safe intrahospital transfers.

Aim. This study, based on the available literature, aims to provide a deeper and more comprehensive insight into the incidence of adverse events caused by intrahospital transfer, identify risk factors, determine the need for more extensive surveillance and propose possible solutions for preventing incidents caused by inadequate IHT and improving the quality of healthcare services.

Methods. Review. Search of scientific studies published from 2019 - 2024 in scientific databases MedLine and Cochrane.

Results. Research was conducted on 24 studies related to patients and intrahospital transfer. Of the total 24 studies included, 17 focused on adult patients, while the remaining 7 examined healthcare professionals, primarily nurses involved in intrahospital transfer.

Conclusion. Many studies have emphasized the high-quality assessment of the potential benefits of the transfer in comparison with the consequences of adverse events. Special attention has been paid to vitally endangered patients as the most sensitive group whose transfers require a multidisciplinary approach and a clearly structured course. The implementation of protocols and procedures reduces the incidence of adverse events and deterioration of the patient's condition during intrahospital transfers. Further studies and meta-analyses are needed.

Introduction

Numerous studies of different approaches are being conducted to reduce adverse events during intrahospital transfers (IHT). Such studies have been conducted since the 1970s and an increasing number of studies correlate the impact of mistakes in intrahospital transfers with a number of factors that contribute to worse clinical outcomes (1). In addition to various clinically unfavorable incidents that prolong hospital stays and indirectly affect positive treatment outcomes, intrahospital transfers lead to much more complex consequences for the healthcare system. Besides the individual approach, the impact of complications and deviations from intrahospital transfer guidelines on the hospital as an organizational structure should also be considered. A reliable course of treatment and movement of patients is of great importance for the hospital system. The unstructured course of intrahospital transfers affects the patient, but also the health care quality in a wider context (2, 3). Therapeutic and diagnostic procedures, especially for patients who require intensive treatment, are necessary to provide patients with timely and appropriate care. Nurses and technicians who supervise the patient during such procedures must possess a wide range of knowledge and competencies to recognize any acute event and react in a timely manner with the aim of preventing adverse events or complications (4). The studies published so far talk discuss the key role of nurses in ensuring the patient's safety during IHT (5). Since it is required to have a high level of knowledge and skills that health professionals must master, some studies also suggest the introduction of specialized teams for IHT (6). In order to find an ideal solution, studies have highlighted not only technical challenges but also a significant prevalence of errors stemming from poor judgment, delayed recognition of acute conditions, deviation from established protocols, and gaps in knowledge and skills (7).

Also, as a relatively common cause of adverse events for the patient, studies single out poor communication among health personnel, which results in conflicts and disobeying the hierarchical structure when making medical decisions (8). The number of intrahospital transfers during a stay in a healthcare facility is ultimately reflected in psychological alterations in patients, as well as in lower satisfaction with the healthcare services (9).

Aim

This study, based on the available literature, aims to provide a deeper and more comprehensive insight into the incidence of adverse events caused by intrahospital transfer, identify risk factors, determine the need for more extensive surveillance and propose possible solutions for the purpose of preventing incidents caused by inadequate IHT and improving the quality of healthcare services.

Methods

Available studies published in the last 5 years, from 2019 - 2024, in scientific databases MedLine and Cochrane were searched.

The search keywords were patient safety, intrahospital transfer, nurses.

The search resulted in 674 papers published in the last 5 years. Adding additional keywords such as 'adverse events' and 'intrahospital transfer protocol', and narrowing the search to a specific goal, resulted in 24 papers, which were then further examined and analyzed according to the stated inclusion criteria.

The basis of the search was to gain insight into the incidence of adverse events caused by intrahospital transfer, identify risk factors, determine the need for more extensive surveillance and propose possible solutions for the purpose of preventing incidents caused by inadequate IHT and improving the quality of healthcare services.

Phase 1 consisted of defining the inclusion and exclusion criteria for this review paper.

Phase 2: Reviews of the above scientific databases using the initial keywords resulted in 674 identified studies. Further filtering regarding specific objectives and keywords resulted in 17 studies concerning adult patient population and 7 studies concerning healthcare professionals.

Phase 3: Thorough analysis and reading of studies.

Phase 4: Writing the review paper

Exclusion and inclusion criteria

Table 1. **Exclusion and inclusion criteria**

INCLUSION CRITERIA	EXCLUSION CRITERIA
Papers published in the last five years	Papers published more than five years ago
Methodologically correctly systematized papers with a clearly defined type of research, goals, methods, and results	Methodologically incorrect and inconsistent research
Papers presenting intrahospital transfers and their components	Papers addressing exclusively transfers outside the hospital, i.e. from one institution to another
Cross-sectional studies, retrospective studies, prospective studies, observational studies, cohort studies, review papers	Scientific articles addressing the evaluation of 'checklists' and the implementation of newly formed 'checklists' at the level of one institution on a statistically insignificant, i.e. insufficient sample
Scientific papers describing the intrahospital transfer of adult patients related to intensive care medicine, surgery, neurology, diagnostic procedures such as magnetic resonance imaging (MRI) and multi slice computed tomography (MSCT) that require intrahospital transfer and those papers describing the impact of protocol implementation and structured communication on the quality of intrahospital transfers	Scientific papers describing intrahospital transfer in any other context
Free access to full text	Paywalled papers

Results

A total of 17 studies for adults and 7 studies regarding healthcare professionals' perspective were identified and analyzed. The majority of studies were cross-sectional or retrospective. Research was conducted on a sample of 56,840 adult patients, one meta-analysis that includes 12,313 within hospital transports and 1,898 patients from 24 studies. A total of 7 of the 24 included studies refer to a sample of 1,395 healthcare professionals, mostly nurses participating in IHT.

Discussion

This review aims to provide insight into the course of IHT, describe the incidence and nature of the most frequent adverse events, bring closer the importance of attention to vitally endangered patients, and demonstrate the importance of integrating protocols and communication structures. The analysis includes studies that, prompted by a large number of incidents, address the flow, the biggest problems, and available tools for improved IHT between various wards. Based on the inclusion and exclusion criteria, the discussion includes 24 studies describing IHT from different perspectives. The study provides an in-depth analysis of the significance of the structured course to IHT, highlighting its impact on both the patients and the hospital as an organizational structure. Special attention is paid to the most vulnerable groups of patients - unstable and vitally endangered patients. Also, these studies provided an insight into the most common reasons for transfers of such patients within the institution, as well as the most frequent adverse events that occur during such transfers. IHT play a critical role when it comes to improving safety and achieving the best treatment outcomes. Numerous studies have demonstrated progress in this area using various protocol and communication tools that contribute to the structured course of IHT.

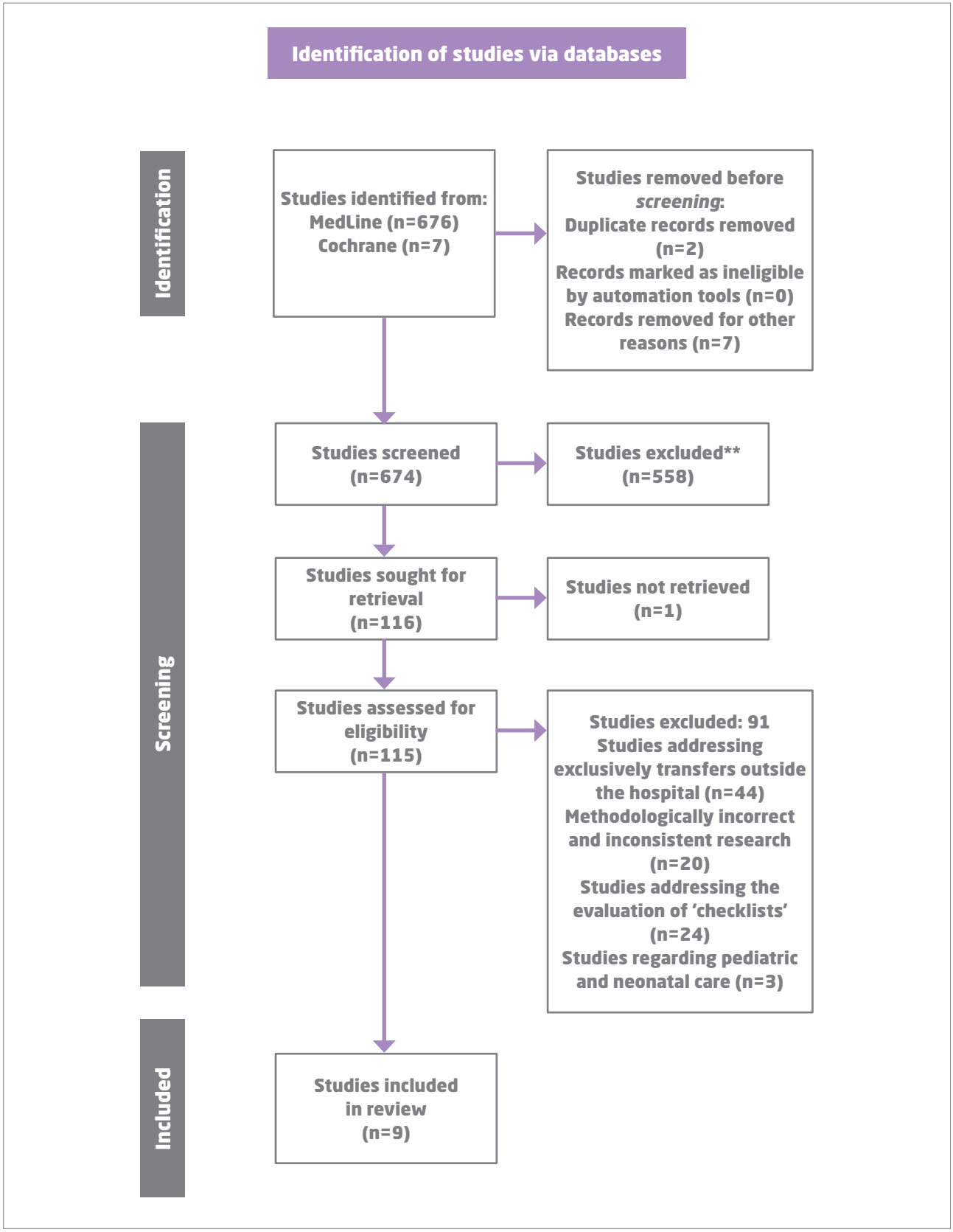

Figure 1. **PRISMA flow diagram**

Table 2. **Studies included regarding adult patient intrahospital transfer**

Author, year, country of origin	Type of study	Sample and time of research	Research objective	Conclusion
Ling L, Xia X, Yuan H, et al., 2023. China	Retrospective study	Intensive Care Unit (ICU) patients Control group (n=420) Observational group (n=380) From June to December 2017 and from January to June 2018.	To assess the effectiveness of a graduated model of intrahospital transfer.	Duration of intrahospital transfers and reduction of adverse events are significantly lower, but not related to length of stay and mortality.
Zirpe KG, Tiwari AM, Kulkarni AP, et al., 2023. India	Observational study	ICU patients (n=893) From March 2022 to February 2023.	To determine the incidence, severity, and effects of adverse events on patients.	High incidence of adverse events, but not associated with mortality.
Parveez MQ, Yaddanapudi LN, Saini V, et al., 2020. India	Prospective observational study	ICU patients (n=160) 8 months	To determine the incidence and types of adverse events (AEs) during IHT	Most IHTs occur for the purpose of diagnostics and small procedures, procedures that can be reduced. Attention is also drawn to compliance with the protocol as the key to patient safety.
Min HJ, Kim HJ, Lee DS, et al., 2019. Republic of Korea	Retrospective cohort study	535 patients from March 2012 to May 2019	To determine the incidence and risks of cardiopulmonary arrest (CPA) during IHT accompanied by RRT.	Regardless of the accompaniment, CPA occurs, risk factors include history of myocardial infarction, manual ventilation, 3+ vasopressors.
Nadig NR, Brinton DL, Simpson KN, et al., 2022. USA	Retrospective quasi-experimental study	ICU patients (n=3774) From 2015 to 2017	To describe transfer patterns and the impact of transfer duration on patients with acute respiratory failure between intensive care units.	Patients transferred to the appropriate ICU earlier face a 55.8% lower risk of in-hospital mortality.
Murata M, Nakagawa N, Kawasaki T, et al., 2022. Japan	Systematic review and meta-analysis	24 studies published up to June 3, 2020.	To examine and describe the safety and side effects during intrahospital transfer of critically ill patients.	Side effects can occur during intrahospital transfer of critically ill patients, and the frequency of critical side effects is relatively low.
Zirpe KG, Alunpipatthanachai B, Matin N, et al., 2023. India	Electronic research	365 hospitals in 32 countries from March 1, 2022 to June 30, 2022	Describing the practice of IHT of neurocritically ill patients in institutions.	Inconsistent standards regarding neurophysiological monitoring during IHT require in-depth monitoring in hospitals and indicate the need for international guidelines for neurocritical care during IHT.

Table 2. **Studies included regarding adult patient intrahospital transfer**

Author, year, country of origin	Type of study	Sample and time of research	Research objective	Conclusion
Pedrosa L, Hoyos J, Reyes L, et al., 2024. Spain	Cochrane systematic review	Severe brain injury patients (n=27) IHTs (n=67) between January 2017 and January 2019	To quantify the effect of IHT on brain metabolism by monitoring both hemispheres with bilateral MD.	Brain metabolism is altered after IHT in neurocritically ill patients, without being limited to the affected hemisphere.
Schmidbauer ML, Wiegand TLT, Keidel L, et al., 2023. Germany	Retrospective cohort study	Patients with subarachnoid hemorrhage (SAH) (n=25) IHTs (n=108) between January 2016 and April 2019	Analysis of IHTs for demographics, rationale of transport, clinical outcomes, and pre/post IHT follow-up parameters.	Relevant hemodynamic thresholds were breached in 31.5% of cases, while respiratory complications occurred in 63.9% and neurological complications in 20.4%.
Beekman R, Crawford A, Mazurek MH, et al., 2022. SAD	Retrospective, single-center study	22 low-field MRIs were performed in 19 patients resuscitated from cancer from September 2020 to January 2022	To apply a new approach to assess brain injury after cancer in critically ill patients at high risk for adverse neurological outcome.	Low-field MRI was performed in all patients without interfering with intensive care unit equipment monitoring and there were no safety events.
Dusse F, Putz J, Bohmer A, et al., 2021. Germany	Prospective observational study	Patient handovers (n=102) 2014	The aim of this research was to examine the completeness of information transfer and the amount of information.	The completeness of the handover is affected by time pressure, interruptions, and inadequate environment that increase the risk of information loss
Lin SJ, Tsan CY, Su MY, et al., 2020. Taiwan	Quality improvement study	ICU admission (n=8014) From January 2015 to December 2017	Implementation of intrahospital transfer protocols in order to improve the safety of mechanically ventilated patients.	The implementation of the established protocol significantly reduced the number and incidence of adverse events.
Scott J, Dawson P, Heavey E, et al., 2019. United Kingdom	Retrospective study	Incidents (n=278) March 2014 – August 2014, January 2015 – June 2015)	The aim of the research was to analyze the content of incident reports.	Almost 70% of incident reports related to pressure ulcers, falls, medication and documentation errors.

Table 3. **Studies included regarding healthcare professionals' perspective on intrahospital transfer**

Author, year, country of origin	Type of study	Sample and time of research	Research objective	Conclusion
Hashemian M, Salami Z, Islam Azizpour, et al., 2023. Iran	Cross-sectional study	Emergency and intensive care nurses (n=288)	To assess the safety of critically endangered patients during intrahospital transfers.	The safety rate is low, and hospitals are obliged to provide a favorable environment for intrahospital transfers by recognizing the risks and taking the necessary measures.
Temsah MH, Al-Sohime F, Alhaboob A, et al., 2021. Saudi Arabia	Cross-sectional study	Healthcare professionals (n=312) April 2017	To identify the practices of IHT in different health institutions and to compare the course of transfers in unstable patients compared to stable patients.	Initiatives to improve transfer quality can improve patient safety, and respiratory and hemodynamic complications represent the most significant adverse events.
Song Y, Zhao Q, Yang M, et al., 2022. China	Cross-sectional study	ICU nurses (n=480) From July to August 2019	To describe the experiences and attitudes of adult intensive care nurses towards IHT of critically ill patients.	Nurses experienced IHT as a source of stress and increased workload. Checklists and training were useful for patient safety during IHT.
Bergman L, Chaboyer W, Petterson M, et al., 2020. Sweden	Cross-sectional study	Healthcare professionals in 12 intensive care units in Sweden In the period from February to April 2019, a total of 315	To develop and evaluate the psychometric properties of a scale for measuring patient safety during the process of intrahospital transfer to ICU.	The results showed acceptable validity and reliability of the scale among a sample of Swedish healthcare professionals.
Venn AM, Sotomayor CA, Godambe SA, et al., 2021. USA	Single-center study	ER nurses and physicians. 355 (84%) of 400 ED-to-ICU admissions had completed IHT checklists. From July 23, 2019 to July 22, 2020	To improve the safety of IHT for emergency patients admitted to the pediatric ICU.	The IHT checklist was feasible and associated with improvements in perceived safety and reporting of incident events.
Lee SH, Wee C, Phan P, et al., 2023. Singapore	Mixed methods study	6 focus groups with 34 health professionals consisting of doctors and nurses November 2017	This study reports on the differences in protocols and data elements between receiving and sending transfers in the ICU and the elements that make transfer readiness.	General ward clinicians are more likely to receive ICU patients with complete discharge summaries, while ICU clinicians admitting general ward patients receive significantly less data.
Mamalelala TT, Schmollgruber S, Botes M, et al. 2023. South Africa	Cross-sectional study	171 nurses	The aim of this study was to describe nurses' opinions on the effectiveness of handover between ED and ICU nurses.	The study showed that ER and ICU nurses have significantly different requirements and expectations from handover procedures.

Based on interviews of healthcare personnel and retrograde analyzes of IHT, studies have agreed on relatively low rates of safety and a structured course of IHT. They show the incidence of adverse events, including significant declines in vital functions. Hospitals strive to be maximally safe institutions; therefore, they must recognize risks and adopt measures to avoid adverse events when providing health care (5, 10). Also, when identifying risk factors, it is important to take into account the patient's health condition as a predisposing factor. Although adverse events during IHT transfer do not affect the mortality rate, they slow down the course of treatment and prolong the stay in the institution, especially when it comes to patients requiring intensive treatment (11). Their characteristics as such represent risks for adverse events during the transfer, and before considering the other numerous components of the quality and structured course of IHT, according to one study, the incidence of adverse events stagnates without significant deviations regardless of the specialized team. In vitally endangered patients, the emphasis in risk identification and prevention is placed on patient evaluation (12). Taking that into account, another study emphasizes that stabilization of the patients before IHT takes place may reduce incidence of adverse events (13). Also, the training of health professionals plays a key role if adverse events for the patient occur (14).

