

e-ISSN 2791-7835



LOKMAN HEKİM HEALTH SCIENCES

Volume 6 Issue 3 Year 2026

www.lokmanhekimhs.com



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AIM&SCOPE

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- The journal is published 4 issues in a year.

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Editorial comment: Editorial comments provide a brief critical commentary by an invited experienced author in the topic of a research article previously published in the journal. The word count is limited to 1200 and 10 references may be included.

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In systematic reviews, a direct question should be addressed. Data sources, study eligibility criteria, participants, interventions, and statistical analysis should be defined in detail. The main text of a systematic review should contain Introduction, Methods, Results, Discussion, and Conclusion subheadings.

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Authors are required to prepare manuscripts in accordance with the international guidelines* below

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Non-Randomized Trial**	TREND (Transparent Reporting of Evaluations with Non-randomised Designs) (https://www.cdc.gov/trendstatement/index.html)
Trial Protocol	SPIRIT (Standard Protocol Items Recommendations for Interventional Trials)
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Systematic Reviews and Meta-Analyses	PRISMA (the Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
Systematic Reviews and Meta-Analyses Protocol	PRISMA-P (the Preferred Reporting Items for Systematic Reviews and Meta-Analyses - Protocol)
Experimental Animal Studies	ARRIVE (the Animal Research: Reporting of In Vivo Experiments)
Diagnostic Accuracy Studies	STARD (the Standards for Reporting Diagnostic Accuracy)
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	COREQ (COnsolidated criteria for Reporting Qualitative research: interviews and focus groups)
Methodological Studies (Translating and Adapting Tests)	ITC (International Test Commission) Guidelines for Translating and Adapting Tests (https://www.intestcom.org/)
Methodological Studies (Developing Tests)	COSMIN (COnsensus based Standarts for the selection of Health Measurement Instruments- Study Design for Patient-reported outcome measurement instruments)
Case Report	CARE (Case Reporting)

*Enhancing the QUALity and Transparency Of Health Research (equator network) (<https://www.equator-network.org/>)

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Type of manuscript	Word limit	Abstract word limit	Reference limit	Table or figure limit
Editorial comments	1200	No abstract, keywords	10	No tables, figures, images.
Original article	3000–3500	250 (Structured)	30	6
Brief report	1500	150	15	1 table and 3 figures
Narrative review	4000	250	40	6
Systematic review	4000	250 (Structured)	Depends on review frame (60 maximum)	6
Case report	1200	150 (Structured)	10	1 table, 2 figures or images
Letter to the editor	500	No abstract, keywords	5	No tables, figures, images
History of medicine	1500	250	depends on review frame (40 maximum)	6

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Journal article: Wu CC, Econs MJ, DiMeglio LA, Insogna KL, Levine MA, Orchard PJ, et al. Diagnosis and management of osteopetrosis: Consensus guidelines from the Osteo-petrosis Working Group. *J Clin Endocrinol Metab* 2017;102(9):3111–23.

Armstrong N, Ryder S, Forbes C, Ross J, Quek RGW. A systematic review of the international prevalence of BRCA mutation in breast cancer. *Cecconi M, Evans L, Levy M, Rhodes A. Sepsis and septic shock. Lancet* 2018;392(10141):7587.

Aslan MH, Vural M. Gram Negative Bacteria Isolated from Blood Cultures and Their Antibiotic Susceptibility. *Trends Surg Sci* 2025;4(1):11-17. [In Turkish]

Epub ahead-of-print article: Huyut MA. Kidney Injury Molecule-1 Is Associated with Contrast-Induced Nephropathy in Elderly Patients with Non-STEMI. *Arq Bras Cardiol*. 2021 Mar 29;S0066-782X2021005005201. Portuguese, English. doi: 10.36660/abc.20200172. Epub ahead of print. PMID: 33787767.

Manuscript published in electronic format: T.C. Ministry of Health, General Directorate of Public Health. COVID-19 (SARS-CoV2 Infection) Guide (Science Board Study) March 25, 2020. www.hsgm.saglik.gov.tr

Book section: Suh KN, Keystone JS. Malaria and babesiosis. *Gorbach SL, Barlett JG, Blacklow NR, editors. Infectious Diseases. Philadelphia: Lippincott Williams; 2004.p.2290-308.*

Conference proceedings: Bengissson S. Sothemin BG. Enforcement of data protection, privacy and security in medical informatics. In: Lun KC, Degoulet P, Piemme TE, Rienhoff O, editors. *MEDINFO 92. Proceedings of the 7th World Congress on Medical Informatics; 1992 Sept 6-10; Geneva, Switzerland. Amsterdam: North-Holland; 1992. pp.1561-5.*

Scientific or technical report: Cusick M, Chew EY, Hoogwerf B, Agrón E, Wu L, Lindley A, et al. Early Treatment Diabetic Retinopathy Study Research Group. Risk factors for renal replacement therapy in the Early Treatment Diabetic Retinopathy Study (ETDRS), Early Treatment Diabetic Retinopathy Study Kidney Int: 2004. Report No: 26.

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The Determinants of Wound Care Clinic Utilization: An Empirical Analysis of Patient Admission Reasons

 Songül Güngör¹,  Ulviye Özcan Yüce¹,  Havva Doğan Kırtıloğlu²

¹Department of Nursing, Osmaniye Korkut Ata University Faculty of Health Sciences, Osmaniye, Türkiye

²Directorate of Healthcare Services Osmaniye State Hospital, Osmaniye, Türkiye

Abstract

Introduction: The aim of the study was to identify the reasons why patients seek care at a wound care clinic, the most common wound types encountered, previous treatment experiences, and patient perceptions and expectations regarding care.

Methods: This cross-sectional descriptive study was conducted between January and March 2025. Data were collected from the patients who applied to the Wound Care Clinic, through face-to-face interviews using a structured questionnaire.

Results: The study included 391 patients. The main reasons for admission were pain, signs of infection, and the need for regular wound care. Surgical wounds, diabetic foot ulcers, and pressure ulcers were the most frequently treated wound types. Although most patients had previously undergone treatment, only a small percentage reported complete healing, indicating persistent challenges in wound management. Nurses were identified as the primary providers of wound care, and the majority of participants stated they had received information about their condition.

Discussion and Conclusion: The findings highlight persistent challenges in wound management and emphasize the need for nurse-led patient education, early identification, and proactive management of chronic wounds. Integrating evidence-informed complementary approaches and strengthening referral pathways may enhance care quality, promote holistic patient-centered care, and improve overall outcomes.

Keywords: Chronic wounds; Nursing; Patient admission; Wound care; Wound types

Wound care is a critical healthcare service that directly affects individuals' health status and, if not properly managed, can lead to serious complications. Acute and chronic wounds may significantly reduce patients' quality of life, resulting in problems such as increased risk of infection, prolonged healing periods, and psychosocial impacts. Although such wounds can be treated with appropriate care and treatment, mismanagement of the

process may lead to permanent health problems.^[1] Wound care clinics play a critical role in monitoring the wound healing processes, providing necessary treatment and care, and supporting patients in gaining knowledge about their health conditions. The services offered in these clinics aim not only to promote physical recovery but also to preserve patients' quality of life, thereby establishing a patient-centered approach to wound management.^[2]

Cite this article as: Güngör S, Yüce ÜÖ, Kırtıloğlu HD. The Determinants of Wound Care Clinic Utilization: An Empirical Analysis of Patient Admission Reasons. Lokman Hekim Health Sci 2026;6(3):383–390.

Correspondence: Songül Güngör. Osmaniye Korkut Ata Üniversitesi Sağlık Bilimleri Fakültesi, Hemşirelik Anabilim Dalı, Osmaniye, Türkiye

E-mail: songulgungor@osmaniye.edu.tr **Submitted:** 09.05.2025 **Revised:** 09.11.2025 **Accepted:** 15.11.2025 **Available Online:** 06.08.2026



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Identifying the reasons for patients' admission to wound care clinics, their treatment processes, and the extent to which they are informed about their care plays a critical role in enhancing nursing practice and increasing patient satisfaction.^[3,4] Factors such as patients' treatment experiences and the reasons for admission based on wound types can serve as a guide for improving both individualized care plans and overall healthcare services.^[5] Adopting a patient-centered approach in wound care services may foster patients' active participation in the treatment process, thereby accelerating recovery and increasing the effectiveness of healthcare delivery.^[6] Furthermore, informing and guiding patients throughout this process can positively influence their adherence to treatment and improve long-term health outcomes.^[5]

The accurate and effective management of wound care plays a critical role in accelerating the healing process and preventing complications.^[7] This study aims to contribute to the improvement of nursing practice and healthcare services by analyzing patients' reasons for seeking care at a wound care clinic, the most frequently encountered wound types, and their experiences throughout the wound care process. The findings of the study are expected to strengthen the patient-centered care approach and facilitate the development of a more effective and efficient strategy in wound care management.

Although patient-centered care, communication, and access barriers in chronic wound management have been widely discussed, empirical evidence remains limited regarding why patients utilize wound care clinics, how admission patterns relate to wound types, and how prior treatment experiences shape clinic use.^[8] Recent studies underscore the adverse outcomes of delays in care-seeking and access challenges, yet few investigations quantitatively align these determinants with clinic admission reasons and utilisation dynamics.^[9] This study addresses this gap by jointly analyzing patients' reasons for clinic attendance, the most frequent wound types, and their care experiences, thereby informing evidence-based, patient-centered nursing strategies.

Materials and Methods

Study Place and Design

This study is designed as a cross-sectional and descriptive research. This report followed the Strengthening the Reporting of Observational Studies in Epidemiology recommendations for cohort studies.^[10] The study population consisted of patients aged 18 years or older

who had any type of wound (acute wound, surgical wound, diabetic foot ulcer, pressure ulcer, venous ulcer, etc.) persisting for at least 1 week. In cases where patients had limited physical or cognitive capacity, the data collection process was supported by a caregiver after obtaining informed consent. Data were collected using a structured questionnaire developed by the researchers based on a review of the literature and expert opinions. The questionnaire included sections on sociodemographic characteristics, reasons for admission, and wound care-related information and contained both open- and closed-ended questions. The questionnaire was administered in the clinic through face-to-face interviews conducted by trained researchers in an appropriate setting.

Research Questions

1. What are the most common wound types for which patients seek care at the wound care clinic?
2. Did patients undergo any treatment before their admission to the wound care clinic, and what were the outcomes of those treatments?
3. Have patients received information regarding the wound care process?
4. From whom do patients primarily receive wound care (self-care, family support, professional healthcare providers, etc.)?
5. What are patients' suggestions and expectations regarding the wound care process?

Sample Size Calculation

The sample size for the study was determined based on prevalence (proportion) estimation. The following criteria were used in the calculation:

- Confidence level: 95% ($Z=1.96$)
- Prevalence (p): As the prevalence rate was unknown, $p=0.5$ was adopted as the most conservative estimate
- Margin of error (d) was assumed to be 5% ($d=0.05$). Based on these criteria, the required minimum sample size was calculated as 385. A total of 391 patients who met the inclusion criteria participated in the study.

Inclusion Criteria

- Being 18 years of age or older
- Having any type of wound (acute wound, surgical wound, diabetic foot ulcer, pressure ulcer, venous ulcer, etc.) for at least 1 week
- Having applied to the Wound Care Clinic

- Having no barriers to communication (no speech or comprehension difficulties)
- Possessing the physical and mental capacity to actively participate in the research process; for patients with limited capacity, participation in the data collection process was supported through a caregiver after obtaining informed consent.

Data Collection Method

In this study, data were collected between January 2025 and March 2025 through face-to-face interviews using a structured descriptive questionnaire developed by the researchers based on a review of the literature and expert opinions. The questionnaire included sections on sociodemographic characteristics, reasons for admission, and wound care-related information and contained both open- and closed-ended questions. Individual interviews were conducted with participants who agreed to take part in the study, and each interview lasted approximately 10–15 minutes. For individuals with limited physical or cognitive capacity, data collection was supported by their relatives after obtaining informed consent.