IHTs are mostly required for diagnostic purposes and minor procedures. As diagnostic techniques become increasingly advanced and include a series of procedures aimed at the best possible clinical assessment, the clinician and the multidisciplinary team must always carefully weigh the benefits of the test compared to the possible complications of the transfer and the procedure itself (15). During IHT, significant hemodynamic thresholds can be crossed, leading to an increased risk of vital instability, a series of potential complications and prolonged hospital stays (16). This is supported by studies that specifically assess neurocritical patients and speak in favor of the need for analysis and improvement of the IHT procedure (17). Studying the metabolism of the brain before and after such migrations, changes are noted that are not exclusively related to damaged brain areas (18). In addition, any atypical transfer results in prolonged treatment (3). The assessment of brain injury is of great importance for the therapeutic approach; therefore, the implementation of portable diagnostic devices is an important factor in the prevention of complications that may occur during IHT. Research has shown that portable MRI in the assessment of ischemic brain injury in the ICU did not interfere with the workflow (19). Also, the same research is carried out when it comes to portable CT. Although achieving such conditions represents a financial challenge, research indicates the same effectiveness of the test without interfering with the interventions in the ICU. MSCT, as a frequent and important diagnostic test, in a portable form represents a significant reduction in the need for IHT during intensive treatment. Although the number of adverse events did not decrease significantly, the research showed the need for additional analyzes (20). Timely transfers between intensive care units represent an important moment in the course of treatment. A timely transfer between two ICUs reduces the risk of in-hospital mortality by 55.6%, therefore special attention must be paid to ensuring the orderly transfer (21). Also, the analysis of atypical transfers and the network of movement within the hospital are of great importance for identifying risks and ensuring quality (2). In addition to life-threatening events during IHT, pressure ulcers and pressure injuries, falls and errors in treatment and documentation are cited as the dominant incidents. In addition to preventing vital collapses, hospitals strive to maintain the highest possible quality of life, therefore such incidents are entirely preventable and should not occur (22).

Clinicians must harmonize and clearly emphasize mutual expectations when exchanging information taking different protocols into consideration (23). The integrity of the handover is significantly affected by time pressure, interruptions, and inappropriate surroundings (24). Also, using the example of nursing handovers in emergency medicine compared with intensive care, we can notice different expectations of the handover content. High quality handover is essential for avoiding adverse effects. According to this study, nurses from different specialties should agree on a structured handover. Although this study was conducted in tertiary academic hospital and the results cannot be generalised, it speaks in favor of necessary structure when it comes to final part of IHT: handover (25). Quality improvement initiatives can affect the reduction of adverse events. Healthcare workers' satisfaction with IHT is related with implementation of formal protocols for IHT and the handover structure. More importantly, better patient outcomes were noted when using formally adapted tools (26). It is recommended to use pre-transport checklists in order to minimize adverse events. Also, minor surgical procedures and better bedside diagnostics are highly recommended to consider in future (15). Before implementing the protocol, it is necessary to evaluate the one created

by the health professionals. According to one study, the IHT protocol for Swedish hospitals was created in this way (27). And the very integration of the checklist and protocol proved to be effective in reducing adverse events (28, 29). In order to ensure better management of transfer processes, a network analysis has proven effective. Prior to protocol development, this approach involves a detailed examination of patient movements within the institution. However, the study's small and specific sample remains a notable limitation (30).

Conclusion

An analysis of available literature reveals that adverse events during IHTs are a widespread challenge faced by many healthcare institutions. Although such events do not directly affect mortality, they contribute to worse clinical outcomes and longer treatment. They affect hospitals as organizational structures and reduce the quality of healthcare. Research indicates the need for extensive analyzes on larger samples. Regardless of the absence of a universally applicable protocol, individual analyzes and guidelines have proved effective. Numerous studies have emphasized the importance of thoroughly assessing the potential benefits of the transfer against the risks of adverse events. Special attention has been paid to vitally endangered patients as the most sensitive group whose transfers require a multidisciplinary approach and a clearly structured course. Communication and coordination of all team members, as well as the availability of the necessary resources proved to be vital in ensuring the safety of all patients during intrahospital transfers.

Author contributions

Author contributions: Conceptualization (KV, LL); Data Curation (VK, RD); Data Analysis (KV, LL, RD); Writing – Original Draft (KV, LL). All authors contributed to revising and editing the final manuscript

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Veiga VC, Postalli NF, Alvarisa TK, Travassos PP, Vale RT da S, Oliveira CZ de, et al. Adverse events during intrahospital transport of critically ill patients in a large hospital. Revista Brasileira de Terapia Intensiva. 2019;31(1):15-20. https://doi.org/10.1038/s41598-023-41966-w
2. Zhang C, Eken T, Jørgensen SB, Thoresen M, Søvik S. Effects of patient-level risk factors, departmental allocation and seasonality on intrahospital patient transfer patterns: network analysis applied on a Norwegian single-centre data set. BMJ Open. 2022;12(3):e054545. https://doi.org/10.1136/bmjopen-2021-054545
3. Mendelsohn E, Honeyford K, Brittin A, Mercuri L, Klaber RE, Expert P, et al. The impact of atypical intrahospital transfers on patient outcomes: a mixed methods study. Sci Rep. 2023;13(1):15417. https://doi.org/10.1038/s41598-023-41966-w
4. Ott LK, Hoffman LA, Hravnak M. Intrahospital transport to the radiology department: risk for adverse events, nursing surveillance, utilization of a MET and practice implications. J Radiol Nurs. 2011;30(2):49-52. https://doi.org/10.1016/j. 2011.02.001
5. Hashemian M, Salami Z, Islam Azizpour, Alireza Mirzaei. Evaluation of the safety status of intrahospital transfer of critically ill patients from the perspective of emergency and ICU nurses: a cross-sectional study in Iran. BMJ Open. 2023;13(10):e072584-4. https://doi.org/10.1016/j.2011.02.001
6. Kue R, Brown P, Ness C, Scheulen J. Adverse clinical events during intrahospital transport by a specialized team: a preliminary report. Am J Crit Care. 2011;20(2):153-62. https://doi.org/10.4037/ajcc2011478
7. Yang SH, Jerng JS, Chen LC, et al. Incidence of patient safety events and process-related human failures during intra-hospital transportation of patients: retrospective exploration from the institutional incident reporting system. BMJ Open. 2017;7(11):e017932. https://doi.org/10.1136/bmjopen-2017-017932
8. Germack HD, Fekieta R, Campbell Britton M, Feder SL, Rosenberg A, Chaudhry SI. Cooperation and conflict in intra-hospital transfers: A qualitative analysis. Nurs Open. 2019;7(2):634-41. https://doi.org/10.1002/nop2.434

9. Mortensen B, Borkowski N, O'Connor SJ, Patrician PA, Weech-Maldonado R. The relationship between hospital interdepartmental transfers and patient experience. J Patient Exp. 2020;7(2):263-9. https://doi.org/10.1177/2374373519836467
10. Murata M, Nakagawa N, Kawasaki T, Yasuo S, Yoshida T, Ando K, et al. Adverse events during intrahospital transport of critically ill patients: A systematic review and meta-analysis. Am J Emerg Med. 2022;52:13-19. https://doi.org/10.1016/j.ajem.2021.11.021
11. Ling L, Xia X, Yuan H, Liu S, Guo Z, Zhang C, et al. Effectiveness of the graded transport mode for the intrahospital transport of critically ill patients: A retrospective study. Front Public Health. 2023;10:979238. https://doi.org/10.3389/fpubh.2022.979238
12. Min HJ, Kim HJ, Lee DS, Choi YY, Yoon M, Lee D, et al. Intra-hospital transport of critically ill patients with rapid response team and risk factors for cardiopulmonary arrest: A retrospective cohort study. PLoS One. 2019;14(3):e0213146. https://doi.org/10.1371/journal.pone.0213146
13. Zirpe KG, Tiwari AM, Kulkarni AP, Govil D, Dixit SB, Munjal M, et al. Adverse events during intrahospital transport of critically ill patients: a multicenter, prospective, observational study (I-TOUCH Study). Indian J Crit Care Med. 2023;27(9):635-41. https://doi.org/10.5005/jp-journals-10071-24530
14. Song Y, Zhao Q, Yang M, Xie X, Gong M, Chen H. Intrahospital transport of critically ill patients: A cross-sectional survey of Nurses' attitudes and experiences in adult intensive care units. J Adv Nurs. 2022;78(9):2775-84. https://doi.org/10.1111/jan.15179
15. Parveez MQ, Yaddanapudi LN, Saini V, Kajal K, Sharma A. Critical events during intra-hospital transport of critically ill patients to and from intensive care unit. Turk J Emerg Med. 2020;20(3):135-41. https://doi.org/10.4103/2452-2473.290067
16. Schmidbauer ML, Wiegand TLT, Keidel L, Zibold J, Dimitriadis K. Intrahospital transport of critically ill patients with subarachnoid hemorrhage-frequency, timing, complications, and clinical consequences. J Clin Med. 2023;12(24):7666. https://doi.org/10.3390/jcm12247666
17. Zirpe KG, Alunpipatthanachai B, Matin N, Gulek BD, Blissitt PA, Palmieri K, et al. Benchmarking hospital practices and policies on intrahospital neurocritical care transport: the safe-neuro-transport study. J Clin Med. 2023;12(9):3183. https://doi.org/10.3390/jcm12093183
18. Pedrosa L, Hoyos J, Reyes L, Mosteiro A, Zattera L, Topczewski T, et al. Brain metabolism response to intrahospital transfers in neurocritical ill patients and the impact of microdialysis probe location. Sci Rep. 2024;14(1):7388. https://doi.org/10.1038/s41598-024-57217-5
19. Beekman R, Crawford A, Mazurek MH, Prabhat AM, Chavva IR, Parasuram N, et al. Bedside monitoring of hypoxic ischemic brain injury using low-field, portable brain magnetic resonance imaging after cardiac arrest. Resuscitation. 2022;176:150-8. https://doi.org/10.1016/j.resuscitation.2022.05.002
20. Yoann L, Clément M, François E, Elise B, Hubert S, Jean-Cristophe F, et al. Implementation of portable head CT imaging in patients with severe acute brain injury in a French ICU: a prospective before-after design pilot study. Sci Rep. 2022;12(1):20846. https://doi.org/10.1038/s41598-022-25263-6
21. Nadig NR, Brinton DL, Simpson KN, Goodwin AJ, Simpson AN, Ford DW. The impact of timing on clinical and economic outcomes during inter-icu transfer of acute respiratory failure patients: Time and tide wait for no one. Crit Care Explor. 2022;4(3):e0642. https://doi.org/10.1097/CCE.0000000000000642
22. Scott J, Dawson P, Heavey E, Brún AD, Buttery A, Waring J, et al. Content analysis of patient safety incident reports for older adult patient transfers, handovers, and discharges: do they serve organizations, staff, or patients? J Patient Saf. 2021;17(8):e1744-58. https://doi.org/10.1097/PTS.0000000000000654
23. Lee SH, Wee C, Phan P, Kowitlawakul Y, Tan CK, Mukhopadhyay A. Readiness for transfer: a mixed-methods study on ICU transfers of care. BMJ Open. 2023;13(5):e064492. https://doi.org/10.1136/bmjopen-2022-064492
24. Dusse F, Pütz J, Böhmer A, Schieren M, Joppich R, Wappler F. Completeness of the operating room to intensive care unit handover: a matter of time? BMC Anesthesiol. 2021;21(1):38. https://doi.org/10.1186/s12871-021-01247-3
25. Mamalelala TT, Schmollgruber S, Botes M, Holzemer W. Effectiveness of handover practices between emergency department and intensive care unit nurses. Afr J Emerg Med. 2023;13(2):72-7. https://doi.org/10.1016/j.afjem.2023.03.001
26. Temsah MH, Al-Sohime F, Alhaboob A, Al-Eyadhy A, Aljamaan F, Hasan G, et al. Adverse events experienced with intrahospital transfer of critically ill patients: A national survey. Medicine (Baltimore). 2021;100(18):e25810. https://doi.org/10.1097/MD.0000000000025810
27. Bergman L, Chaboyer W, Pettersson M, Ringdal M. Development and initial psychometric testing of the Intrahospital Transport Safety Scale in intensive care. BMJ Open. 2020;10(10):e038424. https://doi.org/10.1136/bmjopen-2020-038424
28. Venn AM, Sotomayor CA, Godambe SA, Vazifedan T, Jennings AD, et al. Implementation of an intrahospital transport checklist for emergency department admissions to intensive care. Pediatr Qual Saf. 2021;6(4):e426. https://doi.org/10.1097/pq9.0000000000000426
29. Lin SJ, Tsan CY, Su MY, Wu CL, Chen LC, Hsieh HJ, et al. Improving patient safety during intrahospital transportation of mechanically ventilated patients with critical illness. BMJ Open Qual. 2020;9(2):e000698. https://doi.org/10.1136/bmjoq-2019-000698
30. Secor EA, Hamilton D, D'Huyvetter C, Salottolo K, Bar-Or D. Network analysis examining intrahospital traffic of patients with traumatic hip fracture. J Healthc Qual. 2023;45(2):83-90. https://doi.org/10.1097/JHQ.0000000000000367
31. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst Rev. 2021;372:n71. https://doi.org/10.1136/bmj.n71

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Effects of Exergaming on Cognitive Function in Older Adults with Dementia: A Literature Review

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Abstract

Introduction. As the world population is ageing, it is expected that the number of many chronic diseases common for elderly age will rise, including different forms of dementias. Dementias are a global problem, considering there are no effective medication or cure to date, and there is a need to develop new tools that would be used to slow down or postpone symptoms, of which one of the most pronounced is cognitive decline. The use of exergaming has been proved to improve cognitive functioning in healthy elderly people and in those suffering from various diseases.

Aim. The aim of this review was to present research on the impact of this intervention on the cognitive abilities of older adults suffering from dementia.

Methods. A literature search was conducted in PubMed and Scopus for articles published between 2015 and February 7, 2025. Predefined search strings and inclusion/exclusion criteria based on the PICO framework were applied to identify relevant studies.

Results. A total of 213 papers were identified through database search, using search strings. Following duplicate removal and study selection, 8 studies were included in this review.

Conclusion. Only a few randomized controlled studies have been conducted researching into the effectiveness of exergaming on cognition in people with dementia. Findings indicate that exergaming may be a promising tool for improving cognition in this population, but more well-designed studies are needed to confirm its efficacy.

Introduction

As the world population is ageing, the number of people suffering from major neurocognitive disorders, including different forms of dementias is expected to rise even more in the following years (1). Dementia is a syndrome characterized by progressive brain damage, affecting cognitive function and difficulty performing everyday activities. 60–70% of all dementia cases are Alzheimer's disease, which is the most common form of the condition. According to World Health Organization (WHO) data from 2023, an estimated 55 million people worldwide are currently living with different forms of dementia, and projections from WHO Global action plan on the public health response to dementia 2017 – 2025, suggest that this number will nearly triple by year 2050 to 132 million. These numbers have a great effect on healthcare systems and overall society, and there is a great need for action on a global plan (2,3). Regarding the European Union (EU) and according to data from Eurostat and the Organisation for Economic Co-operation and Development (OECD) in 2018, the number of people with dementia was 9.1 million. Projections estimate that this number will double by 2050, reaching 18.7 million (4). The most common dementias have no cure and there is no effective disease-modifying medication, therefore one of the alternatives is definitely to develop and implement non-pharmacological interventions (5). We now know that physical exercise has a positive effect on cognition in elderly people without dementia, and, the lack of physical activity during earlier life is a risk factor for developing dementia. We are living in an era of rapid technological advancement and the rise of new interventions in healthcare and social care systems, and one of these new interventions is exergaming.

Studies in this field have already been conducted, and have shown that among healthy older adults and in patients with mild cognitive impairment, multiple sclerosis, schizophrenia, and Parkinson's disease, exergames compared to physical exercise training alone have a better effect in improving global cognitive function (6). Exergaming refers to playing videogames that involve physical movement (7). To play these games users need to use various equipment like VR headsets, motion sensors, balance boards, controllers etc. (8). At present, there is growing interest in researching the effects of exergaming on improving cognitive functions in older adults with mild cognitive impairment and dementia. Various studies suggest that exergaming could have a positive impact on cognitive abilities but it is important to say that it is difficult to draw general conclusions because of the differences in study designs, intervention protocols, and participant characteristics (8,9). In order to prevent cognitive decline, physical exercise alone may be insufficient. Interventions which combine physical activity and cognitive stimulation seem to be more effective in maintaining cognitive functions (10,11).

Aim

The aim of this literature review is to examine the effects of exergaming on cognitive functioning of elderly people with dementia.

Methods

A search of the PubMed and Scopus databases was conducted on February 7, 2025, to identify studies relevant in the field of research on the effects of exergaming on cognition in older adults with dementia. The search was conducted using search strings combining terms related to dementia, aging, cognitive function, and exergaming, refined with Boolean operators (AND, OR), and limited to articles published between January 2015 and February 2025. The search targeted titles, abstracts, and keywords in the databases mentioned above. The full search strategies for each database, including the exact keyword combinations, are shown in Table 1. Search was conducted following predefined inclusion and exclusion criteria as shown in Table 2, which were based on the PICO framework shown in Table 3. The target population included individuals aged 65 and older diagnosed with dementia, while the intervention of interest was exergaming. Exergaming is a relatively new intervention so both full-scale randomized controlled trials (RCTs), and pilot RCTs were included to have a more detailed review. Risk of bias was not assessed in this review, as it is a narrative review and focused on summarizing available evidence.

Table 1. **Databases with search string and number of hits**

Core collection	PubMed	Scopus
Search string	((“dementia”[Title/Abstract] OR “Alzheimer Disease”[Title/Abstract] OR “cognitive impairment”[Title/Abstract] OR “major neurocognitive disorder”[Title/Abstract]) AND (“older adult*”[Title/Abstract] OR “elder*”[Title/Abstract] OR “aged”[Title/Abstract] OR “senior*”[Title/Abstract] OR “geriatrics”[Title/Abstract]) AND (“cognition”[Title/Abstract] OR “cognitive function”[Title/Abstract] OR “cognitive decline”[Title/Abstract] OR “cognitive performance”[Title/Abstract])) AND (“exergame*”[Title/Abstract] OR “active video game*”[Title/Abstract] OR “interactive video game*”[Title/Abstract] OR “serious game*”[Title/Abstract])	TITLE-ABS-KEY ((“dementia” OR “Alzheimer Disease” OR “cognitive impairment” OR “major neurocognitive disorder”) AND (“older adult*” OR “elder*” OR “aged” OR “senior*” OR “geriatrics”) AND (“cognition” OR “cognitive function” OR “cognitive decline” OR “cognitive performance”) AND (“exergame*” OR “active video game*” OR “interactive video game*” OR “serious game*”))
Number of hits	52	168

Table 2. **Criteria for including and excluding results**

Criteria	Inclusion	Exclusion
Population	Adults ≥65 years diagnosed with dementia	Other
Language	English	Other languages
Text Availability	Full-text available	Abstract only, no full text
Article Type	Randomized controlled trials (RCTs), pilot RCTs	Other study designs

Table 3. **PICO Framework for study selection**

Component	Description
Population (P)	Older adults (≥65 years) diagnosed with dementia
Intervention (I)	Exergaming interventions that incorporate physical activity as a core component (e.g., VR-based exercises, interactive motion-controlled games, active video games).
Comparison (C)	Standard care (no intervention), conventional exercise programs, or other control conditions used in included RCTs.
Outcome (O)	Cognitive function (e.g., memory, executive function, psychomotor speed, global cognition).