Data Collection Instruments

The data collection form developed for patients admitted to the Wound Care Clinic consists of three main sections:

1. Demographic information: This section includes data on participants' age, gender, educational status, occupation, marital status, and the presence of chronic diseases
2. Reasons for admission: This section examines patients' reasons for seeking care at the wound care clinic, type of wound, wound duration, previous treatment history, and treatment outcomes
3. Information related to wound care: This section assesses whether patients received information about wound care, who provided the care, frequency of clinic admissions, and patients' opinions regarding the wound care process.

The questionnaire was developed based on a review of the literature and expert opinions and was structured to include both open-ended and closed-ended questions. Content validity was ensured through expert evaluation, and a pilot study was conducted with 10 patients; the results of this pilot were not included in the main analysis. The survey was administered by researchers through face-to-face interviews.

Ethical Approval and Participant Consent

Necessary approvals were obtained from the relevant institution and the ethics committee to conduct this study. Informed consent was obtained from individuals participating in the study after providing detailed information about the study's purpose, procedures, and their rights to voluntary participation. For individuals with limited physical or mental capacity, information was collected through their relatives with the patients' consent, ensuring strict adherence to confidentiality and ethical principles throughout the process. Participants were informed that they had the right to withdraw from the study at any time. The research was approved by Osmaniye Korkut Ata University Research Ethics Committee (November 11, 2024-E.205329). This study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Data Analysis

The collected data were analyzed using IBM Statistical Package for the Social Sciences Statistics software (Version 23.0, IBM Corp., Armonk, NY, USA). The analyses were performed as follows:

- Descriptive statistics (frequency, percentage, mean, and standard deviation) were calculated
- Open-ended questions were evaluated using thematic analysis.

Results

The study included 391 patients. The sociodemographic and health-related characteristics of the study participants are given in Table 1. The mean age was 54.93 years (standard deviation=16.87; range=18–92). More than half of the participants were female (54.0%), while 46.0% were male. The majority were married (67.8%), and 32.2% were single. Educational attainment varied, with 12.8% being illiterate, 39.9% having completed primary school, 24.8% secondary school, 14.1% high school, and 8.4% university. In terms of occupational status, 41.9% were unemployed, 26.9% retired, 13.8% workers, 9.0% civil servants, and 8.4% self-employed. A total of 58.8% reported having at least one chronic condition, with diabetes (37.3%) and hypertension (34.3%) being the most prevalent, followed by asthma (18.2%) and heart disease (12.3%).

The clinical characteristics related to wound care among participants are summarized in Table 2. The most common reasons for admission to the wound care clinic were pain (37.9%), signs of infection (30.6%), and the need for regular wound care (29.7%). Other reasons included monitoring

Table 1. Descriptive characteristics of the participants (n=391)

Characteristics	n	%
Age (min, max)	(18, 92)	
Mean±standard deviation	54.93±16.87	
Gender		
Female	211	54.0
Male	180	46.0
Marital status		
Married	265	67.8
Single	126	32.2
Education level		
Illiterate	50	12.8
Primary school	156	39.9
Secondary school	97	24.8
High school	55	14.1
University	33	8.4
Occupation		
Unemployed	164	41.9
Retired	105	26.9
Worker	54	13.8
Civil servant	35	9.0
Self-employed	33	8.4
Presence of chronic disease		
Yes	230	58.8
No	161	41.2
Types of chronic diseases		
Diabetes	146	37.3
Hypertension	134	34.3
Asthma	71	18.2
Heart disease	48	12.3

%. Percentage.

the wound healing process (21.2%) and preventing wound progression (12.0%). Surgical wounds (43.2%) were the most frequently reported wound type, followed by diabetic foot ulcers (19.4%), pressure ulcers (14.8%), traumatic wounds (12.3%), and burns (10.2%). Regarding wound duration, 27.6% had wounds lasting <1 week, 43.2% between 1 week and 1 month, 15.9% between 1 and 3 months, 6.4% between 3 and 6 months, and 6.9% 6 months or longer. While 77.2% had previously received wound treatment, complete healing was reported in only 6.9% of cases, with the majority indicating partial healing (60.1%). Nurses (66.0%) were the primary providers of wound care, followed by patients themselves (25.0%), physicians (21.0%), and family members (18.0%). In addition, 75.7% of participants reported having received information about wound care. In terms of

Table 2. Wound-related characteristics of the participants

Characteristics	n	%
Reason for admission to wound clinic		
Pain	148	37.9
Signs of infection	120	30.6
Regular wound care	116	29.7
Monitoring wound healing process	83	21.2
Preventing wound progression	47	12.0
Type of wound		
Surgical wound	169	43.2
Diabetic foot ulcer	76	19.4
Pressure ulcer	58	14.8
Traumatic wound	48	12.3
Burn	40	10.2
Duration of wound		
1 week	108	27.6
1 week–1 month	169	43.2
1–3 months	62	15.9
3–6 months	25	6.4
6 months or more	27	6.9
Received wound treatment		
Yes	302	77.2
No	89	22.8
Treatment outcome		
Healed	27	6.9
Partially healed	235	60.1
Not healed	40	10.2
Primary provider of wound care		
Nurse	260	66.0
Self	98	25.0
Physician	83	21.0
Family member	71	18.0
Received information about wound care		
Yes	296	75.7
No	95	25.3
Frequency of admission		
First-time admission	151	38.6
Weekly	188	48.1
Monthly	52	13.3
Purpose		
To accelerate wound healing	270	69.0
Follow-up	169	43.0
To obtain information	52	13.0
To prevent complications	18	5.0

%. Percentage.