Results

A total of 213 articles were obtained by searching both databases, of which 52 by searching the PubMed database and 161 by searching the Scopus database. The distribution of published articles by publication year is shown in Figure 1, showing the number of studies published by year prior to applying inclusion and exclusion criteria.

Fifty duplicate articles were removed using Zotero, resulting in 163 remaining articles. After screening titles and abstracts following the inclusion and exclusion criteria listed in Table 2, 119 articles were excluded for not being RCTs, 33 for not meeting population criteria, and 3 for not meeting the exergame intervention.

The process of the extraction of the final articles is shown in Figure 1, following the PRISMA flow diagram (12). After the final selection of studies, in this literature review we included 8 relevant articles that matched our predefined search strategy. An overview of included articles by publication year is shown in Table 4. Most of the included studies reported

some cognitive benefits from exergaming, particularly improvements in psychomotor speed and global cognition, while effects on certain specific cognition domains such as memory were less consistent. Several studies also noted physical or mood benefits in the exergaming groups.

Regarding effects of exergaming on cognitive functions, five out of eight included studies have shown explicit benefits. One study showed improvements in psychomotor speed, though it did not show improvements in memory or executive processes, and two studies primarily investigated outcomes that were not related to cognition, such as neuropsychiatric symptoms.

Discussion

Overall, the evidence from observed studies suggests thar exergaming has beneficial effects on certain cognitive functions in older adults with dementia, along with improvements in related areas such as motor skills and even neuropsychiatric symptoms.

Regarding quality of life, majority of included studies that investigated this aspect, did not show significant improvements.

Wiloth et al. in their research concluded that exergaming can improve motor-cognitive functions in people with dementia. In their intervention group (IG), they used exergame system Physiomat that combines balance tasks with cognitive challenges. Their study showed positive impact in the duration and accuracy of task execution in the exergame IG compared to the control group (CG). After 3 months, a follow-up was conducted. The benefits diminished, but remained higher in the IG group. However, they point out several limitations, such as not having a non-intervention control group, a possible Hawthorne effect, and a short follow-up period (13). Werner et al. in their research also used Physiomat system to analyse the time course of improvement in motor-cognitive functions. Their research also showed positive effects of exergaming, which plateaued after the first 3 weeks of intervention. This could suggest that initial motor-cognitive improvements in exergame may be rapid, but for maintaining progress it may require a gradual increase in exercise difficulty. Best improvements were identified in participants with initially lower cognitive abilities. Regarding limitations, this study lacked a CG for comparison and had a relatively small

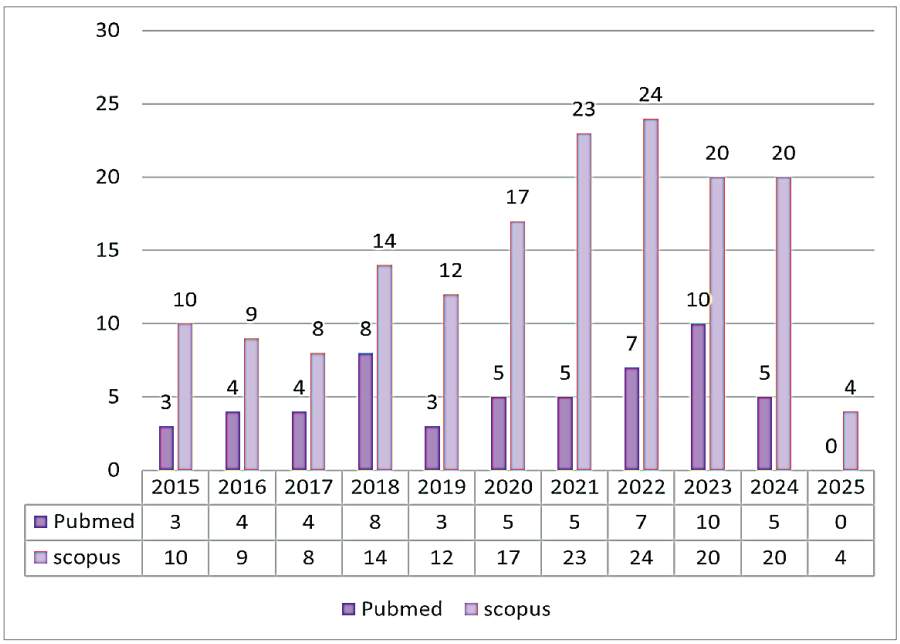

Figure 1. **Distribution of published articles by publication year prior to applying inclusion and exclusion criteria**

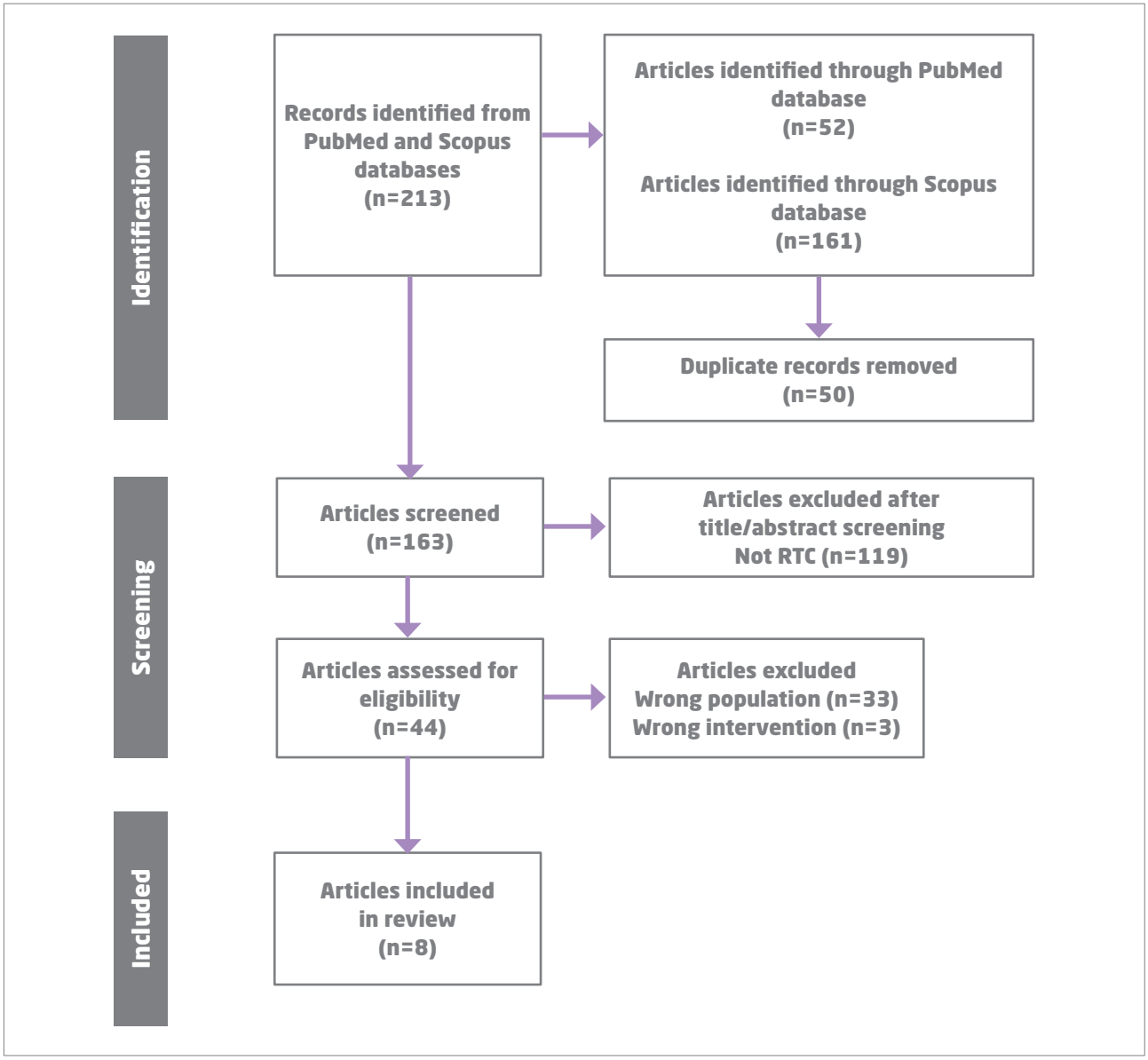

Figure 2. **PRISMA flow diagram**

sample, which limits the applicability of the results to the wider population of people with dementia (14). Furthermore, two studies by Karssemeijer et al. conducted in 2019 were included. Both studies investigated the effects of Bike Labyrinth exergaming on physical and cognitive functions in people with dementia. This exergame combines cycling on a stationary bike with a virtual surrounding where participants drive through cities while solving cognitive tasks, including response inhibition, switching between tasks, and speed of information processing. The first study investigated the effects on frailty and showed that IG significantly reduced frailty compared to the CG although there was no improvement in motor skills, physical activity or activities of daily living. Second study examined the effects on cognitive functions and showed that IG group had improvements in psychomotor speed, and this effect was maintained after 24 weeks, compared to CG. However, there were no significant improvements in executive functions, episodic memory, or working memory. Their results could be clinically important, as it is known that in patients

Table 4. **An overview of articles by publication year identified in the literature review**

Authors	Methods	Intervention duration (IG and CG)	Purpose	General outcomes	Follow up	Limitations
Wiloth et al. 2017 (13)	RCT (10 weeks, 99 participants, 2 groups: IG-exergame, CG-low intensity strength and flexibility while seated	10 weeks, IG: 2x per week, 1.5h CG: 2x a week, 1 hour	To evaluate effects of Physiomat exergaming on motor-cognitive functions in older adults with dementia	Significant improvement in duration and accuracy of task execution in motor-cognitive functions, improvement in transfer also to untrained tasks	After 3 months, improvements in the IG group declined, but remained superior to those in the CG	No usual care group included, no long-term follow up
Werner et al. 2018 (14)	Secondary analysis of RCT (10 weeks, 56 participants, IG group only)	IG: 10 weeks, 2x per week, 10 min	To analyse time course of motor-cognitive improvements and predictors of early training response	Significant improvements in exergame-based motor-cognitive performances within 3 weeks, benefits plateaued later, lower baseline cognitive ability predicted greater improvements	No follow up	No control group comparison, small sample size, focus on short-term improvements, limited generalization to severe dementia cases
Karssemeijer et al. 2019 (15)	RCT (12 weeks, 3 groups 115 participants: IG -exergame, CG1-aerobic training, CG2-active control)	12 weeks, 3x per week IG: Exergaming (30–50 min per session, cycling with cognitive tasks) CG1: Aerobic training (30–50 min per session, cycling without cognitive tasks) CG2: Active control (30 min per session, relaxation & flexibility exercises	To examine whether exergaming can reduce frailty in older adults with dementia	Exergaming reduced frailty compared to the control group. No major effects on physical function or daily activities	After 24 weeks	No blinding, only mobile participants included, some tests not feasible for all participants
Karssemeijer et al. 2019 (16)	RCT (12 weeks, 3 groups, 115 participants: IG -exergame, CG1-aerobic training, CG2-active control)	12 weeks, 3x per week IG: Exergaming (30–50 min per session, cycling with cognitive tasks) CG1: Aerobic training (30–50 min per session, cycling without cognitive tasks) CG2: Active control (30 min per session, relaxation & flexibility exercises)	To examine the effects of exergaming on executive functions in older adults with dementia	Both exergaming and aerobic training improved psychomotor speed compared to the active control group, with effects sustained at the 24-week follow-up. No significant improvements were observed in executive functions, episodic memory, or working memory	After 24 weeks	No blinding, only mobile participants included, short intervention period (12 weeks), cognitive improvements may require longer training duration, possible floor effect

Table 4. **An overview of articles by publication year identified in the literature review**

Authors	Methods	Intervention duration (IG and CG)	Purpose	General outcomes	Follow up	Limitations
Robert et al. 2021 (17)	Cluster RCT (12 weeks, 125 participants, 2 groups: IG-exergame CG- standard care)	12 weeks, 2x per week for 15 minutes IG: X-Torp exergame (combined motor and cognitive tasks) CG: standard care	To examine the efficacy of serious exergames in improving neuropsychiatric symptoms in people with neurocognitive disorders	X-Torp significantly improved apathy and prevented worsening of neuropsychiatric symptoms, while symptoms worsened in the control group. There were no significant improvements in cognitive function	24 weeks	Small sample size, heterogeneous participants, different levels of stimulation, possible medication effects
Swinnen et al. 2021 (18)	Pilot RCT (8 weeks, 55 participants, 2 groups: IG – exergaming, CG – music intervention)	8 weeks, IG 3 times a week, 15 min per session, CG: 3 times a week, 15 min per session	To examine the effects of exergaming on cognitive, motor and neuropsychiatric outcomes in people with dementia in long-term care	Improved gait speed, mobility, balance and cognitive function, reduced depressive symptoms, no significant effect on quality of life or ability to perform activities of daily living	No follow up	Small sample, only motived patients included, short intervention period, no evaluated standardized protocol, no active control group, no follow up
Swinnen et al. 2023 (19)	Pilot RCT (12 weeks, 18 participants: IG-exergaming, CG-traditional exercise)	12 weeks, 3 times a week for 30 min	To examine the feasibility and preliminary effectiveness of the VITAAL exergame prototype in people with severe neurocognitive disorder	Exergame group had better results in cognitive and physical functions then CG. There were no significant differences in neuropsychiatric symptoms, depression and quality of life	No follow up	Small sample size, only volunteers included, no control in medication effects, potential social desirability bias, low adherence rate, no follow up
Wu et al. 2023(20)	RCT (12 weeks, 2 groups, 52 participants initially, 24 completed: IG-exergaming, CG-cycling)	12 weeks, IG: 3 times a week, initially 30 min, gradually increased to 50 min), CG cycling with increasing resistance	To examine the effects of exergaming on cognitive and physical functions in older adults with dementia	Exergaming improved executive function (shorter reaction times, increased neural activity in attention and working memory) and enhancement of lower body strength and cardiorespiratory endurance compared to CG	No follow up	Small sample size (24 participants), high dropout rate, no nonexercise CG, MMSE not measured post intervention

with dementia, psychomotor speed is an important predictor of functional decline, and that effects of exergaming on cognitive functioning should be further researched and studied. Authors point out that people with more severe forms of dementia will have a harder time achieving improvement in cognitive function using exergaming, than people with milder forms or healthy older adults (15,16). These findings are consistent with previous research which also indicate greater benefits of exergaming in populations with milder cognitive impairment (13,14). Another included study is by Robert et al. that researched the effect of X-Torp exergame on neuropsychiatric symptoms in people with neurocognitive disorders. Their results showed a reduction in apathy in the IG, while symptoms worsened in the CG. No significant improvement in cognitive functions was found (17), which distinguishes this study from some earlier research (13,14,15,16). The findings support the thesis that exergaming can have a broader therapeutic effect but point out that there is a need for additional research with larger samples (17). Furthermore, two included studies were authored by Swinnen et al. First study is from 2021, and second from 2023 and both examined the effects of exergaming on cognitive and motor functions in people with dementia in long-term care facilities. It is important to highlight that different intervention systems and protocols were used. In a study from 2021, the IG used pressure-sensitive platform that detects steps in four directions called "Dividat Senso" stepping exergame. Games were designed to train selective attention, flexibility, postural control and visuospatial working memory, and the level of difficulty was automatically adjusted to the participants capabilities. The results showed improvements in gait speed, balance, mobility and cognitive function with a reduction in depressive symptoms compared to CG that watched music videos. Regarding quality of life and activities of daily living there were no significant changes. In their second study in 2023, the IG group used the "VITAAL stepping exergame," a system with wearable foot sensors that combined balance exercises and cognitive tasks. The results showed that the IG group maintained or improved MMSE score while the CG had a deterioration. Also, motor functions were stable in the exergaming group, while they significantly decreased in the control group. Together, these studies suggest that exergaming may play an important role in preserving cognitive and motor skills in people with dementia (18,19). Furthermore, in a recent study by Wu et al., the IG used a device called ExerHeart in which players played interactive game called Alchemist's Treasure. In order to progress in the game participants had to run, avoid obstacles and collect objects, thereby incorporating physical and cognitive stimulation at the same time. Their results showed that exergame is superior to exercise alone in improving reaction speed, attention and working memory. Also, they concluded that exergame had a significant effect on muscle mass increase, lower extremity strength, and cardiovascular endurance. Regarding limitations, there was a high dropout rate of participants and a small sample size (20). In general, the studies mentioned above show that the use of exergame could have a beneficial effect on the cognitive, motor and neuropsychiatric functions in people with dementia. Most improvements have been shown in psychomotor speed, balance, mobility and motivation, while effects on executive function and memory are less consistent.

Similar conclusions have been described in previous systematic literature reviews, which highlighted the similar effects of exergaming on cognitive and motor functions in people with dementia like the results from the studies above (21,22). This further confirms the need for future work with larger and more diverse samples to better understand the cognitive impact of exergaming interventions.

Identified gaps

The most obvious gap in this literature review is the small number of studies conducted in this field of research, particularly those conducted on people with serious cognitive impairment. Also, despite the fact that the majority of these studies have shown improvements both in physical and cognitive functions, the long-term sustainability of these effects is still unclear due to the limited duration of the interventions. Most interventions lasted about 12 weeks, and there is a lack of follow up after the therapy ended. Also, it is important to know that the use of exergaming in treating people with dementia has many practical challenges, particularly due to different degrees of cognitive impairment and the need for expert supervision. Some of the participants have had difficulties in accepting and using the technology needed for the application of exergames, which suggests that there is a need for additional adaptations to ensure better compliance and easier wider application in everyday care. Also, there is a problem of a high rate of participant dropout, which also indicates the

above-mentioned challenges in implementing exergaming-based interventions. Finally, there is a lack of control groups, which makes it difficult to compare exergaming with other forms of therapy.

Conclusion

According to the data shown in the research included in this literature review, it was found that the use of exergames could be a potentially useful intervention that positively affects the cognitive and motor abilities of elderly people with dementia. Given that the ageing population, particularly those suffering from various forms of dementias, is expected to grow, this will pose challenges for socioeconomic systems globally. There is a need to develop instruments that can slow down or delay the progression of the disease and exergaming has shown great potential to do so. Further studies should be conducted on larger number of participants, including different groups of people with dementia (mobile, immobile, those housed in institutions and those living in their own homes, etc.) in order to better develop and adjust such technologies. By putting this issue in the focus of researchers, substantial progress could be achieved in a short period of time, and it is important to note that further research is certainly needed to identify the best ways to implement these new technologies as a tool for slowing down cognitive decline in patients with dementia. Also, it is worth noticing that all included studies were conducted in controlled settings, which limits the generalization of the findings to home use without supervision.