Table 3. Participants’ opinions and suggestions regarding the wound care process

*Opinions and suggestions	n	%
We are satisfied with the wound care services	199	51.0
New wound care methods could be used	102	26.0
Nurses should recommend herbal oils for wound care	98	25.0
Wound care brochures should be provided	53	14.0
I am unable to perform wound dressing on my own	41	10.0
More effective care should be provided for diabetic wounds	18	5.0
Natural products that reduce post-operative scars should be discussed	9	2.0

*: Participants could select more than one option.

admission frequency, 38.6% were 1st-time admissions, 48.1% attended weekly, and 13.3% monthly. The most common purposes for attending the clinic were to accelerate wound healing (69.0%), for follow-up (43.0%), to obtain information (13.0%), and to prevent complications (5.0%).

Perspectives on wound care services are presented in Table 3. More than half of the participants (51.0%) expressed satisfaction with the services provided. Suggestions included the implementation of new wound care methods (26.0%) and the recommendation of herbal oils by nurses (25.0%). Furthermore, 14.0% highlighted the need for brochures to enhance patient education, and 10.0% reported difficulties in performing wound dressing independently. A smaller proportion emphasized the necessity of more effective care for diabetic wounds (5.0%) and expressed interest in natural products aimed at reducing post-operative scars (2.0%).

Discussion

The wound care process is a comprehensive area of care that not only promotes physical healing but also affects individuals’ quality of life, psychological well-being, and social functioning.^[11] Therefore, nurses are responsible for accurately assessing and prioritizing patients’ needs in wound management and delivering a holistic approach to care.^[12] The study revealed that the primary needs of individuals seeking care at the wound clinic are largely centered around pain management, infection control, and regular wound care practices.

The study revealed that pain was the most frequently reported complaint among patients seeking care at the wound clinic. Similarly, Tegegne et al.^[13] reported that patients experienced moderate to severe pain related to their wounds. Consistent with these findings, the literature

indicates that wound-related pain can limit individuals’ daily activities and may trigger problems such as insomnia, anxiety, and depression.^[14] In this context, it is essential for wound care nurses to assume an active role not only in dressing and wound management but also in pain control.^[15] The prominence of pain as a primary reason for wound care admission highlights the need for regular pain assessments during the care process, the use of appropriate pharmacological and non-pharmacological interventions, and the inclusion of pain management information in patient education.^[16] The present findings are consistent with the literature, emphasizing that pain remains a critical issue in the wound healing process.

A considerable proportion of patients presented with signs of infection, and the literature confirms that infected wounds delay healing, extend hospital stays, and impair patient comfort.^[14] In this context, infection control should be considered a primary and indispensable component of nursing practices in wound care. Since the development of infection not only affects the local condition of the wound but also increases the risk of systemic complications, nurses are required to conduct regular and comprehensive assessments of both the wound site and the patient’s overall condition.^[17] Furthermore, early diagnosis and intervention in wound infections play a critical role in reducing morbidity and mortality rates.^[18] The implementation of aseptic dressing techniques in accordance with wound care protocols, accurate identification of infected areas, and timely communication with the clinical team in the event of complications are essential for ensuring high-quality care.^[18] In addition, one of the key responsibilities of nurses is to promote patients’ active participation in wound care by educating them about signs of infection and raising their awareness.^[19]

Data from this study revealed a striking finding: Only 6.9% of patients who had received prior treatment reported complete healing. This finding likely reflects delayed presentation, non-standard care in primary settings, and fragmented referral pathways, further complicated by comorbidity burden (e.g., diabetes, peripheral vascular disease).^[20] Consistent with recent evidence, delays in early lower limb assessment and onward referral for specialist wound care represent key barriers that can prolong healing and increase healthcare resource use.^[21] Addressing these system-level gaps through early assessment, timely referral, and nurse-led structured education may reduce delays in receiving appropriate therapy and improve outcomes.^[3,20]

An analysis of the study data indicates that receiving regular wound care was a major reason for patients' admission to the wound clinic. Notably, several participants reported being unable to perform wound dressing independently, underscoring the need for professional support during the healing process and revealing the limitations of home-based care in certain cases. Similarly, Groenen et al.^[22] found that many patients struggled to manage wound care at home. Taken together, these findings emphasize the importance of structured home-care programs and regular professional follow-up.^[20]

This study found that surgical wounds were the most common reason for patients' admission to the wound care clinic. Wounds resulting from planned or emergency surgical interventions are among the leading causes of admission to wound care clinics.^[22] Considering that approximately 266 million surgical procedures are performed worldwide each year,^[23] this finding is not unexpected. The study highlights the burden that surgical wounds place on healthcare systems and underscores the need for professional care in their management, including protocolized post-surgical wound follow-up.

The study found that diabetic foot ulcers ranked second among the reasons for admission to wound care clinics based on wound type. This underlines the need for early assessment and time-bound referral for diabetic foot ulcers. Wounds that develop in diabetic patients are particularly difficult to heal and prone to complications due to peripheral neuropathy and vascular disorders. The healing process of diabetic foot ulcers is prolonged, associated with high costs, and has a substantial negative impact on quality of life.^[24] This finding indicates that this wound type constitutes a significant patient group in wound care clinics.

Pressure ulcers were identified as the third most common wound type in this study. Frequently observed in elderly and immobile patients, pressure ulcers are difficult to heal, carry a high risk of infection, and directly affect the quality of patient care.^[25] As preventable complications, pressure ulcers can largely be avoided through appropriate positioning, skin care, and timely preventive measures.^[26] The prevalence reported in this study suggests that pressure ulcers remain a significant issue and highlights the need to strengthen preventive care practices. This study offers valuable insights for identifying priority patient groups in wound care services, organizing targeted educational programs, and developing care protocols. The prevalence highlights

the need to strengthen preventive bundles (positioning, skin care, timely off-loading).