Author contributions

Conceptualization and methodology (BS, JP); Data curation and formal analysis (FL, SL, BI, AM,); Investigation and project administration (BS, FL); Writing – original draft (BS, FL) and Review & editing (BI, JP, SL). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. Jin R, Pilozzi A, Huang X. Current Cognition Tests, Potential Virtual Reality Applications, and Serious Games in Cognitive Assessment and Non-Pharmacological Therapy for Neurocognitive Disorders. Journal of Clinical Medicine. 2020 Oct 13;9(10):3287. https://doi.org/10.3390/jcm9103287
2. World Health Organization. Dementia [Internet]. World Health Organization. World Health Organization; 2023. Available at: https://www.who.int/news-room/fact-sheets/detail/dementia Accessed: 11. 12. 2024.
3. World Health Organization. Global action plan on the public health response to dementia 2017-2025 [Internet]. Geneva: World Health Organization; 2017. Available at: https://www.who.int/publications/i/item/global-action-plan-on-the-public-health-response-to-dementia-2017---2025 Accessed: 11. 12. 2024.
4. Dementia prevention [Internet]. Knowledge for Policy. Available at: https://knowledge4policy.ec.europa.eu/health-promotion-knowledge-gateway/dementia-prevention_en. Accessed: 11. 12. 2024.
5. Winblad B, Amouyel P, Andrieu S, Ballard C, Brayne C, Brodaty H, et al. Defeating Alzheimer's disease and other dementias: a priority for European science and society. The Lancet Neurology. 2016;15(5):455-532. https://doi.org/10.1016/S1474-4422(16)00062-4
6. Stanmore E, Stubbs B, Vancampfort D, de Bruin ED, Firth J. The effect of active video games on cognitive functioning in clinical and non-clinical populations: a meta-analysis of randomized controlled trials. Neurosci Biobehav Rev. 2017 Jul;78:34-43. https://doi.org/10.1016/j.neubiorev.2017.04.011
7. Oh Y, Yang S. Defining Exergames & Exergaming [Internet]. Available at: https://meaningfulplay.msu.edu/proceedings2010/mp2010_paper_63.pdf Accessed: 12. 12. 2024.
8. Cai X, Xu L, Zhang H, Sun T, Yu J, Jia X, et al. The effects of exergames for cognitive function in older adults with mild cognitive impairment: a systema-

tic review and meta-analysis. Front Neurol. 2024 Jul 16;15:1424390. https://doi.org/10.3389/fneur.2024.1424390

9. Peng Y, Wang Y, Zhang L, Zhang Y, Sha L, Dong J, et al. Virtual reality exergames for improving physical function, cognition and depression among older nursing home residents: A systematic review and meta-analysis. Geriatr Nurs. 2024 Feb;57:31-44. https://doi.org/10.1016/j.gerinurse.2024.02.032
10. Law LL, Barnett F, Yau MK, Gray MA. Effects of combined cognitive and exercise interventions on cognition in older adults with and without cognitive impairment: a systematic review. Ageing Res Rev. 2014;15:61–75. https://doi.org/10.1016/j.arr.2014.02.008
11. Rocha R, Fernandes SM, Santos IM. The importance of technology in the combined interventions of cognitive stimulation and physical activity in cognitive function in the elderly: A systematic review. Healthcare. 2023;11(17):2375. https://doi.org/10.3390/healthcare11172375
12. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. https://doi.org/10.1136/bmj.n71
13. Wiloth S, Werner C, Lemke NC, Bauer J, Hauer K. Motor-cognitive effects of a computerized game-based training method in people with dementia: a randomized controlled trial. Aging & Mental Health. 2017 Jul 6;22(9):1130–41. https://doi.org/10.1080/13607863.2017.1348472
14. Werner C, Rosner R, Wiloth S, Lemke NC, Bauer JM, Hauer K. Time course of changes in motor-cognitive exergame performances during task-specific training in patients with dementia: identification and predictors of early training response. Journal of NeuroEngineering and Rehabilitation. 2018 Nov 8;15(1):100. https://doi.org/10.1186/s12984-018-0433-4
15. Karssemeijer EGA, Bossers WJR, Aaronson JA, Sanders LMJ, Kessels RPC, Olde Rikkert MGM. Exergaming as a physical exercise strategy reduces frailty in people with dementia: a randomized controlled trial. Journal of the American Medical Directors Association. 2019 Dec;20(12):1502-8.e1. https://doi.org/10.1016/j.jamda.2019.06.026
16. Karssemeijer EGA, Aaronson JA, Bossers WJR, Donders R, Olde Rikkert MGM, Kessels RPC. The quest for synergy between physical exercise and cognitive stimulation via exergaming in people with dementia: a randomized controlled trial. Alzheimer's Research & Therapy. 2019 Jan 5;11(1):3. https://doi.org/10.1186/s13195-018-0454-z
17. Robert P, Albrengues C, Fabre R, Derreumaux A, Pancrazi MP, Luporsi I, et al. Efficacy of serious exergames in improving neuropsychiatric symptoms in neurocognitive disorders: results of the XźTORP cluster randomized trial. Alzheimer's & Dementia: Translational Research & Clinical Interventions. 2021 Jan;7(1):e12149. https://doi.org/10.1002/trc2.12149
18. Swinnen N, Vandenbulcke M, de Bruin ED, Akkerman R, Stubbs B, Firth J, et al. The efficacy of exergaming in people with major neurocognitive disorder residing in long-term care facilities: a pilot randomized controlled trial. Alzheimer's Research & Therapy. 2021 Mar 30;13(1):70. https://doi.org/10.1186/s13195-021-00806-7
19. Swinnen N, de Bruin ED, Guimarães V, Dumoulin C, De Jong J, Akkerman R, et al. The feasibility of a stepping exergame prototype for older adults with major neurocognitive disorder residing in a long-term care facility: a mixed methods pilot study. Disability and Rehabilitation. 2023 Feb 23;1–15. https://doi.org/10.1080/09638288.2023.2182916
20. Wu S, Ji H, Won J, Jo EA, Kim YS, Park JJ. The effects of exergaming on executive and physical functions in older adults with dementia: randomized controlled trial. JMIR Serious Games. 2023 Mar 7;11:e39993. https://doi.org/10.2196/39993
21. Hung L, Park J, Levine H, Call D, Celeste D, Lacativa D, et al. Technology-based group exercise interventions for people living with dementia or mild cognitive impairment: a scoping review. PLoS ONE. 2024 Jun 13;19(6):e0305266. https://doi.org/10.1371/journal.pone.0305266
22. Zhao Y, Feng H, Wu X, Du Y, Yang X, Hu M, et al. Effectiveness of exergaming in improving cognitive and physical function in people with mild cognitive impairment or dementia: systematic review. JMIR Serious Games. 2020 Jun 30;8(2):e16841. https://doi.org/10.2196/16841

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Review

Technological Advancements in Triage: How the Development of Artificial Intelligence Is Changing Medical Practice – A Literature Review

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Abstract

Introduction. Artificial intelligence can analyze large-scale datasets to enhance decision-making and efficiency. Artificial intelligence has potential in trauma triage, yet remains underexplored. Effective triage is essential for optimizing patient outcomes and resource allocation, but current systems heavily rely on nurses' judgment, which is subject to variability. AI-driven models could enhance accuracy, reduce bias, and support clinical decision-making in emergency care.

Aim. This literature review explores the role of artificial intelligence in medical triage, assessing its impact on accuracy, efficiency, and decision-making in patient assessment and prioritization.

Methods. A systematic search was conducted in March 2025 using PubMed, Web of Science and Hrčak databases to identify studies published between 2022 and 2025. Articles meeting predefined inclusion criteria were selected, resulting in 31 studies being included in the final review. The review followed PRISMA guidelines. Inclusion criteria consisted of systematic reviews, review articles, original research papers, cross-sectional studies, clinical trials, randomized controlled trials, and meta-analyses published in Croatian or English. The search terms included "artificial intelligence", "triage", "medical practice" and "nursing practice".

Results. The reviewed studies demonstrate that AI models can enhance triage accuracy and reliability, sometimes outperforming healthcare professionals

in specific tasks. They showed high specificity in identifying critical cases and improving triage consistency. However, limitations were noted, including reduced accuracy in complex cases, overestimation of urgency, and variability in performance across different triage systems. Key limitations identified include suboptimal reproducibility in disaster simulations, poor performance in complex triage scenarios, training data bias, and lack of algorithm transparency. These inconsistencies highlight the need for cautious interpretation and refinement before clinical implementation. While AI supports triage decision-making, human oversight remains essential. The potential of artificial intelligence depends on model training, data quality, and clinical integration. While some models perform well in emergency triage, others show inconsistencies in disaster scenarios. AI should be seen as a complement to human expertise rather than a replacement. The implications of these limitations include risks to patient safety, limited generalizability and challenges in regulatory validation. Addressing these issues is crucial to ensure safe and effective integration of AI into clinical workflows. Challenges such as data bias, transparency, and model variability must be addressed for successful AI implementation in emergency medicine.

Conclusion. AI-driven triage systems improve accuracy and efficiency but require further refinement for reliability in complex cases. They function best as supportive tools rather than independent decision-makers. Future research should focus on optimizing AI integration into clinical practice to enhance emergency care outcomes.

Introduction

Technological advancements have played a crucial role in shaping global development, with artificial intelligence emerging as one of the most rapidly evolving fields, particularly in medicine (1). Artificial intelligence (AI) refers to the ability of non-human systems to analyze input data and make decisions accordingly. Within artificial intelligence, machine learning focuses on developing algorithms that continuously improve through data exposure, allowing them to identify key patterns linked to specific outcomes. These patterns are stored in model parameters, which guide data processing and decision-making. Deep learning, a subset of machine learning, enables models to recognize and apply intricate data patterns (2). Artificial intelligence models are typically developed by training on extensive datasets to generate meaningful outputs that address predefined objectives. In medicine, such objectives may include patient diagnosis or prognosis, drug discovery and note transcription (3). Despite its growing applications, one underexplored area where artificial intelligence could be transformative is trauma triage. Triage involves categorizing patients based on injury severity to ensure they receive appropriate care at the right time and location (4). Effective triage minimizes preventable disabilities and fatalities while preventing emergency departments from becoming overwhelmed (5).

Nurses play a highly specialized role in the triage process, particularly within emergency departments where clinical urgency and time pressures demand rapid, accurate decision-making. Triage nurses are responsible for conducting fast yet thorough clinical assessments, determining the urgency and severity of patient conditions and ensuring appropriate prioritization for care. This complex task requires not only clinical experience but also critical thinking, decision-making skills, and the ability to perform under pressure. To perform triage effectively and minimize the risk of error, nurses must undergo structured education and continuous training tailored to the demands of this high-stakes environment (6).

Errors in triage can lead to over-triage, where non-critical patients are sent to higher-level facilities unnecessarily, or under-triage, where critically injured patients do not receive specialized trauma care. Both scenarios contribute to poor patient outcomes and inefficient resource allocation (7). Currently, nurses use various conventional triage tools, such as the *National Early Warning Score*, *Modified Early Warning Score*, *Revised Trauma Score*, and *Trauma and Injury Severity Score*, depending on hospital protocols. These tools rely on basic physiological data, including respiratory rate, systolic blood pressure, heart rate, capillary refill time and *Glasgow Coma Scale*. Nurses integrate this information with diagnostic reasoning to determine a patient's triage category. This typically follows an analytical reasoning approach where

past experience and existing knowledge inform decision-making (8). However, the effectiveness of these tools depends on nurses' judgment, which can be influenced by stress levels, variability in physical examinations, and differences in clinical experience (9). Artificial intelligence, machine learning and deep learning offer a potential solution to these limitations by leveraging predictive analytics and large trauma databases such as the *Trauma Audit & Research Network* (9). Although several studies have explored the application of artificial intelligence in various domains of medicine, there is a notable lack of focused reviews that critically assess its role specifically in emergency and trauma triage. Existing literature often discusses artificial intelligence applications broadly, without addressing the unique challenges and opportunities related to triage settings. Therefore, this review aims to fill this gap by synthesizing recent findings on the integration of artificial intelligence into triage systems, evaluating its impact on decision-making accuracy, efficiency and potential clinical implications.

Aim

This literature review aims to explore the impact of artificial intelligence on triage processes in medical practice, examining how technological advancements enhance efficiency, accuracy, and decision-making in patient assessment and prioritization.

Methods

Search strategy

A systematic literature search was performed in March 2025 utilizing PubMed, Web of Science and Hrčak databases, covering the period from January 2022 to January 2025. The selection process was guided by predefined inclusion and exclusion criteria to ensure that only high-quality and relevant studies were included in the review (Table 1). The rationale for selecting this time frame was to focus on the most recent developments in AI applications in triage, as rapid advancements have occurred in the field in the last three years. The literature search was conducted independently by a single researcher under the guidance of a mentor, as part of a manuscript prepared for publication. We selected PubMed, Web of Science and Hrčak for our systematic literature review to ensure comprehensive coverage across international biomedical and multidisciplinary research, alongside regionally specific Croatian scientific output. While this combination maximizes relevance for our topic, it may inherently limit the inclusion of studies from other specialized databases.

Eligibility criteria

Eligible studies included systematic reviews, review articles, original research papers, cross-sectional studies, clinical trials, randomized controlled trials and meta-analyses. These study types were chosen due to their methodological rigor and ability to provide comprehensive, evidence-based insights relevant to the research question. To maintain focus on the most recent advancements, only articles published between 2022 and 2025 were considered. Additionally, studies had to be published in either Croatian or English to be included in the analysis. These language criteria were selected to ensure accurate interpretation of the content by the researchers.

Search terms and strategy

During the search, the authors used the following keywords for the inclusion criteria: "artificial intelligence", "triage", "medical practice" and "nursing practice". These terms were selected based on their relevance to the intersection of artificial intelligence and emergency care, as well as their frequent appearance in the literature. Boolean operators such as "AND" and "OR" were used to combine keywords effectively and broaden the search scope. For example, the query in PubMed was structured as: "artificial intelligence" OR "machine learning" AND "triage" AND "medical practice" AND "nursing practice". No additional filters were applied regarding article type or study design, to avoid prematurely excluding relevant literature.

Data collection and synthesis

The screening process followed the PRISMA guidelines to ensure the selection of relevant studies (Figure 1). Initially, records were identified from three databases, two international and one Croatian database: PubMed (n=289), Web of Science (n=15) Hrčak (n=1), resulting in a total of 305 records. Duplicate records (n=13) were removed, along with records excluded for other reasons (n=246), such as being outside the scope of the review, not being peer-reviewed articles or lacking relevance to the research question. Following these exclusions, 46 records were screened based on their titles and abstracts. During this phase, 15 records were excluded, with the primary reason being the unavailability of a full-text version. The remaining 31 studies were assessed for eligibility, all of which met the inclusion criteria and were subsequently included in the final review. The data from the included studies were synthesized narratively. Key themes, findings, and methodological characteristics were extracted and summarized in a descriptive manner to identify common patterns, trends, and gaps in the literature. No quantitative synthesis (meta-analysis) was performed due to the heterogeneity of the included studies.

Table 1. **Inclusion and exclusion criteria**

	Inclusion criteria	Exclusion criteria
Type/category of the article	Systematic review Review article Original research paper Cross-sectional study Clinical trial Randomized controlled trials Meta-analyses	Letters Editorials Book chapters
Content (keywords)	Artificial intelligence Triage Medical practice Nursing practice	Other
Publication date	2022-2025	Articles published before 2022
Language	Croatian English	Other

Results

This systematic review included 31 articles published in the last three years (2022-2025). Due to the heterogeneity in study designs, populations, and outcome measures, a narrative synthesis was conducted. These articles were selected to provide an overview of the role of artificial intelligence models, particularly large language models, in emergency department triage and decision-making processes. The results were thematically grouped into key areas relevant to triage accuracy, model reliability, comparison of AI models with healthcare professionals and clinical implications.

Table 2 includes a detailed compilation of the results from these articles. We included the information about the authors, the year the paper was written, the aim, the type of study and the population of the research.

Triage accuracy and performance of artificial intelligence models

A total of 12 studies demonstrated that AI models, particularly fine-tuned large language models achieved high levels of triage accuracy, often outperforming or closely matching healthcare professionals in specific scenarios (10,12-15,20,22,25-27,33,36). For example, GPT-4.0 and Claude-3 Opus models showed sensitivity greater than 77% and specificity greater than 91% in pediatric emergency cases (10). ChatGPT also demonstrated strong agreement with expert assessments, achieving accuracy greater than 94% in identifying high-acuity patients (14,20,23,25,27,34,36). In contrast, the AI-powered tool SMASS showed worse performance compared to nurses (11).

Reliability and consistency

While AI models showed high initial performance, their consistency varied depending on context and case complexity. Five studies identified reproducibility issues in simulated disaster scenarios and complex patient cases. For example, ChatGPT showed suboptimal repeatability in mass casualty triage (17,18,28,29,31), with performance heavily dependent on prompt design and prior training. In contrast,

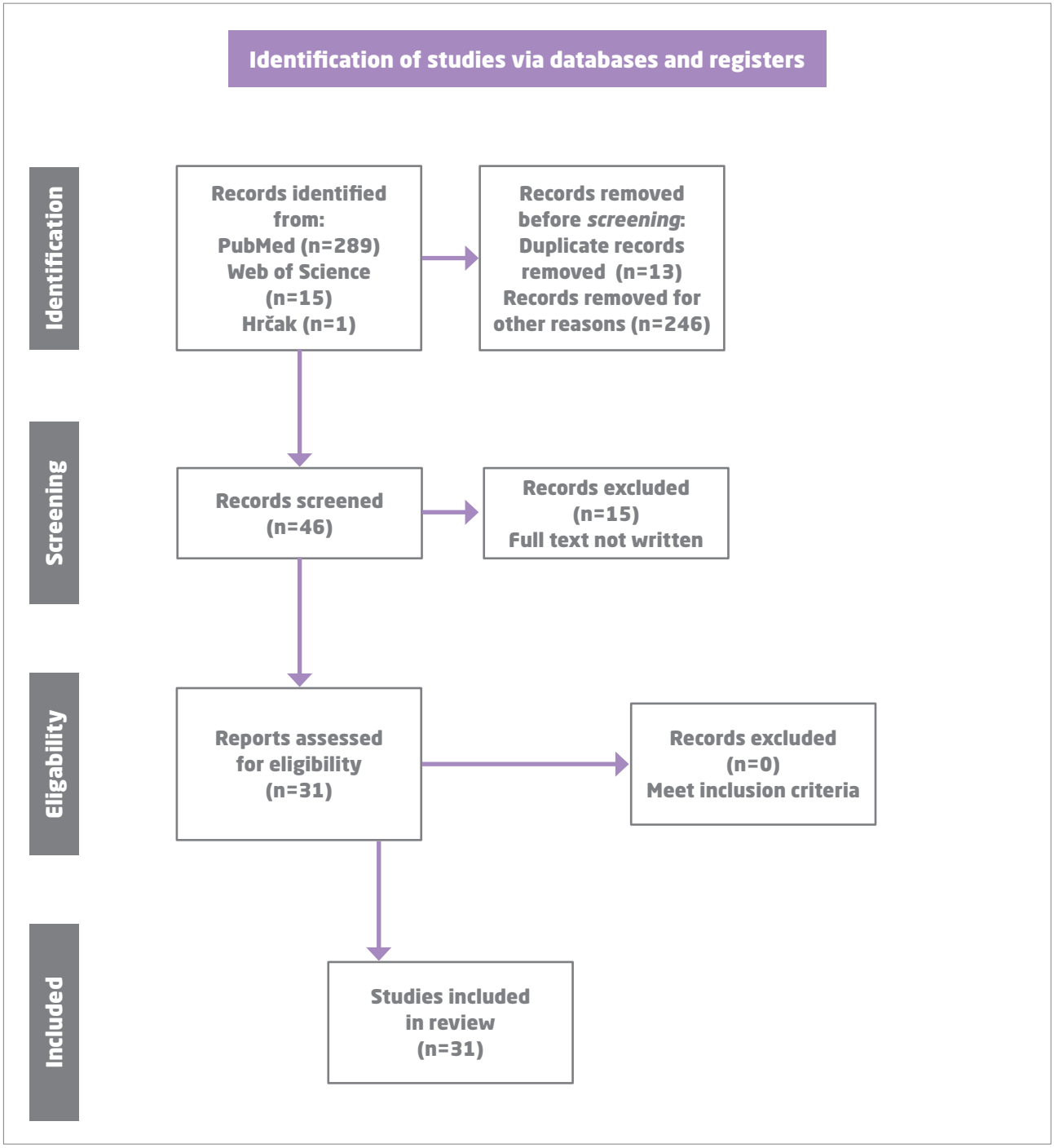

Figure 1. **PRISMA flow diagram**

four studies reported improved reliability metrics for fine-tuned models, suggesting that targeted training can enhance consistency (10,20,23,30).