The effectiveness of wound care can vary significantly depending on who performs the care and how it is administered.^[27] In a study by Kapp and Santamaria, the majority of patients reported performing wound cleansing, removing dressings, and applying new dressings themselves.^[28] In the present study, it was found that wound care was predominantly provided by nurses; however, some patients performed their own dressing changes or received assistance from family members. This situation, however, must be evaluated based on wound type. While home-based care may be appropriate and practical for low-risk wounds, professional care should be preferred for high-risk cases such as those involving infection-prone wounds, diabetic foot ulcers, pressure ulcers, and certain surgical wounds, to reduce the risk of complications.^[29] Therefore, the assignment of wound care responsibilities should be planned according to the wound type and associated risk factors. Therefore, wound-care responsibilities should be risk-stratified by wound type and severity.

The findings of this study indicate that patients were informed about the wound care process. However, whether information alone is sufficient to improve wound care outcomes remains a matter of debate. Providing information is an important initial step toward increasing patient engagement in the wound care process, a critical concern is whether patients correctly understand and effectively implement the information provided.^[30] The literature highlights that the effectiveness of patient education in wound care is influenced by various factors, including patients' health literacy, motivation, and access to care support.^[19] Indeed, patients who receive information about wound care may still encounter difficulties when performing home-based wound care.^[22] Beyond verbal/written information, teach-back and hands-on training are needed to ensure correct application at home.^[2]

In this study, although the majority of patients expressed satisfaction with wound care services, there was a notable expectation for nurses to recommend natural products, such as medicinal plant oils, as part of the care process, which should be addressed within an evidence-based, safety-focused framework and with clear guidance on indications/contraindications. These findings indicate a growing societal acceptance of traditional and complementary approaches in wound care. Accordingly, healthcare professionals should consider patients' cultural values and individual preferences when integrating

evidence-based conventional medicine with appropriate traditional practices, as this approach may enhance patient satisfaction and improve wound care outcomes.^[5,6] Furthermore, aligning early assessment, coordinated referral, and nurse-led education with risk-stratified care pathways may address the identified gaps and strengthen patient-centered wound management.^[3,21]

Study Limitations

This study has several limitations. Since the data were collected only from patients who applied to the wound care clinic of a single center, the generalizability of the findings is limited. The inclusion of only individuals who had been experiencing a wound problem for at least 1 week excluded cases involving more acute or short-term wounds. In addition, differences in wound types and severity were not classified in detail, which limited the ability to conduct in-depth analyses based on specific wound categories. Finally, due to the cross-sectional design of the study, causal relationships cannot be established.

Conclusion

This study demonstrated that the most common reasons for admission to the wound care clinic were pain, signs of infection, and the need for regular wound care. Chronic wound types were prevalent, and previous treatments often resulted in only partial healing. While patients reported satisfaction with the care provided by nurses, they also expressed additional expectations, such as information on natural products and the provision of educational materials. Beyond these findings, the study highlights the need for nurse-led education programs, early diagnosis, proactive management strategies, and holistic care approaches that integrate both clinical and supportive dimensions. Strengthening referral pathways and standardizing primary-level wound management may reduce delays in effective treatment. These recommendations emphasize the importance of a patient-centered, multidisciplinary, and innovative framework to improve wound care outcomes.

Relevance to Clinical Practice

To improve the quality of services in wound care clinics, it is recommended to strengthen patient education and implement early detection and proactive management strategies. Supporting nurses in assuming leadership roles and integrating holistic approaches into care plans may enhance clinical outcomes and increase patient satisfaction.

Ethics Committee Approval: The Osmaniye Korkut Ata University Research Ethics Committee granted approval for this study (date: 11.11.2024, number: 2024-E.205329).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Financial Disclosure: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Use of AI for Writing Assistance: The authors declare that no artificial intelligence (AI)-assisted technologies were used in the design, conduct, data analysis, or writing of this manuscript.

Authorship Contributions: Concept: SG, UÖY, HDK; Design: SG, UÖY, HDK; Supervision: SG, UÖY, HDK; Resource: SG, UÖY, HDK; Materials: SG, UÖY, HDK; Data Collection or Processing: SG, UÖY, HDK; Analysis or Interpretation: SG, UÖY, HDK; Literature Search: SG, UÖY, HDK; Writing: SG, UÖY, HDK; Critical Review: SG, UÖY, HDK.

Peer-review: Double blind peer-reviewed.

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The Effect of Nursing Students' Perspectives Toward Foreign Nationals on Post-operative Patient Care

 Hatice Merve Alptekin¹,  Berrak Tuğ^{2*},  Ezgi Seyhan Ak³

¹Department of Surgical Nursing, Kocaeli University Faculty of Health Sciences, Kocaeli, Türkiye

²American Hospital, İstanbul, Türkiye

³Department of Surgical Nursing, Istanbul University-Cerrahpaşa, Florence Nightingale Faculty of Nursing, İstanbul, Türkiye

Abstract

Introduction: This study aimed to determine the effect of nursing students' perspectives toward foreign nationals on the quality of post-operative patient care.

Methods: Data were collected between May 02, 2023 and January 30, 2024, from nursing students enrolled in the departments of two foundation universities. A 30-item questionnaire developed by the researcher based on the literature was used to gather data through face-to-face interviews.

Results: The study was completed with 249 participants. Among the participants, 60.6% did not prefer to include foreign national patients when preparing care plans, primarily due to limited foreign language proficiency (54.2%). Furthermore, 70.7% reported difficulties in providing post-operative care because of inadequate foreign language skills, while 53% experienced challenges related to cultural differences. Overall, 62.7% of students who held negative perceptions of foreign nationals had difficulty in providing post-operative care.

Discussion and Conclusion: The growing number of foreign nationals has contributed to negative perceptions among nursing students. Language barriers and cultural differences were the main factors impeding effective post-operative care. It is recommended that nursing curricula emphasize transcultural nursing and that further research be conducted to enhance students' cultural competence and attitudes toward diversity.