Comparison with healthcare professionals

Although artificial intelligence demonstrated strong capabilities, eight studies consistently highlighted the superior accuracy and contextual judgment of trained healthcare professionals, especially in complex or high-stakes triage scenarios (16,18,19,23,28-30,36). In several cases, artificial intelligence models underperformed or showed tendencies toward over-triage or under-triage, underscoring the continued need for human oversight. For instance, a real-time voice AI system for medical record input demonstrated mixed results for completeness and accuracy compared to manual nurse input, despite improving efficiency (40).

Clinical implications and integration challenges

Seven studies addressed the broader implications of artificial intelligence implementation. Benefits include reduced administrative workload, earlier identification of critical cases, and improved decision support (15,21-23,26,33). However, significant challenges were also identified, such as data bias, lack of transparency, ethical concerns, and variability in performance depending on the model and specific use case (15,30,35).

Discussion

This literature review has identified a collection of studies that provide substantial evidence supporting the advantageous impact of artificial intelligence in triage across various emergency care settings. The findings highlight the ability of artificial intelligence to enhance accuracy, reduce human bias, improve consistency, and support clinical decision-making in both routine and mass casualty incidents. While artificial intelligence demonstrates significant potential in optimizing emergency triage, its effectiveness varies depending on the model, training data, and the complexity of cases.

However, these benefits must be interpreted cautiously in light of significant limitations. Key limitations include model inconsistency, lack of transparency and potential algorithmic biases. These factors may compromise decision-making accuracy and raise concerns regarding patient safety. Inadequate transparency makes it difficult for healthcare providers to understand and trust AI-generated decisions, potentially leading to resistance in adoption or delayed critical interventions.

In addressing the research question, "How does the application of artificial intelligence influence the accuracy, consistency, and efficiency of triage in various emergency care settings?", the findings indicate a multifaceted impact, demonstrating both significant promise and areas requiring careful consideration.

Accuracy and reliability of artificial intelligence in emergency triage

Artificial intelligence models have demonstrated remarkable accuracy in triage classification, often performing at levels comparable to, or exceeding, human clinicians. Fine-tuned GPT-4.0, for example, achieved a sensitivity of 77.1% and specificity of 92.5% in predicting *Emergency Severity Index (ESI)* levels, while Claude-3 Opus exhibited the highest reliability among tested AI models, with a Fleiss κ of 0.85 in pediatric triage (10). Similarly, ChatGPT showed strong agreement with human experts in emergency department triage (Kappa = 0.659) and a high specificity of 99.86% in identifying critical cases (11). This addresses the part of the research question by showing that artificial intelligence generally enhances triage accuracy, particularly in identifying high-acuity patients and predicting ESI levels. However, AI's accuracy is not uniform across all triage systems. When tested on the *Canadian Triage and Acuity Scale (CTAS),* ChatGPT exhibited only 47.5% accuracy, with a substantial rate of over-triage (38.7%) and under-triage (13.7%), raising concerns about its reliability in certain frameworks (17). Similarly, ChatGPT's triage performance in simulated disaster scenarios using the START protocol was suboptimal (63.9%) due to inconsistencies in repeatability and reproducibility (16). These variations highlight that while artificial intelligence holds promise, its effectiveness is highly dependent on the triage system used and the complexity of cases it encounters.

Table 2. **Overview of the research findings on technological advancements in triage**

Authors, year	Type of study	Population	AI Models Evaluated	Comparators	Key findings	AI vs. Human performance
Ho et al. (2025). (10)	Original research paper	70 pediatric vignettes (ESI Handbook v4)	Claude-3 Opus, GPT-4.0 (fine-tuned), Mistral-Large	N/A	Claude-3 Opus: Sensitivity 80.6%, Specificity 91.3%, F1 73.9%; Fine-tuned GPT-4.0 improved: F1 74.6%, P < 0.04	AI models (especially fine-tuned) show strong accuracy and reliability (κ: 0.85)
Lindner, Ravioli (2025). (11)	Original research paper (retrospective)	1021 adult ED patients	SMASS (AI-powered assessment tool)	MTS (Manchester Triage System)	SMASS showed significant over-/under-triage vs. MTS (Kappa 0.167). Sensitivity 62%, specificity 73% for acute/non-acute.	SMASS performed worse than human-applied MTS, requires significant training on real-world ED data to improve accuracy and consistency.
Porcellato et al. (2025). (12)	Systematic review	24 studies on critical care patients	Diverse AI techniques (machine learning, deep learning, LLMs	Varies by included study (traditional methods, other AI models)	Predictive models show varying performance (e.g., one AI-ECG model showed 76% accuracy, 73% sensitivity=	AI significantly enhances human decision-making in trauma triage, outperforming conventional tools (AUC-ROC 0.09), though study variations prevent universally firm conclusions.
Arslan et al. (2024). (13)	Observational study	468 adult ED patients	ChatGPT, Copilot	Triage nurses	ChatGPT: 66.5%, Copilot: 61.8%, Nurses: 65.2%; AI better at identifying high-risk patients (87.8% vs. 32.7%)	AI outperformed nurses in high-risk identification, more consistent across ages
Colakca et al. (2024). (14)	Cross-sectional study	745 adult ED patients	ChatGPT-4	Expert triage	High agreement (Kappa = 0.659); Specificity: ESI-1: 99.86%, ESI-2: 95.38%	AI highly effective at identifying critical cases
Di Sarno et al. (2024). (15)	Literature review	Pediatric patients in emergency medicine settings	AI-driven Clinical Decision Support Systems (CDS), Socially Assistive Robots (SARs)	Traditional clinical assessment methods	AI improves triage accuracy, early sepsis detection, and traumatic brain injury evaluation; SARs reduce pediatric stress	AI models outperform traditional methods in accuracy and efficiency, but issues with data bias, transparency, and clinical integration remain

Table 2. **Overview of the research findings on technological advancements in triage**

Authors, year	Type of study	Population	AI Models Evaluated	Comparators	Key findings	AI vs. Human performance
Eraybar et al. (2024). (16)	Observational study	86 clinicians (ED professionals)	ChatGPT, Google Bard	Human professionals	Professionals: 30.7 correct, AI: 25.5; No significant AI difference (p=0.821)	Humans outperformed AI; AI not yet as accurate
Franc et al. (2024). (17)	Original research paper	391 disaster triage vignettes	ChatGPT-4	START protocol (no human comparator)	Accuracy: 63.9%; Poor reproducibility; caution advised	AI performance suboptimal for disaster triage
Franc, Cheng et al. (2024). (18)	Original research paper	61 CTAS vignettes	ChatGPT	Canadian Triage Scale	Accuracy: 47.5%; Over-triage 38.7%, Under-triage 13.7%	ChatGPT showed high variability and low reliability
Kim et al. (2024). (19)	Original research paper	202 virtual patient cases	ChatGPT-3.5, ChatGPT-4.0	Human paramedics	GPT-4.0 κ=0.523 vs. 3.5 κ=0.320; Human κ=0.646	AI less reliable than humans, but GPT-4.0 better than 3.5
Liu et al. (2024). (20)	Original research paper – retrospective and prospective cohort study	Retrospective - 30 outpatient medical records Prospective - manual vs. ChatGPT triage for 45 outpatients based on age, gender, and symptoms	ChatGPT	Manual triage	Prospective: 93.3–100% agreement; Retrospective: 17/30 rated 9.5-10	High consistency with manual triage
Mani et al. (2024). (21)	Review article	Patients, healthcare providers, and AI systems in emergency departments	AI tools for triage, patient monitoring, diagnosis, treatment planning, and decision support	Conventional nursing workflows	AI applications improve triage accuracy, monitoring, diagnosis, treatment planning, and decision-making, enhancing patient outcomes and workflow efficiency.	AI enhances performance but requires addressing data security, ethics, algorithm reliability, and staff training to achieve effective implementation.
Ventura et al. (2024). (22)	Literature review	Patients that needed triage assessment	Deep learning models for injury diagnosis and outcome prediction	Traditional triage methods	Deep learning achieved high accuracy in diagnosing traumatic injuries and predicting hospitalization, mortality, and ICU admission.	AI outperformed traditional triage methods in accuracy and predictive performance.
Masanneck et al. (2024). (23)	Original research paper	124 anonymized ED case vignettes	ChatGPT (GPT-3.5, GPT-4)	Untrained doctors	GPT-4 ≈ untrained doctors; GPT-3.5 worse; Over-triage common	LLMs showed potential, but didn't match experts

Table 2. **Overview of the research findings on technological advancements in triage**

Authors, year	Type of study	Population	AI Models Evaluated	Comparators	Key findings	AI vs. Human performance
Preiksaitis et al. (2024). (24)	Review article	Patients needing triage assessment	Large Language Models (LLMs)	Traditional triage and administrative methods	LLMs improve emergency care by enhancing real-time triage, recognizing patient urgency earlier, reducing administrative workload, and supporting patient-centered care.	LLMs show potential to support clinicians by increasing efficiency and triage accuracy, but direct performance comparisons with humans were not detailed.
Sorich et al. (2024). (25)	Original research paper	48 case vignettes	GPT-4o, Claude 3.5, Gemini 1.5 Pro	N/A	Triage accuracy ~92% across models; Claude-3.5 best overall	AI shows strong diagnostic and triage performance
Tyler et al. (2024). (26)	Review article	Patients admitted to emergency departments in the USA	AI and Machine Learning models for triage, specific models not mentioned	Traditional triage systems (e.g., Emergency Severity Index)	AI and ML models improved triage by reducing mis-triage, enhancing prediction of critical outcomes, and outperforming conventional systems in forecasting admissions, disease identification, and deterioration.	AI models outperformed human-based systems in triage accuracy, efficiency, and resource allocation.
Yi et al. (2024). (27)	Systematic review	Patients needing triage assessment	AI-based triage models, specific models not mentioned	Manual triage methods	AI demonstrated high accuracy (80.5%–99.1%), improved triage speed, reduced mis-triage, and enabled urgency classification and prognosis prediction more effectively.	AI triage outperformed manual methods in both accuracy and time efficiency.
Mayerhoffer H. (2024). (28)	Original research paper	AI triage categorization	ChatGPT	Traditional triage	Correct in 43.33%; Tendency to over-triage for safety	AI errs conservatively but lacks high precision

Table 2. **Overview of the research findings on technological advancements in triage**

Authors, year	Type of study	Population	AI Models Evaluated	Comparators	Key findings	AI vs. Human performance
Fraser et al. (2023). (29)	Original research paper	Original research paper / 40 emergency department patients	ChatGPT 3.5, ChatGPT 4.0, WebMD, Ada Health	ED diagnoses and physician reviews	ChatGPT 3.5 had the highest diagnostic accuracy (40% top-1, 63% top-3), but the highest unsafe triage rate (41%). ChatGPT 4.0 had better triage agreement (76%) and lower unsafe rate (22%), making it more reliable.	ChatGPT models showed moderate diagnostic accuracy but varied in triage safety—ChatGPT 4.0 performed better than 3.5 in triage alignment with physicians.
Gan Uddin et al. (2023). (30)	Cross-sectional study	Simulated MCI scenarios	ChatGPT vs. Google Bard	Medical students	Bard: 60%, ChatGPT: 26.7%, Students: 64.3%	Bard comparable to students; ChatGPT significantly lower
Gan, Ogbodo et al. (2023). (31)	Cross-sectional study	Simulated MCI scenarios	ChatGPT vs. Google Bard	Medical students	Bard: 60%, ChatGPT: 26.7%, Students: 64.3%	Bard comparable to students; ChatGPT significantly lower
Gebrael et al. (2023). (32)	Original research paper	56 prostate cancer patients in ED	ChatGPT	ER physicians	ChatGPT showed 95.7% sensitivity for admission decisions, 18.2% specificity for discharges, aligned with physician diagnosis in 87.5% of cases, used more accurate medical terminology, and offered more comprehensive recommendations.	ChatGPT showed cautious but accurate diagnostic support; outperformed physicians in terminology and completeness but lacked discharge precision.
Adebayo et al. (2023). (33)	Systematic review	Systematic review / Triage patients	AI, ML, DL models	Conventional triage tools	AI-based models significantly improved prediction of mortality, hospitalization, and ICU admission, surpassing traditional triage tools.	AI models statistically outperformed conventional tools in predictive accuracy for critical outcomes.
Jacob J. (2023). (34)	Original research paper	Polytrauma scenarios	ChatGPT	ESI and Australasian Triage Scales	ChatGPT accurately classified polytrauma patients with one initial misclassification corrected upon review; AI demonstrated potential in rapid classification.	ChatGPT showed strong potential for fast and accurate triage support with self-correction capability.

Table 2. **Overview of the research findings on technological advancements in triage**

Authors, year	Type of study	Population	AI Models Evaluated	Comparators	Key findings	AI vs. Human performance
Masoumian et al. (2023). (35)	Systematic review	Triage patients	Various AI applications, specific models not mentioned	Not directly compared	AI used for triage, disease prediction, emergency management; ethical concerns highlighted, particularly regarding transparency.	AI showed clinical potential, but lack of transparency challenges trust and adoption.
Sarbay et al. (2023). (36)	Cross-sectional study	50 ESI scenarios	ChatGPT	Emergency Medicine (EM) specialists	ChatGPT showed fair agreement (κ=0.341), 22% over-triage, 18% under-triage, strong in high-acuity cases with 76.2% sensitivity and 93.1% specificity.	ChatGPT effective in high-acuity triage; moderate agreement with specialists suggests supportive role.
Boonstra, Laven. (2022). (37)	Systematic literature review	ED patients	General AI tools, specific models not mentioned	Not directly compared	AI improved decision-making, triage efficiency, reduced overcrowding and clinician burden; designed to support, not replace clinicians.	AI supports human clinicians by optimizing workflow and resource allocation.
Ilicki J. (2022). (38)	Systematic review	Triage patients	Patient-operated AI triage systems	Not directly compared	Main limitations were epistemological, ontological, and methodological; caution required in interpreting accuracy claims.	AI triage systems need critical appraisal; performance evaluation is complex and context-dependent.
Mueller et al. (2022). (39)	Review article	Triage patients	ML applications in emergency medicine, specific models not mentioned	Traditional triage	ML enhances triage by analyzing patient data, improving prioritization, reducing delays, and predicting risk.	AI enhances traditional methods, offering faster and more precise risk assessment.
Cho et al. (2022). (40)	Original research paper	1063 triage cases from a Level 1 ED (19 ED nurses)	RMIS-AI (Real-time medical record input assistance system with voice AI, utilizing voice recognition & NLP)	Manual EMR input by nurses	RMIS-AI significantly shortened triage time (204s vs 231s). Mixed results for record completeness and accuracy compared to manual input.	RMIS-AI improved efficiency, but accuracy/ completeness varied, suggesting a supportive rather than replacement role for human nurses.

Such inconsistency in performance introduces risk when AI systems are used without adequate human oversight. This underscores the need for stringent validation of AI tools before widespread deployment.

Role of artificial intelligence in reducing human bias and improving triage consistency

Artificial intelligence improves triage by reducing human biases that lead to patient misclassification. In one study, ChatGPT identified high-risk patients more accurately than nurses (87.8% vs. 32.7%) and showed consistent accuracy across age groups, minimizing age-related bias (10). Additionally, AI models enhance triage consistency, with ChatGPT-4.0 achieving an inter-rater agreement of κ=0.523, though still lower than human professionals (κ=0.646). However, artificial intelligence struggles with complex cases—ChatGPT-3.5 had poor performance in severe emergencies (κ=0.067), highlighting the need for further improvements in high-risk triage scenarios (18).

Artificial intelligence in mass casualty and disaster triage

Artificial intelligence has also demonstrated potential in mass casualty incidents, where rapid and accurate triage is essential for optimizing patient outcomes. Studies have shown that AI can improve triage performance in these scenarios. After being trained on the START protocol, ChatGPT's accuracy in MCI triage reached 80%, surpassing medical students (29). However, when compared to Google Bard, ChatGPT underperformed, achieving only 26.67% accuracy versus Bard's 60% (30). These results highlight the variability across different models, underscoring the need for further training and validation before deployment in disaster response. In real-world mass casualty incidents, AI's lack of contextual awareness and inability to adapt dynamically to chaotic environments further complicates its practical utility. The risk of over-reliance on AI in such high-pressure settings could delay life-saving interventions without immediate human correction.

Challenges and future directions

Artificial intelligence in triage faces challenges such as data bias, transparency issues, and inconsistent reliability across models (20). Ultimately, AI is most effective in a hybrid model, complementing human expertise rather than replacing it. Continuous assessment and refinement will be essential for its safe and effective use in emergency medicine. Future research should focus on improving AI's performance in complex triage cases, enhancing model interpretability, and ensuring seamless integration with existing healthcare systems. A promising direction involves collaboration among multiple AI models, as demonstrated in studies where LLMs worked together to achieve a diagnostic accuracy of 98% (24).

Equally important are the practical barriers to implementation. These include high development and integration costs, the need for technical training, resistance from clinical staff, and unresolved regulatory and legal frameworks. Establishing trust in AI systems will require transparent reporting, independent validation, and ethical oversight. Comparing the performance of AI models and nurses should be a key focus of future research to clarify the capabilities and limitations of AI. Tasks that require complex thinking and emotional understanding should still be handled by humans, because AI does not yet understand context or have moral judgment. To deal with current problems, we need better solutions like making AI more understandable, reducing bias when creating datasets and training AI systems to adjust as medical environments change. We also need real-life studies and pilot programs to test how AI performs in practice. These should assess patient outcomes, staff acceptance, and cost-effectiveness across different healthcare settings.

Conclusion

This review shows that artificial intelligence has the potential to improve triage accuracy, reduce certain human biases and assist in clinical decision-making across emergency settings. Studies show artificial intelligence driven models improve risk identification, triage consistency, and emergency care assessments, reinforcing their value in healthcare. However, artificial intelligence models still face important challenges such as model inconsistency, limited transparency and varying performance across clinical contexts. These challenges can affect patient safety and decision making. Current evidence suggests artificial intelligence is best used as a support tool rather than an independent triage system.

Future research should focus on validating AI tools in real-world clinical environments, improving their performance in complex and high-risk cases, and ensuring transparency to build clinician trust. Studies should assess not only diagnostic accuracy but also patient outcomes, staff acceptance and cost-effectiveness. Efforts are also needed to develop guidelines for ethical use, legal accountability, and integration into existing emergency protocols. Ongoing validation and refinement will be essential to ensuring safe and effective deployment in emergency medicine.

Author contributions

Conceptualization and methodology (BI, HM); Data curation and formal analysis (HM); Investigation and project administration (HM); Writing – original draft (BI, HM); and Review & editing (BI, HM). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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References

1. Tang X, Li X, Ding Y, Song M, Bu Y. The pace of artificial intelligence innovations: speed, talent, and trial-and-error. J Informetr. 2020;14(4):101094. https://doi.org/10.1016/j.joi.2020.101094
2. Cho B, Geng E, Arvind V, Valliani A, Tang J, Schwartz J et al. Understanding artificial intelligence and predictive analytics. JBJS Rev. 2022;10(3). https://doi.org/10.2106/JBJS.RVW.21.00142
3. LeCun Y, Bengio Y, Hinton G. Deep learning. Nature. 2015;521:436-44. https://doi.org/10.1145/3448250
4. Jenkins JL, McCarthy ML, Sauer LM, Green GB, Stuart S, Thomas TL et al. Mass-casualty triage: time for an evidence-based approach. Prehosp Disaster Med. 2008;23(1):3-8. https://doi.org/10.1017/s1049023x00005471
5. Malik NS, Chernbumroong S, Xu Y, Vassallo J, Lee J, Bowley DM et al. The BCD triage sieve outperforms all existing major incident triage tools: comparative analysis using the UK national trauma registry population. EclinicalMedicine. 2021;36:100888. https://doi.org/10.1016/j.eclinm.2021.100888
6. Thawley A, Aggar C, Williams N. The educational needs of triage nurses. Health Education in Practice: Journal of Research for Professional Learning. 2020;3(1):26-38. https://doi.org/10.33966/hepj.3.1.14121
7. Frykberg ER, Tepas JJ. Terrorist bombings: lessons learned from belfast to beirut. Ann Surg. 1988;208(5):569-76. https://doi.org/10.1097/00000658-198811000-00005
8. Ying Y, Huang B, Zhu Y, Jianx X, Dong J, Ding Y et al. Comparison of five triage tools for identifying mortality risk and injury severity of multiple trauma patients admitted to the emergency department in the daytime and nighttime: a retrospective study. Appl Bionics Biomech. 2022;25;9368920. https://doi.org/10.1155/2022/9368920
9. Rutschmann OT, Kossovsky M, Geissbühler A, Perneger TV, Vermeulen B, Simon J et al. Interactive triage simulator revealed important variability in both process and outcome of emergency triage. J Clin Epidemiol. 2006;59(6):615-21. https://doi.org/10.1016/j.jclinepi.2005.11.003
10. Ho B, Lu M, Wang X, Butler R, Park J, Ren D. Evaluation of Generative Artificial Intelligence Models in Predicting Pediatric Emergency Severity Index Levels. Pediatr Emerg Care. 2025;41(4):251-5. https://doi.org/10.1097/PEC.0000000000003315.
11. Lindner G, Ravioli S. Performance of the artificial intelligence-based Swiss medical assessment system versus Manchester triage system in the emergency department: A retrospective analysis. The American Journal of Emergency Medicine. 2025;94:46-9. https://doi.org/10.1016/j.ajem.2025.04.023
12. Porcellato E, Lanera C, Ocagli H, Danielis M. Exploring Applications of Artificial Intelligence in Critical Care Nursing: A Systematic Review. Nursing Reports. 2025;15(2):55. https://doi.org/10.3390/nursrep15020055
13. Arslan B, Nuhoglu C, Satici MO, Altinbilek E. Evaluating LLM-based generative AI tools in emergency triage: A comparative study of ChatGPT Plus, Copilot Pro, and triage nurses. Am J Emerg Med. 2025;89:174-81. https://doi.org/10.1016/j.ajem.2024.12.024
14. Colakca C, Ergın M, Ozensoy HS, Sener A, Guru S, Ozhasenekler A. Emergency department triaging using ChatGPT based on emergency severity index principles: a cross-sectional study. Sci Rep. 2024:27;14(1):22106. https://doi.org/10.1038/s41598-024-73229-7
15. Di Sarno L, Caroselli A, Tonin G, Graglia B, Pansini V, Causio FA et al. Artificial Intelligence in Pediatric Emergency Medicine: Applications, Challenges, and Future Perspectives. Biomedicines. 2024:30;12(6):1220. https://doi.org/10.3390/biomedicines12061220
16. Eraybar S, Dal E, Aydin MO, Begenen M. Transforming emergency triage: A preliminary, scenario-based cross-sectional study comparing artificial intelligence models and clinical expertise for enhanced accuracy. Bratisl Lek Listy. 2024;125(11):738-43. https://doi.org/10.4149/BLL_2024_114

17. Franc JM, Hertelendy AJ, Cheng L, Hata R, Verde M. Accuracy of a Commercial Large Language Model (ChatGPT) to Perform Disaster Triage of Simulated Patients Using the Simple Triage and Rapid Treatment (START) Protocol: Gage Repeatability and Reproducibility Study. J Med Internet Res. 2024;26:e55648. https://doi.org/10.2196/55648
18. Franc JM, Cheng L, Hart A, Hata R, Hertelendy A. Repeatability, reproducibility, and diagnostic accuracy of a commercial large language model (ChatGPT) to perform emergency department triage using the Canadian triage and acuity scale. CJEM. 2024;26(1):40-6. https://doi.org/10.1007/s43678-023-00616-w
19. Kim JH, Kim SK, Choi J, Lee Y. Reliability of ChatGPT for performing triage task in the emergency department using the Korean Triage and Acuity Scale. Digit Health. 2024;10:20552076241227132. https://doi.org/10.1177/20552076241227132
20. Liu X, Lai R, Wu C, Yan C, Gan Z, Yang Y et al. Assessing the utility of artificial intelligence throughout the triage outpatients: a prospective randomized controlled clinical study. Front Public Health. 2024;12:1391906. https://doi.org/10.3389/fpubh.2024.1391906
21. Mani Z, Albagawi B. AI frontiers in emergency care: the next evolution of nursing interventions. Front Public Health. 2024;12:1439412. https://doi.org/10.3389/fpubh.2024.1439412
22. Ventura CAI, Denton EE, David JA. Artificial Intelligence in Emergency Trauma Care: A Preliminary Scoping Review. Med Devices (Auckl). 2024;17:191-211. https://doi.org/10.2147/MDER.S467146
23. Masanneck L, Schmidt L, Seifert A, Kölsche T, Huntemann N, Jansen R, et al. Triage Performance Across Large Language Models, ChatGPT, and Untrained Doctors in Emergency Medicine: Comparative Study. J Med Internet Res. 2024;26:e53297. https://doi.org/10.2196/53297
24. Preiksaitis C, Ashenburg N, Bunney G, Chu A, Kabeer R, Riley F et al. The Role of Large Language Models in Transforming Emergency Medicine: Scoping Review. JMIR Med Inform. 2024;12:e53787. https://doi.org/10.2196/53787
25. Sorich MJ, Mangoni AA, Bacchi S, Menz BD, Hopkins AM. The Triage and Diagnostic Accuracy of Frontier Large Language Models: Updated Comparison to Physician Performance. J Med Internet Res. 2024;26:e67409. https://doi.org/10.2196/67409
26. Tyler S, Olis M, Aust N, Patel L, Simon L, Triantafyllidis C et al. Use of Artificial Intelligence in Triage in Hospital Emergency Departments: A Scoping Review. Cureus. 2024;16(5):e59906. https://doi.org/10.7759/cureus.59906
27. Yi N, Baik D, Baek G. The effects of applying artificial intelligence to triage in the emergency department: A systematic review of prospective studies. J Nurs Scholarsh. 2024;57(1):105-118. https://doi.org/10.1111/jnu.13024
28. Mayerhoffer H. The Future of Triage: The Analysis of Traditional Methods Compared to ChatGPT. Croatian Nursing Journal. 2024;8(1):29-36. https://doi.org/10.24141/2/8/1/3
29. Fraser H, Crossland D, Bacher I, Ranney M, Madsen T, Hilliard R. Comparison of Diagnostic and Triage Accuracy of Ada Health and WebMD Symptom Checkers, ChatGPT, and Physicians for Patients in an Emergency Department: Clinical Data Analysis Study. JMIR Mhealth Uhealth. 2023;11:e49995. https://doi.org/10.2196/49995
30. Gan RK, Uddin H, Gan AZ, Yew YY, González PA. ChatGPT's performance before and after teaching in mass casualty incident triage. Sci Rep. 2023;13(1):20350. https://doi.org/10.1038/s41598-023-46986-0
31. Gan RK, Ogbodo JC, Wee YZ, Gan AZ, González PA. Performance of Google bard and ChatGPT in mass casualty incidents triage. Am J Emerg Med. 2024;75:72-78. https://doi.org/10.1016/j.ajem.2023.10.034
32. Gebrael G, Sahu KK, Chigarira B, Tripathi N, Mathew Thomas V, Sayegh N et al. Enhancing triage efficiency and accuracy in emergency rooms for patients with metastatic prostate cancer: a retrospective analysis of artificial intelligence-assisted triage using ChatGPT 4.0. Cancers. 2023;15(14):3717. https://doi.org/10.3390/cancers15143717
33. Adebayo O, Bhuiyan ZA, Ahmed Z. Exploring the effectiveness of artificial intelligence, machine learning and deep learning in trauma triage: A systematic review and meta-analysis. Digit Health. 2023;9:20552076231205736. https://doi.org/10.1177/20552076231205736
34. Jacob J. ChatGPT: Friend or Foe?-Utility in Trauma Triage. Indian J Crit Care Med. 2023;27(8):563-6. https://doi.org/10.5005/jp-journals-10071-24498
35. Masoumian Hosseini M, Masoumian Hosseini ST, Qayumi K, Ahmady S, Koohestani HR. The Aspects of Running Artificial Intelligence in Emergency Care; a Scoping Review. Arch Acad Emerg Med. 2023;11(1):e38. https://doi.org/10.22037/aaem.v11i1.1974
36. Sarbay İ, Berikol GB, Özturan İU. Performance of emergency triage prediction of an open access natural language processing based chatbot application (ChatGPT): A preliminary, scenario-based cross-sectional study. Turk J Emerg Med. 2023;23(3):156-61. https://doi.org/10.4103/tjem.tjem_79_23
37. Boonstra A, Laven M. Influence of artificial intelligence on the work design of emergency department clinicians a systematic literature review. BMC Health Serv Res. 2022;22(1):669. https://doi.org/10.1186/s12913-022-08070-7
38. Ilicki J. Challenges in evaluating the accuracy of AI-containing digital triage systems: A systematic review. PLoS One. 2022;17(12):e0279636. https://doi.org/10.1371/journal.pone.0279636
39. Mueller B, Kinoshita T, Peebles A, Graber MA, Lee S. Artificial intelligence and machine learning in emergency medicine: a narrative review. Acute Med Surg. 2022;9(1):e740. https://doi.org/10.1002/ams2.740
40. Cho A, Min IK, Hong S, Chung HS, Lee HS, Kim JH. Effect of applying a real-time medical record input assistance system with voice artificial intelligence on triage task performance in the emergency department: prospective interventional study. JMIR Medical Informatics. 2022;10(8):e39892. https://doi.org/10.2196/39892

Supplementary file

Table 1. **Excluded studies**

Author	Name	Year	Reason of exclusion
Abdulgader, S. M.	Diagnosing Tuberculosis: What Do New Technologies Allow Us to (Not) Do?	2022	Not related to the topic
Abi-Rafeh, J.	Complications Following Facelift and Neck Lift: Implementation and Assessment of Large Language Model and Artificial Intelligence (ChatGPT) Performance Across 16 Simulated Patient Presentations	2023	Not related to the topic
Abou Chaar, M. K.	ChatGPT vs Expert-Guided Care Pathways for Postesophagectomy Symptom Management	2024	Not related to the topic
Acharji, S.	Prognostic significance of elevated baseline troponin in patients with acute coronary syndromes and chronic kidney disease treated with different antithrombotic regimens: a substudy from the ACUITY trial	2012	Published before 2022.
Acosta, J. N.	The Need for Medical Artificial Intelligence That Incorporates Prior Images	2022	Not related to the topic
Adams, S. J.	Artificial Intelligence Solutions for Analysis of X-ray Images	2021	Not related to the topic
Agarwal, S.	Systematic Review of Artificial Intelligence for Abnormality Detection in High-volume Neuroimaging and Subgroup Meta-analysis for Intracranial Hemorrhage Detection	2023	Not related to the topic
Aggelidis, X.	Tele-Monitoring Applications in Respiratory Allergy	2024	Not related to the topic
Ahmed, A.	Role of Digital Health During Coronavirus Disease 2019 Pandemic and Future Perspectives	2022	Not related to the topic
Akkerhuis, K. M.	Recurrent ischemia during continuous 12-lead ECG-ischemia monitoring in patients with acute coronary syndromes treated with eptifibatide: relation with death and myocardial infarction. PURSUIT ECG-Ischemia Monitoring Substudy Investigators. Platelet...	2000	Published before 2022.
Alizadehsani, R.	Coronary artery disease detection using artificial intelligence techniques: A survey of trends, geographical differences and diagnostic features 1991-2020	2021	Published before 2022.
AlNuaimi, D.	The role of artificial intelligence in plain chest radiographs interpretation during the Covid-19 pandemic	2022	Not related to the topic
Altamimi, I.	Snakebite Advice and Counseling from Artificial Intelligence: An Acute Venomous Snakebite Consultation With ChatGPT	2023	Not related to the topic
Amundson, S. A.	Transcriptomics for radiation biodosimetry: progress and challenges	2023	Not related to the topic
Anderson, P.	Stress granules: the Tao of RNA triage	2008	Published before 2022.
Ankolekar, A.	Using artificial intelligence and predictive modelling to enable learning healthcare systems (LHS) for pandemic preparedness	2024	Not related to the topic
	CADTH Horizon Scans	2023	Not related to the topic
	CADTH Horizon Scans	2023	Duplicate
Ayoub, M.	Mind + Machine: ChatGPT as a Basic Clinical Decisions Support Tool	2023	Not related to the topic
Bahl, M.	Updates in Artificial Intelligence for Breast Imaging	2022	Not related to the topic
Bahl, M.	Artificial Intelligence for Breast Ultrasound: AJR Expert Panel Narrative Review	2024	Not related to the topic
Baker, A.	A comparison of artificial intelligence and human doctors for the purpose of triage and diagnosis	2020	Published before 2022.
Barlow, A.	Pulmonary arterial hypertension in the emergency department: A focus on medication management	2021	Published before 2022.
Batra, P.	Artificial Intelligence in Teledentistry	2022	Not related to the topic
Baughan, N.	Past, Present, and Future of Machine Learning and Artificial Intelligence for Breast Cancer Screening	2022	Not related to the topic
Behrens, A. J.	Glycosylation profiling to evaluate glycoprotein immunogens against HIV-1	2017	Published before 2022.
Ben Alaya, I.	Applications of artificial intelligence for DWI and PWI data processing in acute ischemic stroke: Current practices and future directions	2022	Not related to the topic
Ben Alaya, I.	Automatic triaging of acute ischemic stroke patients for reperfusion therapies using Artificial Intelligence methods and multiple MRI features: A review	2023	Not related to the topic
Bhattaram, S.	ChatGPT: The next-gen tool for triaging?	2023	Full text not written

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Author	Name	Year	Reason of exclusion
Biswas, S.	Utility of artificial intelligence-based large language models in ophthalmic care	2024	Not related to the topic
Biswas, S.	Utility of artificial intelligence-based large language models in ophthalmic care	2024	Duplicate
Boochoon, K.	Deep Learning for the Assessment of Facial Nerve Palsy: Opportunities and Challenges	2023	Not related to the topic
Boyd, C. J.	Artificial Intelligence as a Triage Tool during the Perioperative Period: Pilot Study of Accuracy and Accessibility for Clinical Application	2024	Not related to the topic
Buchlak, Q. D.	Charting the potential of brain computed tomography deep learning systems	2022	Not related to the topic
Bydon, M.	Commentary: A Quantitative Assessment of Chat-GPT as a Neurosurgical Triaging Tool	2024	Not related to the topic
Cao, X. F.	Application of artificial intelligence in digital chest radiography reading for pulmonary tuberculosis screening	2021	Published before 2022.
Cascella, M.	The Breakthrough of Large Language Models Release for Medical Applications: 1-Year Timeline and Perspectives	2024	Not related to the topic
Casterella, P. J.	Review of the 2005 American College of Cardiology, American Heart Association, and Society for Cardiovascular Interventions guidelines for adjunctive pharmacologic therapy during percutaneous coronary interventions: practical implications, new clinical...	2008	Published before 2022.
Chandrabhatla, A. S.	Artificial Intelligence and Machine Learning in the Diagnosis and Management of Stroke: A Narrative Review of United States Food and Drug Administration-Approved Technologies	2023	Not related to the topic
Chennareddy, S.	Portable stroke detection devices: a systematic scoping review of prehospital applications	2022	Not related to the topic
Choe, J.	Artificial Intelligence in Lung Imaging	2022	Not related to the topic
Chu, K.	Evaluating risk stratification scoring systems to predict mortality in patients with COVID-19	2021	Published before 2022.
Chu, L. C.	Pancreatic ductal adenocarcinoma staging: a narrative review of radiologic techniques and advances	2024	Not related to the topic
Cicero, M. X.	60 seconds to survival: A pilot study of a disaster triage video game for prehospital providers	2017	Published before 2022.
Ciecierski-Holmes, T.	Artificial intelligence for strengthening healthcare systems in low- and middle-income countries: a systematic scoping review	2022	Not related to the topic
Corbacho Abelaira, M. D.	Use of Conventional Chest Imaging and Artificial Intelligence in COVID-19 Infection. A Review of the Literature	2021	Published before 2022.
Dafni, M. F.	Empowering cancer prevention with AI: unlocking new frontiers in prediction, diagnosis, and intervention	2024	Not related to the topic
Daneshjou, R.	Lack of Transparency and Potential Bias in Artificial Intelligence Data Sets and Algorithms: A Scoping Review	2021	Published before 2022.
Dangi, R. R.	Transforming Healthcare in Low-Resource Settings with Artificial Intelligence: Recent Developments and Outcomes	2024	Not related to the topic
Daripa, B.	Artificial Intelligence-Aided Headache Classification Based on a Set of Questionnaires: A Short Review	2022	Not related to the topic
Dasegowda, G.	Suboptimal Chest Radiography and Artificial Intelligence: The Problem and the Solution	2023	Not related to the topic
David, D.	The use of artificial intelligence based chat bots in ophthalmology triage	2024	Not related to the topic
Davidović, M.	Facility-Based Indicators to Manage and Scale Up Cervical Cancer Prevention and Care Services for Women Living With HIV in Sub-Saharan Africa: a Three-Round Online Delphi Consensus Method	2024	Not related to the topic
Delgado, J.	Bias in algorithms of AI systems developed for COVID-19: A scoping review	2022	Not related to the topic
Delsoz, M.	The Use of ChatGPT to Assist in Diagnosing Glaucoma Based on Clinical Case Reports	2023	Not related to the topic
Denkinger, C. M.	Defining the needs for next generation assays for tuberculosis	2015	Published before 2022.
Desai, S. M.	Direct Transfer to the Neuroangiography Suite for Patients with Stroke	2023	Not related to the topic