Keywords: Migrants, Nursing care, Nursing students, Post-operative care

With globalization, interactions among individuals from diverse cultures have become increasingly common, largely due to migration. Over the past century, millions of people have migrated worldwide because of wars, ethnic and religious conflicts, economic hardship, educational and employment opportunities, and marriage. Most migrants move to more developed regions seeking better living conditions and stability.^[1,2] According to the

International Organization for Migration, approximately 281 million international migrants were recorded in 2020, representing 3.6% of the global population.^[3] The countries hosting the largest migrant populations include the Islamic Republic of Iran, Türkiye, Colombia, and Germany. Most refugees in Iran and Pakistan are Afghans, while nearly all refugees in Türkiye are Syrians.^[4] As of July 2024, more than three million Syrian refugees were registered in Türkiye.^[5]

*The current affiliation of the author: Dr. Gamze Eren Reconstructive and Aesthetic Surgery Clinic, İstanbul, Türkiye

Cite this article as: Alptekin HM, Tuğ B, Seyhan Ak E. The Effect of Nursing Students' Perspectives Toward Foreign Nationals on Post-operative Patient Care. Lokman Hekim Health Sci 2026;6(3):391–400.

Correspondence: Hatice Merve Alptekin. Kocaeli Üniversitesi Sağlık Bilimleri Fakültesi, Cerrahi Hastalıklar Hemşireliği Anabilim Dalı, Kocaeli, Türkiye
E-mail: imervealptekini@hotmail.com **Submitted:** 16.06.2025 **Revised:** 11.11.2025 **Accepted:** 03.12.2025 **Available Online:** 06.08.2026



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The increasing migrant population has brought about various challenges, including economic strain, stigmatization, limited health literacy, and communication barriers.^[6] Furthermore, the growing presence of foreign nationals in daily life may influence social perceptions, potentially leading to prejudice and negative attitudes that undermine the quality of healthcare services.^[7]

Nursing, as a profession, plays a fundamental role in promoting and protecting the health of individuals, families, and communities, as well as in restoring physical and mental well-being. Nurses frequently interact with patients from diverse cultural backgrounds and are expected to adhere to the ethical principles outlined by the International Council of Nurses (ICN). The ICN Code of Ethics emphasizes that nursing care is universal and grounded in respect for human life and rights, regardless of nationality, religion, gender, belief, age, political opinion, or social status.^[8,9]

Culturally competent healthcare professionals are better equipped to meet the needs of foreign national patients. Cultural competence involves recognizing and respecting cultural differences and integrating them into individualized care planning.^[6,7,10] A culturally competent nurse understands that health perceptions vary across cultures and provides holistic care by incorporating patients' cultural values, beliefs, and lifestyles. A lack of cultural competence, however, may result in misinterpretation of patient behaviors and hinder effective communication.^[7] Developing cultural competence begins with self-awareness—understanding one's own cultural background, biases, and professional identity. Nurses thus have a crucial role in identifying and addressing the social determinants of health affecting foreign nationals and in improving their quality of life. Nursing students, as future healthcare professionals, also play a vital role in this process.^[6,7,10]

Negative or prejudiced attitudes among nurses and nursing students toward culturally diverse patients can adversely affect treatment outcomes and the overall quality of care.^[7] Surgical interventions cause significant physiological and psychological stress, requiring high-quality post-operative nursing care to ensure recovery and well-being.^[11] Such care demands competence, professionalism, empathy, respect, and patient advocacy.^[11,12] The quality of post-operative care provided to foreign nationals can influence outcomes, such as wound healing and length of hospital stay.^[12]

Although previous studies have examined the experiences of nurses and nursing students in caring for foreign national

patients, limited research has focused on post-operative care in this context.^[7,13–15] Post-operative patients from different cultural backgrounds particularly depend on nurses to act as advocates, especially in overcoming communication barriers and managing complications related to anesthesia and surgery. In contrast to internal medicine ward, where students often spend extended periods with patients, surgical patients are typically discharged within a few days, limiting the opportunity for in-depth communication and holistic assessment.^[11] In this context, the present study aimed to determine the effect of nursing students' perspectives toward foreign nationals on post-operative patient care.

Materials and Methods

Study Place and Design

This descriptive study was conducted among nursing students enrolled in the nursing departments of two foundation universities in Türkiye.

Research Questions

The study sought to address the following research questions:

1. What are the perspectives of nursing students toward foreign nationals?
2. What challenges do nursing students encounter in providing post-operative care to foreign patients?
3. Does the perspective of nursing students toward foreign nationals influence the quality of post-operative patient care?
4. Do nursing students' perspectives on foreign nationals differ according to their sociodemographic characteristics?

Population and Sample of the Study

The study population consisted of 2nd, 3rd, and 4th grade students (n=530) who will study in the Nursing departments of two Foundation Universities in the 2023–2024 academic year. 1st year students were not included in the study because they would not have been involved in the clinical practice of the surgical nursing course on the dates when the study was planned. The sample size of the study was calculated using the Raosoft sample size calculator based on the known population formula, with a significance level of $\alpha=0.05$ and a power of $1-\beta=0.95$, and the required sample was determined as 223 participants. Considering potential data loss, it was decided to collect data from approximately

10% more participants, resulting in a target of 250 students. Stratified sampling was conducted according to students' academic years, and data were collected accordingly. As a result, the study was completed with 249 students. The study included the 2nd-, 3rd-, and 4th-year nursing students who agreed to participate in the study and who had done or were doing the clinical practice of the surgical nursing course. Students had not taken a course on transcultural nursing. Students who were on report/leave at the time of the study were not included in the study.

Data Collection Tools

The data were collected with a 30-question data collection form prepared by the researcher in line with the literature. [7,8,13,16–19] The data collection form consists of three sections: Descriptive characteristics, questions evaluating nursing students' perspective on foreign nationals, and questions evaluating post-operative patient care. The descriptive characteristics form consists of 8 questions about students' age, gender, year in school, etc. There are 14 questions evaluating the students' perspective on foreign nationals and 8 questions about post-operative patient care and determining the practices that students have difficulty in caring for foreign national patients.