Table 1. **Excluded studies**

Author	Name	Year	Reason of exclusion
Desmet, C. M.	Factors Affecting the Quality of Tooth Enamel for In Vivo EPR-Based Retrospective Biodosimetry	2016	Published before 2022.
Dheda, K.	A position statement and practical guide to the use of particulate filtering facepiece respirators (N95, FFP2, or equivalent) for South African health workers exposed to respiratory pathogens including Mycobacterium tuberculosis and SARS-CoV-2	2021	Published before 2022.
Dias Gonçalves Lima, F.	The Accuracy of Anal Swab-Based Tests to Detect High-Grade Anal Intraepithelial Neoplasia in HIV-Infected Patients: A Systematic Review and Meta-analysis	2019	Published before 2022.
DiCarlo, A. L.	Radiation injury after a nuclear detonation: medical consequences and the need for scarce resources allocation	2011	Published before 2022.
Dimitsaki, S.	Benchmarking of Machine Learning classifiers on plasma proteomic for COVID-19 severity prediction through interpretable artificial intelligence	2023	Not related to the topic
Doeleman, T.	Artificial intelligence in digital pathology of cutaneous lymphomas: A review of the current state and future perspectives	2023	Not related to the topic
Dossantos, J.	Eyes on AI: ChatGPT's Transformative Potential Impact on Ophthalmology	2023	Not related to the topic
Eaby-Sandy, B.	Side effects of targeted therapies: rash	2014	Published before 2022.
Ebrahimian, S.	FDA-regulated AI Algorithms: Trends, Strengths, and Gaps of Validation Studies	2022	Not related to the topic
Ellis, M. J.	Ki67 Proliferation Index as a Tool for Chemotherapy Decisions During and After Neoadjuvant Aromatase Inhibitor Treatment of Breast Cancer: Results from the American College of Surgeons Oncology Group Z1031 Trial (Alliance)	2017	Published before 2022.
Escalé-Besa, A.	The Use of Artificial Intelligence for Skin Disease Diagnosis in Primary Care Settings: A Systematic Review	2024	Not related to the topic
Fanni, S. C.	Artificial Intelligence-Based Software with CE Mark for Chest X-ray Interpretation: Opportunities and Challenges	2023	Not related to the topic
Feit, F.	Safety and efficacy of bivalirudin monotherapy in patients with diabetes mellitus and acute coronary syndromes: a report from the ACUITY (Acute Catheterization and Urgent Intervention Triage Strategy) trial	2008	Published before 2022.
Flood, A. B.	Benefits and challenges of in vivo EPR nail biodosimetry in a second tier of medical triage in response to a large radiation event	2023	Not related to the topic
Fox, K. A.	Management of acute coronary syndromes: an update	2004	Published before 2022.
Freeman, K.	Use of artificial intelligence for image analysis in breast cancer screening programmes: systematic review of test accuracy	2021	Published before 2022.
Frosolini, A.	The Role of Large Language Models (LLMs) in Providing Triage for Maxillofacial Trauma Cases: A Preliminary Study	2024	Not related to the topic
Galatsis, P.	Leucine-rich repeat kinase 2 inhibitors: a patent review (2014-2016)	2017	Published before 2022.
Galecio-Castillo, M.	Direct to angiosuite strategy versus standard workflow triage for endovascular therapy: systematic review and meta-analysis	2023	Not related to the topic
Garrido, C.	Heat shock proteins 27 and 70: anti-apoptotic proteins with tumorigenic properties	2006	Published before 2022.
Gershlick, A. H.	The acute management of myocardial infarction	2001	Published before 2022.
Gibler, W. B.	Continuum of Care for Acute Coronary Syndrome: Optimizing Treatment for ST-Elevation Myocardial Infarction and Non-St-Elevation Acute Coronary Syndrome	2018	Published before 2022.
Gilotra, K.	Role of artificial intelligence and machine learning in the diagnosis of cerebrovascular disease	2023	Not related to the topic
Giordano, P.	ChatGPT e il suo utilizzo nel supporto decisionale clinico: una scoping review	2024	Not in the language criteria
Giuffrè, M.	Systematic review: The use of large language models as medical chatbots in digestive diseases	2024	Not related to the topic
Giustino, G.	Safety and Efficacy of Bivalirudin in Patients with Diabetes Mellitus Undergoing Percutaneous Coronary Intervention: From the REPLACE-2, ACUITY and HORIZONS-AMI Trials	2016	Published before 2022.

Table 1. **Excluded studies**

Author	Name	Year	Reason of exclusion
Goh, E.	ChatGPT Influence on Medical Decision-Making, Bias, and Equity: A Randomized Study of Clinicians Evaluating Clinical Vignettes	2023	Full text not written
Goldstein, J.	Determinants for scalable adoption of autonomous AI in the detection of diabetic eye disease in diverse practice types: key best practices learned through collection of real-world data	2023	Not related to the topic
Goto, K.	Predictors of outcomes in medically treated patients with acute coronary syndromes after angiographic triage: an Acute Catheterization And Urgent Intervention Triage Strategy (ACUITY) substudy	2010	Published before 2022.
Goto, K.	Prognostic value of angiographic lesion complexity in patients with acute coronary syndromes undergoing percutaneous coronary intervention (from the acute catheterization and urgent intervention triage strategy trial)	2014	Published before 2022.
Gradíssimo, A.	Molecular tests potentially improving HPV screening and genotyping for cervical cancer prevention	2017	Published before 2022.
Guermazi, A.	How AI May Transform Musculoskeletal Imaging	2024	Not related to the topic
Gulati, S.	Artificial intelligence in luminal endoscopy	2020	Published before 2022.
Gunasekera, K. S.	Development of treatment-decision algorithms for children evaluated for pulmonary tuberculosis: an individual participant data meta-analysis	2023	Not related to the topic
Gunzer, F.	Reproducibility of artificial intelligence models in computed tomography of the head: a quantitative analysis	2022	Not related to the topic
Gurgitano, M.	Interventional Radiology ex-machina: impact of Artificial Intelligence on practice	2021	Published before 2022.
Gutierrez, G.	Examining the role of AI technology in online mental healthcare: opportunities, challenges, and implications, a mixed-methods review	2024	Not related to the topic
Haase, L.	Horse Diagnosis and Triage Accuracy of GPT-4o	2024	Not related to the topic
Haider, S. P.	Admission computed tomography radiomic signatures outperform hematoma volume in predicting baseline clinical severity and functional outcome in the ATACH-2 trial intracerebral hemorrhage population	2021	Published before 2022.
Halaseh, F. F.	ChatGPT's Role in Improving Education Among Patients Seeking Emergency Medical Treatment	2024	Not related to the topic
Hamilton, A.	Artificial Intelligence and Healthcare Simulation: The Shifting Landscape of Medical Education	2024	Not related to the topic
Hamilton, A. J.	Machine learning and artificial intelligence: applications in healthcare epidemiology	2021	Published before 2022.
Hamza, I.	Artificial Intelligence Echocardiography in Resource-Limited Regions: Applications and Challenges	2024	Not related to the topic
Haq, M.	Revolutionizing Acute Stroke Care: A Review of Food and Drug Administration-Approved Software as Medical Devices for Stroke Triage	2024	Not related to the topic
Hayat, J.	The Utility and Limitations of Artificial Intelligence-Powered Chatbots in Healthcare	2024	Not related to the topic
Hickey, M. D.	Effect of a patient-centered hypertension delivery strategy on all-cause mortality: Secondary analysis of SEARCH, a community-randomized trial in rural Kenya and Uganda	2021	Published before 2022.
Hickman, S. E.	Adoption of artificial intelligence in breast imaging: evaluation, ethical constraints and limitations	2021	Published before 2022.
Hickman, S. E.	Machine Learning for Workflow Applications in Screening Mammography: Systematic Review and Meta-Analysis	2022	Published before 2022.
Hirtsiefer, C.	Capabilities of ChatGPT-3.5 as a Urological Triage System	2024	Full text not written
Hogarty D. T.	Current state and future prospects of artificial intelligence in ophthalmology: a review.	2019	Published before 2022.
Hsieh, C.	Using Machine Learning to Predict Response to Image-guided Therapies for Hepatocellular Carcinoma	2023	Not related to the topic
Hsueh, J.	Applications of Artificial Intelligence in Helicopter Emergency Medical Services: A Scoping Review	2024	Not related to the topic
Huang, A. E.	Artificial Intelligence and Pediatric Otolaryngology	2024	Not related to the topic

Table 1. **Excluded studies**

Author	Name	Year	Reason of exclusion
Hunter, O. F.	Science fiction or clinical reality: a review of the applications of artificial intelligence along the continuum of trauma care	2023	Not related to the topic
Ingielewicz, A.	Drinking from the Holy Grail-Does a Perfect Triage System Exist? And Where to Look for It?	2024	Not related to the topic
İsmail Mendi, B.	Artificial Intelligence in the Non-Invasive Detection of Melanoma	2024	Not related to the topic
Ittarat, M.	Personalized Care in Eye Health: Exploring Opportunities, Challenges, and the Road Ahead for Chatbots	2023	Not related to the topic
Ittarat, M.	Personalized Care in Eye Health: Exploring Opportunities, Challenges, and the Road Ahead for Chatbots	2023	Duplicate
Iyer, R.	Detection of Suicide Risk Using Vocal Characteristics: Systematic Review	2022	Not related to the topic
Jennings, L. K.	Antiplatelet and anticoagulant agents: key differences in mechanisms of action, clinical application, and therapeutic benefit in patients with non-ST-segment-elevation acute coronary syndromes	2008	Published before 2022.
Joudar, S. S.	Triage and priority-based healthcare diagnosis using artificial intelligence for autism spectrum disorder and gene contribution: A systematic review	2022	Published before 2022.
Jovin, T. G.	Thrombectomy for anterior circulation stroke beyond 6 h from time last known well (AURORA): a systematic review and individual patient data meta-analysis	2022	Published before 2022.
Kachman, M. M.	How artificial intelligence could transform emergency care	2024	Full text not written
Kalisz, K. R.	Immune Checkpoint Inhibitor Therapy-related Pneumonitis: Patterns and Management	2019	Published before 2022.
Kaluski, E.	Glycoprotein IIb/IIIa inhibitors: questioning indications and treatment algorithms	2007	Not related to the topic
Kang, C.	Artificial intelligence for diagnosing exudative age-related macular degeneration	2024	Not related to the topic
Khalsa, R. K.	Artificial intelligence and cardiac surgery during COVID-19 era	2021	Published before 2022.
Kiburg, K. V.	Telemedicine and delivery of ophthalmic care in rural and remote communities: Drawing from Australian experience	2022	Not related to the topic
Kim, K. H.	[Applications of Artificial Intelligence in Mammography from a Development and Validation Perspective]	2021	Published before 2022.
Kim, Y.	Applications of artificial intelligence in the thorax: a narrative review focusing on thoracic radiology	2021	Not related to the topic
Knebel, D.	Assessment of ChatGPT in the Prehospital Management of Ophthalmological Emergencies - An Analysis of 10 Fictional Case Vignettes	2024	Not related to the topic
Koren, J., 3rd	The Right Tool for the Job: An Overview of Hsp90 Inhibitors	2020	Published before 2022.
Koren, J., 3rd	The Right Tool for the Job: An Overview of Hsp90 Inhibitors	2020	Duplicate
Korobelnik, J. F.	Guidance for anti-VEGF intravitreal injections during the COVID-19 pandemic	2020	Published before 2022.
Krause, A. J.	An update on current treatment strategies for laryngopharyngeal reflux symptoms	2022	Not related to the topic
Krothapalli, N.	Mobile stroke units: Beyond thrombolysis	2024	Not related to the topic
Krusche, M.	Diagnostic accuracy of a large language model in rheumatology: comparison of physician and ChatGPT-4	2024	Not related to the topic
Kumar, D.	Comparison of Bivalirudin versus Bivalirudin plus glycoprotein IIb/IIIa inhibitor versus heparin plus glycoprotein IIb/IIIa inhibitor in patients with acute coronary syndromes having percutaneous intervention for narrowed saphenous vein aorto-coronary...	2010	Published before 2022.
Kumar, H.	A clinical perspective on the expanding role of artificial intelligence in age-related macular degeneration	2022	Not related to the topic
Kunze, K. N.	Editorial Commentary: The Scope of Medical Research Concerning ChatGPT Remains Limited by Lack of Originality	2024	Not related to the topic
Kunze, K. N.	The Large Language Model ChatGPT-4 Exhibits Excellent Triage Capabilities and Diagnostic Performance for Patients Presenting With Various Causes of Knee Pain	2024	Full text not written

Table 1. **Excluded studies**

Author	Name	Year	Reason of exclusion
Kusunose, K.	Radiomics in Echocardiography: Deep Learning and Echocardiographic Analysis	2020	Published before 2022.
Laino, M. E.	Prognostic findings for ICU admission in patients with COVID-19 pneumonia: baseline and follow-up chest CT and the added value of artificial intelligence	2022	Not related to the topic
Lalla, R.	Assessing the validity of the Triage Risk Screening Tool in a third world setting.	2018	Published before 2022.
Lamb, L. R.	Artificial Intelligence (AI) for Screening Mammography, From the AJR Special Series on AI Applications	2022	Not related to the topic
Lång, K.	Artificial intelligence-supported screen reading versus standard double reading in the Mammography Screening with Artificial Intelligence trial (MASAI): a clinical safety analysis of a randomised, controlled, non-inferiority, single-blinded, screening...	2023	Not related to the topic
Lang, M.	Artificial Intelligence in Cardiovascular Imaging: "Unexplainable" Legal and Ethical Challenges?	2022	Not related to the topic
Le, K. D. R.	Applications of natural language processing tools in the surgical journey	2024	Duplicate
Le, K. D. R.	Applications of natural language processing tools in the surgical journey	2024	Not related to the topic
Leung, E. H.	Ocular and Systemic Complications of COVID-19: Impact on Patients and Healthcare	2022	Not related to the topic
Li, Y.	Emergency trauma care during the outbreak of corona virus disease 2019 (COVID-19) in China	2020	Published before 2022.
Lincoff, A. M.	Influence of timing of clopidogrel treatment on the efficacy and safety of bivalirudin in patients with non-ST-segment elevation acute coronary syndromes undergoing percutaneous coronary intervention: an analysis of the ACUITY (Acute Catheterization and...	2008	Published before 2022.
Liu, Z.	Toward Clinical Implementation of Next-Generation Sequencing-Based Genetic Testing in Rare Diseases: Where Are We?	2019	Published before 2022.
Lo Gullo, R.	AI Applications to Breast MRI: Today and Tomorrow	2024	Not related to the topic
Lodise, N. M.	Hypoactive sexual desire disorder in women: treatment options beyond testosterone and approaches to communicating with patients on sexual health	2013	Published before 2022.
Loggers, S. A. I.	Definition of hemodynamic stability in blunt trauma patients: a systematic review and assessment amongst Dutch trauma team members	2017	Published before 2022.
Lopes, R. D.	Advanced age, antithrombotic strategy, and bleeding in non-ST-segment elevation acute coronary syndromes: results from the ACUITY (Acute Catheterization and Urgent Intervention Triage Strategy) trial	2009	Published before 2022.
Luo, W.	The Influence of the Novel Computer-Aided Triage System Based on Artificial Intelligence on Endovascular Therapy in Patients with Large Vascular Occlusions: A Meta-Analysis	2024	Not related to the topic
Lyons, R. J.	Artificial intelligence chatbot performance in triage of ophthalmic conditions	2024	Not related to the topic
Malycha, J.	Artificial intelligence and clinical deterioration	2022	Not related to the topic
Marko, M.	Management and outcome of patients with acute ischemic stroke and tandem carotid occlusion in the ESCAPE-NA1 trial	2022	Not related to the topic
Marques, M.	The Medicine Revolution Through Artificial Intelligence: Ethical Challenges of Machine Learning Algorithms in Decision-Making	2024	Not related to the topic
Mehran, R.	Impact of chronic kidney disease on early (30-day) and late (1-year) outcomes of patients with acute coronary syndromes treated with alternative antithrombotic treatment strategies: an ACUITY (Acute Catheterization and Urgent Intervention Triage...	2009	Published before 2022.
Meral, G.	Comparative analysis of ChatGPT, Gemini and emergency medicine specialist in ESI triage assessment	2024	Full text not written
Meral, G.	Comparative analysis of ChatGPT, Gemini and emergency medicine specialist in ESI triage assessment	2024	Duplicate
Miller, B. S.	Emergency management of adrenal insufficiency in children: advocating for treatment options in outpatient and field settings	2020	Not related to the topic
Milne-Ives, M.	The Effectiveness of Artificial Intelligence Conversational Agents in Health Care: Systematic Review	2020	Not related to the topic