Data Collection Procedure

Data were collected between May 02, 2023 and January 30, 2024, from students in the nursing departments of two foundation universities. The questionnaire was reviewed by five faculty experts to ensure clarity and content validity. Revisions were made according to expert feedback, and a pilot study was conducted with five students, who were later excluded from the main study. Before data collection, researchers explained the purpose and procedures of the study to the students. Questionnaires were distributed in person at the end of class sessions and completed voluntarily and anonymously in approximately 15–20 min. Completed forms were collected immediately, and researchers checked for completeness before data entry.

Ethical Approach

This study was approved by the Istanbul University-Cerrahpaşa Social and Human Sciences Research Ethics Committee (Date: 06.12.2022, Decision no: 2022/464). Nursing students who participated in the study were informed about the study. It was explained that the answers given by the researchers would be kept anonymous and would only be used for scientific purposes. All study procedures were performed by the ethical standards of the

Helsinki Declaration, and verbal and written consent of the students included in the study were obtained by informing them about the study. An informed consent form was signed for the students who participated in the study, and that they received information and volunteered.

Data Analysis

Data analysis was performed by an independent statistician using the Statistical Package for the Social Sciences version 20.0 for Windows. The normality of data distribution was assessed using the Shapiro–Wilk test, which indicated that the data were not normally distributed. Descriptive statistics for continuous variables were presented as medians (minimum–maximum), while categorical variables were summarized as frequencies and percentages. Relationships between students' ages and their perspectives on foreign national patients were analyzed using the Kruskal–Wallis H test. Associations between students' sociodemographic characteristics, their difficulties in providing post-operative care to foreign patients, and their perspectives toward foreign nationals were examined using the Chi-square test. A $p < 0.05$ was considered statistically significant.

Results

The study was completed with 249 participants. The median age of the participants was 21 years, and 84.3% were female. Most students (82.3%) were graduates of Anatolian high schools, 60.2% had chosen the nursing profession willingly, 94.8% resided in the city, 79.5% had never traveled abroad, and 54.2% reported an intermediate level of foreign language proficiency (Table 1).

A total of 61.4% of students expressed negative opinions about foreign nationals, and 85.1% stated, 75.5% reported feeling uncomfortable with their integration into society, and 80.3% thought that they cause the degeneration of national culture. The majority (81.5%) indicated that foreign nationals benefit more from the advantages offered in Türkiye. Furthermore, 45.4% described foreign nationals as agitated or quarrelsome, 82.7% considered their personal hygiene inadequate, 44.2% believed their expression of problems was exaggerated, and 65.5% stated that they benefited more from health services. Moreover, 83.9% thought that foreign nationals increase disease rates, 75.9% reported that they negatively affect health care policies, 76.7% believed that they do not comply with health care rules, and 63.1% stated that they are not respectful enough toward health care professionals (Table 2).

Table 1. Sociodemographic characteristics of the students (n=249)

Characteristics	Median (min-max)	
Age	21 (19-34)	
	n	%
Gender		
Female	210	84.3
Male	39	15.7
High School		
Regular High School	20	8.0
Anatolian High School	205	82.3
Science High School	9	3.6
Health Vocational High School	15	6.0
Total	249	100.0
Academic year		
Second class	87	34.9
Third class	79	31.7
Fourth class	83	33.3
Did you choose nursing willingly?		
Yes	150	60.2
No	46	18.5
Undecided	53	21.3
Where did you lived the longest?		
City	236	94.8
Town	11	4.4
Villiage	2	0.8
Have you been abroad?		
Yes	51	20.5
No	198	79.5
Foreign language proficiency		
Good	45	18.1
Intermediate	135	54.2
Poor	69	27.7
Total	249	100

It was determined that 64.3% of the students had provided post-operative care to foreign patients during their clinical practice, while 60.6% stated that they did not prefer to prepare nursing care plans for these patients. The primary reason reported was limited foreign language proficiency (54.2%). The majority of students indicated that patients' behaviors (68.3%), religious beliefs (94.0%), gender (95.6%), cultural differences (65.5%), and patient relatives (84.3%) were not perceived as barriers to care. Nevertheless, 55.8% experienced difficulties in providing post-operative care to foreign patients. Specifically, 51.4% reported difficulties

in data collection, 47.8% in communication, and 56.6% in patient education. Concerning clinical practices, students reported challenges in physical examination (83.9%), treatment (84.7%), nursing care (81.9%), patient education (66.3%), evaluation of consciousness (77.5%), pain assessment (61.0%), monitoring vital signs (89.2%), deep breathing exercises (88.0%), spirometer use (90.4%), turning exercises in bed (83.9%), early mobilization (92.4%), fluid monitoring (86.3%), drain monitoring (91.2%), wound care (81.5%), oral care (82.3%), monitoring complications (90.4%), and providing psychological support (61.0%) (Table 3).

Overall, 70.7% of students reported difficulties due to inadequate foreign language proficiency, and 53.0% attributed their challenges to cultural differences. In addition, 59.4% stated that training is necessary for providing post-operative care and communicating with foreign patients (Table 3).

Among students with a positive perspective toward foreign nationals, 55.6% reported difficulty in post-operative care, compared to 62.7% among those with a negative perspective. However, this relationship was not statistically significant ($p=0.02$) (Table 4).

There were no significant differences in students' perspectives based on age ($p=0.95$), gender ($p=0.75$), type of high school ($p=0.60$), academic year ($p=0.47$), or foreign language proficiency ($p=0.14$). Conversely, a significant positive correlation was found between students' willingness to choose the nursing profession ($p=0.00$), having traveled abroad ($p=0.00$), and their perspectives on foreign nationals ($p<0.05$). Among those with negative perspectives, 96.7% lived in the city, and a significant association was observed between place of residence and perspective ($p=0.00$; $p<0.05$) (Table 5).