Table 1. **Excluded studies**

Author	Name	Year	Reason of exclusion
Miyata, Y.	Molecular chaperones and regulation of tau quality control: strategies for drug discovery in tauopathies	2011	Published before 2022.
Momenaei, B.	ChatGPT enters the room: what it means for patient counselling, physician education, academics, and disease management	2024	Not related to the topic
Momenaei, B.	ChatGPT enters the room: what it means for patient counselling, physician education, academics, and disease management	2024	Duplicate
Monga, M.	Artificial Intelligence in Endourology: Maximizing the Promise Through Consideration of the Principles of Diffusion of Innovation Theory	2024	Not related to the topic
Moparthi, K. P.	Acute Care Surgery: Navigating Recent Developments, Protocols, and Challenges in the Comprehensive Management of Surgical Emergencies	2024	Not related to the topic
Morgan, M. B.	Applications of Artificial Intelligence in Breast Imaging	2021	Published before 2022.
Moscicki, A. B.	Screening for Anal Cancer in Women	2015	Published before 2022.
Mukherjee, D.	Pharmacotherapy of acute coronary syndrome: the ACUITY trial	2009	Published before 2022.
Mungmunpuntipantip, R.	ChatGPT in Trauma Triage	2024	Full text not written
Murray, N. M.	Artificial intelligence to diagnose ischemic stroke and identify large vessel occlusions: a systematic review	2020	Published before 2022.
Nardell, E.	Turning off the spigot: reducing drug-resistant tuberculosis transmission in resource-limited settings	2010	Published before 2022.
Nathavitharana, R. R.	Reimagining the status quo: How close are we to rapid sputum-free tuberculosis diagnostics for all?	2022	Not related to the topic
Nazif, T. M.	Comparative effectiveness of upstream glycoprotein IIb/IIIa inhibitors in patients with moderate- and high-risk acute coronary syndromes: an Acute Catheterization and Urgent Intervention Triage Strategy (ACUITY) substudy	2014	Published before 2022.
Nazir, T.	Artificial intelligence assisted acute patient journey	2022	Not related to the topic
Ndrepepa, G.	Bivalirudin versus heparin plus a glycoprotein IIb/IIIa inhibitor in patients with non-ST-segment elevation myocardial infarction undergoing percutaneous coronary intervention after clopidogrel pretreatment: pooled analysis from the ACUITY and...	2012	Published before 2022.
Nikolsky, E.	Gastrointestinal bleeding in patients with acute coronary syndromes: incidence, predictors, and clinical implications: analysis from the ACUITY (Acute Catheterization and Urgent Intervention Triage Strategy) trial	2009	Published before 2022.
Nikolsky, E.	Outcomes of patients with prior coronary artery bypass grafting and acute coronary syndromes: analysis from the ACUITY (Acute Catheterization and Urgent Intervention Triage Strategy) trial	2012	Published before 2022.
O Hern, K.	ChatGPT underperforms in triaging appropriate use of Mohs surgery for cutaneous neoplasms	2023	Not related to the topic
Pai, M.	Tuberculosis diagnostics in 2015: landscape, priorities, needs, and prospects	2015	Published before 2022.
Park, J.	Validation of a Natural Language Machine Learning Model for Safety Literature Surveillance	2024	Not related to the topic
Paslı, S.	Assessing the precision of artificial intelligence in ED triage decisions: Insights from a study with ChatGPT	2024	Full text not written
Paslı, S.	Response to: Methodological issues on precision and prediction value of ChatGPT in emergency department triage decisions	2024	Full text not written
Patel, A. V.	Increasing HIV testing engagement through provision of home HIV self-testing kits for patients who decline testing in the emergency department: a pilot randomisation study	2019	Published before 2022.
Peng, H. T.	Artificial intelligence and machine learning for hemorrhagic trauma care	2023	Not related to the topic
Peng, Z.	Development and evaluation of multimodal AI for diagnosis and triage of ophthalmic diseases using ChatGPT and anterior segment images: protocol for a two-stage cross-sectional study	2023	Not related to the topic
Pépin, J. L.	New management pathways for follow-up of CPAP-treated sleep apnoea patients including digital medicine and multimodal telemonitoring	2024	Not related to the topic

Table 1. **Excluded studies**

Author	Name	Year	Reason of exclusion
Pham, J. H.	Large language model triaging of simulated nephrology patient inbox messages	2024	Not related to the topic
Pinto, D. S.	Economic evaluation of bivalirudin with or without glycoprotein IIb/IIIa inhibition versus heparin with routine glycoprotein IIb/IIIa inhibition for early invasive management of acute coronary syndromes	2008	Published before 2022.
Posadas, E. M.	Targeting angiogenesis in renal cell carcinoma	2013	Published before 2022.
Potnis, K. C.	Artificial Intelligence in Breast Cancer Screening: Evaluation of FDA Device Regulation and Future Recommendations	2022	Not related to the topic
Preiksaitis, C.	The Role of Large Language Models in Transforming Emergency Medicine: Scoping Review	2024	Duplicate, included in the review
Pressman, S. M.	Clinical and Surgical Applications of Large Language Models: A Systematic Review	2024	Not related to the topic
Pressman, S. M.	Clinical and Surgical Applications of Large Language Models: A Systematic Review	2024	Duplicate
Ramkumar, P. N.	Editorial Commentary: Large Language Models Like ChatGPT Show Promise, but Clinical Use of Artificial Intelligence Requires Physician Partnership	2024	Not related to the topic
Razzaki, S.	A comparative study of artificial intelligence and human doctors for the purpose of triage and diagnosis	2018	Published before 2022.
Rengers, T. A.	Academic Surgery in the Era of Large Language Models: A Review	2024	Not related to the topic
Rengers, T. A.	Academic Surgery in the Era of Large Language Models: A Review	2024	Duplicate
Ricklin, D.	Manipulating the mediator: modulation of the alternative complement pathway C3 convertase in health, disease and therapy	2012	Published before 2022.
Rietjens, S. J.	Pharmacokinetics and pharmacodynamics of 3,4-methylenedioxymethamphetamine (MDMA): interindividual differences due to polymorphisms and drug-drug interactions	2012	Published before 2022.
Sabaner, M. C.	Opportunities and Challenges of Chatbots in Ophthalmology: A Narrative Review	2024	Not related to the topic
Sabaner, M. C.	Opportunities and Challenges of Chatbots in Ophthalmology: A Narrative Review	2024	Duplicate
Sabour, A.	Methodological issues on precision and prediction value of ChatGPT in emergency department triage decisions	2024	Full text not written
Saenger, J. A.	Delayed diagnosis of a transient ischemic attack caused by ChatGPT	2024	Not related to the topic
Salim, M.	AI-based selection of individuals for supplemental MRI in population-based breast cancer screening: the randomized ScreenTrustMRI trial	2024	Not related to the topic
Sammer, M. B. K.	Ensuring Adequate Development and Appropriate Use of Artificial Intelligence in Pediatric Medical Imaging	2022	Not related to the topic
Santoro, E.	[Information technology and digital health to support health in the time of CoViD-19.]	2020	Published before 2022.
Satyamitra, M.	Challenges and Strategies in the Development of Radiation Biodosimetry Tests for Patient Management	2021	Published before 2022.
Shapiro, J.	New Diagnostic Tools for Pulmonary Embolism Detection	2024	Not related to the topic
Shekhar, A. C.	Use of a large language model (LLM) for ambulance dispatch and triage	2024	Full text not written
Shlobin, N. A.	Artificial Intelligence for Large-Vessel Occlusion Stroke: A Systematic Review	2022	Not related to the topic
Singh, N.	Infarcts in a New Territory: Insights From the ESCAPE-NA1 Trial	2023	Not related to the topic
Smith, K. P.	Image analysis and artificial intelligence in infectious disease diagnostics	2020	Published before 2022.
Snow, K. D.	Trends in emergency department visits for bronchiolitis, 1993-2019	2024	Not related to the topic
Soun, J. E.	Artificial Intelligence and Acute Stroke Imaging	2021	Published before 2022.
Stegeman, I.	Routine laboratory testing to determine if a patient has COVID-19	2020	Published before 2022.
Stewart, M.	Targeting chaperone modifications: Innovative approaches to cancer treatment	2024	Not related to the topic
Stone, G. W.	Acute Catheterization and Urgent Intervention Triage strategy (ACUITY) trial: study design and rationale	2004	Published before 2022.

Table 1. **Excluded studies**

Author	Name	Year	Reason of exclusion
Stone, G. W.	Bivalirudin in patients with acute coronary syndromes undergoing percutaneous coronary intervention: a subgroup analysis from the Acute Catheterization and Urgent Intervention Triage strategy (ACUITY) trial	2007	Published before 2022.
Swartz, H. M.	Overview of the principles and practice of biodosimetry	2014	Published before 2022.
Swartz, H. M.	Scientific and Logistical Considerations When Screening for Radiation Risks by Using Biodosimetry Based on Biological Effects of Radiation Rather than Dose: The Need for Prior Measurements of Homogeneity and Distribution of Dose	2020	Published before 2022.
Syrowatka, A.	Leveraging artificial intelligence for pandemic preparedness and response: a scoping review to identify key use cases	2021	Published before 2022.
Tarone, G.	Keep your heart in shape: molecular chaperone networks for treating heart disease	2014	Published before 2022.
Taylor, C. R.	Artificial Intelligence Applications in Breast Imaging: Current Status and Future Directions	2023	Not related to the topic
Thomas, L. B.	Artificial Intelligence: Review of Current and Future Applications in Medicine	2021	Published before 2022.
Thomassin-Naggara, I.	[French breast cancer screening: What's the place of artificial intelligence?]	2022	Not related to the topic
Ting, D. S. W.	Artificial intelligence and deep learning in ophthalmology	2019	Not related to the topic
Tortum, F.	Exploring the potential of artificial intelligence models for triage in the emergency department	2024	Full text not written
Toy, J.	Use of artificial intelligence to support prehospital traumatic injury care: A scoping review	2024	Not related to the topic
Trzeciak, A.	Biomarkers and Associated Immune Mechanisms for Early Detection and Therapeutic Management of Sepsis	2020	Not related to the topic
Tse, E.	The diagnosis and management of NK/T-cell lymphomas	2017	Published before 2022.
Vaduganathan, M.	Evaluation of Ischemic and Bleeding Risks Associated With 2 Parenteral Antiplatelet Strategies Comparing Cangrelor with Glycoprotein IIb/IIIa Inhibitors: An Exploratory Analysis from the CHAMPION Trials	2017	Published before 2022.
Vandevenne, M. M.	Artificial intelligence for detecting keratoconus	2023	Not related to the topic
Vedantham, S.	Artificial Intelligence in Breast X-Ray Imaging	2023	Not related to the topic
Verheugt, F. W.	Incidence, prognostic impact, and influence of antithrombotic therapy on access and nonaccess site bleeding in percutaneous coronary intervention	2011	Published before 2022.
Vinay, R.	Ethics of ICU triage during COVID-19	2021	Published before 2022.
Vinny, P. W.	Critical Appraisal of a Machine Learning Paper: A Guide for the Neurologist	2021	Published before 2022.
Walsh, L.	A Systematic Review of Current Teleophthalmology Services in New Zealand Compared to the Four Comparable Countries of the United Kingdom, Australia, United States of America (USA) and Canada	2021	Published before 2022.
Wang, C.	Diagnostic Test Accuracy of Deep Learning Prediction Models on COVID-19 Severity: Systematic Review and Meta-Analysis	2023	Not related to the topic
Wang, X.	ChatGPT: promise and challenges for deployment in low- and middle-income countries	2023	Not related to the topic
Ward, M.	A Quantitative Assessment of ChatGPT as a Neurosurgical Triaging Tool	2024	Not related to the topic
Ward, M.	Analysis of ChatGPT in the Triage of Common Spinal Complaints	2024	Not related to the topic
Warsinske, H.	Host-response-based gene signatures for tuberculosis diagnosis: A systematic comparison of 16 signatures	2019	Published before 2022.
Weisberg, E. M.	The first use of artificial intelligence (AI) in the ER: triage not diagnosis	2020	Published before 2022.
White, H. D.	Safety and efficacy of bivalirudin with and without glycoprotein IIb/IIIa inhibitors in patients with acute coronary syndromes undergoing percutaneous coronary intervention 1-year results from the ACUITY (Acute Catheterization and Urgent Intervention...	2008	Published before 2022.
Wójcik, S.	Beyond ChatGPT: What does GPT-4 add to healthcare? The dawn of a new era	2023	Not related to the topic
Woodfin, M. W.	ChatGPT Effectively Triages Real-World Neoplasms Using Mohs Appropriate Use Criteria	2024	Not related to the topic

Table 1. **Excluded studies**

Author	Name	Year	Reason of exclusion
Xavier, D.	Artificial intelligence for triaging of breast cancer screening mammograms and workload reduction: A meta-analysis of a deep learning software	2024	Not related to the topic
Xie, Y.	Reviewing Hit Discovery Literature for Difficult Targets: Glutathione Transferase Omega-1 as an Example	2018	Published before 2022.
Xie, Y.	Reviewing Hit Discovery Literature for Difficult Targets: Glutathione Transferase Omega-1 as an Example	2018	Duplicate
Xu, R.	Generative artificial intelligence in healthcare from the perspective of digital media: Applications, opportunities and challenges	2024	Not related to the topic
Yamasaki, S.	Reprogramming mRNA translation during stress	2008	Published before 2022.
Yang, Z.	Understanding natural language: Potential application of large language models to ophthalmology	2024	Not related to the topic
Yi, X.	Action plan for hit identification (APHID): KAT6A as a case study	2020	Published before 2022.
Yuba, M.	Systematic analysis of the test design and performance of AI/ML-based medical devices approved for triage/detection/diagnosis in the USA and Japan	2022	Not related to the topic
Zaboli, A.	Human intelligence versus Chat-GPT: who performs better in correctly classifying patients in triage?	2024	Full text not written
Zandi, R.	Exploring Diagnostic Precision and Triage Proficiency: A Comparative Study of GPT-4 and Bard in Addressing Common Ophthalmic Complaints	2024	Not related to the topic
Zarella, M. D.	Artificial intelligence and digital pathology: clinical promise and deployment considerations	2023	Not related to the topic
Zhang, Z.	Associations of immunological features with COVID-19 severity: a systematic review and meta-analysis	2021	Published before 2022.
Susanty, S.	Questionnaire-free machine-learning method to predict depressive symptoms among community-dwelling older adults	2022	Not related to the topic
Al-Zaiti, SS.	Machine learning for ECG diagnosis and risk stratification of occlusion myocardial infarction	2023	Not related to the topic
Charan, GS	Impact of Analytics Applying Artificial Intelligence and Machine Learning on Enhancing Intensive Care Unit: A Narrative Review	2023	Not related to the topic
van Maurik, IS	Targeted Development and Validation of Clinical Prediction Models in Secondary Care Settings: Opportunities and Challenges for Electronic Health Record Data	2024	Not related to the topic
Switzer, DF	Ethics Crisis Standards of Care Simulation	2024	Not related to the topic
Zaboli, A.	Human intelligence versus Chat-GPT: who performs better in correctly classifying patients in triage?	2024	Full text not written
Yang, J	Development and evaluation of an artificial intelligence-based workflow for the prioritization of patient portal messages	2024	Not related to the topic
Duncan, SF	Radiograph accelerated detection and identification of cancer in the lung (RADICAL): a mixed methods study to assess the clinical effectiveness and acceptability of Qure.ai artificial intelligence software to prioritise chest X-ray (CXR) interpretation	2024	Not related to the topic
Chenard, SW	ChatGPT provides safe responses to post-operative concerns following total joint arthroplasty	2024	Not related to the topic
Arends, BKO	Barriers, facilitators and strategies for the implementation of artificial intelligence-based electrocardiogram interpretation: A mixed-methods study	2025	Not related to the topic
Zaboli, A	Chat-GPT in triage: Still far from surpassing human expertise - An observational study	2025	Full text not written
Mani, Z	AI frontiers in emergency care: the next evolution of nursing interventions.	2024	Duplicate

Author Guidelines

AIM AND SCOPE

Croatian Nursing Journal is a peer-reviewed nursing journal that publishes original articles that advance and improve nursing science and practice and that serve the purpose of transfer of original and valuable information to journal readers. Croatian Nursing Journal is published biannualy in the English language. Authors are invited to submit original papers in the form of research findings, systematic and methodological review and literature review related to nursing.

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Manuscripts must be accompanied by a cover letter signed by all authors including a statement that the manuscript has not been published or submitted for publishing elsewhere, a statement that the manuscript has been read and approved by all the authors, and a statement about any financial or other conflict of interest. A statement of copyright transfer to the journal must accompany the manuscript.

PREPARATION OF MANUSCRIPT

The manuscript must be prepared using Microsoft Office Word, in a 12-point font, double spacing, in either Times New Roman, Arial or Calibri.

Double spacing should be used throughout, including the title page, abstract, text, acknowledgments, references, individual tables, and legends. Pages should be numbered consecutively, beginning with the title page. The page number is to be written in the lower right-hand corner of each page. Manuscript must not exceed 7500 words including the abstract, text, references, tables and figures. The text should be accompanied by the title page as a separate page.

The text of the manuscript should be divided into sections: Abstract and Key words, Introduction, Methods, Results, Discussion, Acknowledgment, References.

Title page

The title page should include:

- the title of the article (which should be concise but informative)
- full name of the author(s), with academic degree(s) and institutional affiliation
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Abstract and Key Words

The first page should contain the title and the abstract (summary) both in English and Croatian, of no more than 250 words each.

The abstract should state the purposes of the study or investigation, basic procedures, main findings, and principal conclusions. It should emphasize new and important aspects of the study or observations. Below the abstract, the authors should provide 3 to 8 key words or short phrases that will assist in cross-indexing the article and may be published with the abstract. Terms from the Medical Subject Headings (MeSH) list of Index Medicus should be used for key words.

Introduction/Background

State the purpose of the article and summarize the rationale for the study or investigation. Give a critical review of relevant literature.

Methods

Describe the selection and identify all important characteristics of the observational or experimental participants. Specify carefully what the descriptors mean and explain how the data were collected. Identify the methods, apparatus with the manufacturer's name and address in parentheses, and procedures in sufficient detail to allow other workers to reproduce the results. Provide references to established methods and statistical methods used. Describe new or substantially modified methods, give reasons for using them, and evaluate their limitations. Identify precisely all drugs and chemicals used. Use only generic names of drugs. All measurements should be expressed in SI units.

Ethics

Papers dealing with experiments on human subjects should clearly indicate that the procedures followed were in accordance with the ethical standards of the institutional or regional responsible committee on

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Statistics

Describe statistical methods with enough detail to enable a knowledgeable reader with access to the original data to verify the reported results. Whenever possible, quantify findings and present them with appropriate indicators of measurement error or uncertainty. Specify the statistical software package(s) and versions used.

Results

Present your results in logical sequence in the text, tables, and illustrations. Do not repeat in the text all the data in the tables or illustrations; emphasize or summarize main findings.

Discussion

Emphasize the new and important aspects of the study and the conclusions that follow from them. Do not repeat in detail data or other material given in the Introduction or the Results section. Include in the Discussion section the implications of the findings and their limitations, including implications for future research, but avoid unqualified statements and conclusions not completely supported by the data. Relate the observations from your study to other relevant studies. State new hypotheses when warranted, but clearly label them as such.

Conclusion

Emphasize the new and important aspects of the study and the conclusions that follow from them. Do not repeat in detail data or other material given in the Introduction or the Results section. Identify recommendations for practice/research/education or management as appropriate, and consistent with the limitations.

Tables

Please ensure to embed all tables and figures directly into the text of your manuscript. Do not submit tables as photographs. Number tables consecutively in the order of their first citation in the text and supply a brief title for each. Give each column a short heading. Each table should be self-explanatory. Legend or key should be placed in footnotes below the table.

Figures

Figures and illustrations should be professionally drawn and photographed. Make sure that letters, numbers, and symbols should be legible even when reduced in size for publication. Figures should be numbered consecutively according to the order in which they have been first cited in the text.

The preferred formats are JPEG and TIFF, although any format in general use that is not application-specific is acceptable. Make sure that minimum resolution should be 300 DPI.

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Abbreviations

Use only standard abbreviations. The full term for which an abbreviation stands should precede its first use in the text unless it is a standard unit of measurement.

Acknowledgments

List all contributors who do not meet the criteria for authorship, such as a person who provided purely technical help, writing assistance, or a department chair who provided only general support. Financial and material support should also be acknowledged.

References

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