Discussion

This study examined the effect of nursing students' perspectives toward foreign nationals on post-operative care and found that most participants held negative attitudes. Specifically, 85.1% believed that foreign nationals should return to their home countries once the cause of migration ends; 75.9% stated that they negatively affect healthcare policies; 76.7% thought that they do not comply with healthcare rules; and 63.1% believed that they are not sufficiently respectful toward healthcare professionals. Similar findings were reported by Barutcu and Zengin,^[17] who found that 95% of students believed refugees should return home once conditions improved, and by Tosun and Sinan,^[7]

Table 2. Students' views on foreign nationals (n=249)

Characteristics	n	%	Characteristics	n	%
Opinion about foreign nationals coming to Türkiye			Perception of foreign nationals' personal hygiene		
Positive	27	10.8	Adequate	9	3.6
Negative	153	61.4	Inadequate	206	82.7
Undecided	69	27.7	Undecided	34	13.7
Opinion on what foreign nationals should do after the cause of migration ends			Opinion on how foreign nationals express their problems		
They should return to their country	212	85.1	Exaggerated	110	44.2
They should stay in our country	6	2.4	Appropriate	23	9.2
They should migrate to another country	11	4.4	Insufficient	75	30.1
Undecided	20	8.0	Undecided	41	16.5
Perceived effect of foreign nationals on unemployment rates			Opinion about foreign nationals' access to Türkiye's health services		
Increases	196	78.7	They Benefit More	163	65.5
Decreases	29	11.6	They Benefit Equally	37	14.9
No effect	9	3.6	They Benefit Less	13	5.2
Undecided	15	6.0	They Cannot Benefit	3	1.2
Feelings about foreign nationals mixing with the public			Undecided	33	13.3
Feeling Uncomfortable	188	75.5	Perceived effect of foreign nationals on disease rates		
Not Feeling Uncomfortable	15	6.0	Increases	209	83.9
Not Affected	17	6.8	Decreases	8	3.2
Undecided	29	11.6	No effect	11	4.4
Perceived effect of foreign nationals on national culture			Undecided	21	8.4
Degenerates national culture	200	80.3	Perceived effect of foreign nationals on health care policy		
Develops national culture	6	2.4	Positive	11	4.4
No change	20	8.0	Negative	189	75.9
Undecided	23	9.2	No change	22	8.8
Opinion about foreign nationals benefiting from advantages in Türkiye			Undecided	27	10.8
They Benefit More	203	81.5	Opinion about the compliance of foreign nationals with health care rules		
They Benefit Equally	26	10.4	They Follow the Rules	9	3.6
They Benefit Less	7	2.8	They Do not Follow the Rules	191	76.7
They Cannot Benefit	1	0.4	Undecided	49	19.7
Undecided	12	4.8	Perception of foreign nationals' behavior toward health care professionals		
Perception of foreign nationals' temperament			Not Respectful Enough	157	63.1
Calm and Patient	1	0.4	Respectful Enough	24	9.6
Agitated and Quarrelsome	113	45.4	Undecided	68	27.3
Insecure and Skeptical	88	35.3	Total	249	100
Curious and Talkative	16	6.4			
Undecided	31	12.4			

who observed that students perceived refugees and their relatives as showing limited respect for healthcare staff and hospital rules. Similarly, 53.9% of participants in that study agreed that refugees in Türkiye benefit from healthcare

services more than citizens, suggesting that such negative views may stem from perceptions of inequality in access to resources. Other studies conducted in Türkiye also revealed that nursing students tend to hold unfavorable attitudes

Table 3. Students' views on providing care to foreign nationals (n=249)

Characteristics	n	%	Characteristics	n	%
Have you ever provided care to foreign patients in the post-operative period in your clinical practice?			Deep breathing exercises		
Yes	160	64.3	Yes	30	12.0
No	89	35.7	No	219	88.0
Have you ever not preferred foreign patients when preparing a nursing care plan in your clinical practice?			Use of spirometer		
Yes	74	29.7	Yes	24	9.6
No	151	60.6	No	225	90.4
Sometimes	24	9.6	Turning exercises in bed		
Reason for not choosing*			Yes	40	16.1
Foreign language proficiency			No	209	83.9
Yes	135	54.2	Early mobilization		
No	114	45.8	Yes	19	7.6
Patient's behavior			No	230	92.4
Yes	79	31.7	Monitoring fluid intake and output		
No	170	68.3	Yes	34	13.7
Religious beliefs			No	215	86.3
Yes	15	6.0	Drain monitoring		
No	234	94.0	Yes	22	8.8
Gender discrimination			No	227	91.2
Yes	11	4.4	Wound care		
No	238	95.6	Yes	46	18.5
Cultural differences			No	203	81.5
Yes	86	34.5	Oral care		
No	163	65.5	Yes	44	17.7
Patient relatives			No	205	82.3
Yes	39	15.7	Monitoring of early and late complications		
No	210	84.3	Yes	24	9.6
Have you experienced any difficulties in providing post-operative care to foreign patients?			No	225	90.4
Yes	139	55.8	Providing psychological support to the patient		
No	110	44.2	Yes	97	39.0
Reason for your difficulty*			No	152	61.0
Data collection			Patient education		
Yes	128	51.4	Yes	141	56.6
No	121	48.6	No	108	43.4
Physical examination			Factors making post-operative care for foreign patients difficult		
Yes	40	16.1	Foreign language proficiency		
No	209	83.9	Yes	176	70.7
Treatment			No	73	29.3
Yes	38	15.3	Patient's behavior		
No	211	84.7	Yes	109	43.8
Communication			No	140	56.2
Yes	119	47.8	Religious beliefs		
No	130	52.2	Yes	25	10.0
Nursing care			No	224	90.0
Yes	45	18.1	Gender discrimination		
No	204	81.9	Yes	28	11.2
Patient education			No	221	88.8
Yes	84	33.7	Cultural differences		
No	165	66.3	Yes	132	53.0
Evaluation of the patient's state of consciousness			No	117	47.0
Yes	56	22.5	Patient relatives		
No	193	77.5	Yes	81	32.5
Evaluation and monitoring of pain			No	168	67.5
Yes	97	39.0	Is it necessary to receive training on approaching and providing post-operative care to foreign patients?		
No	152	61.0	Yes	148	59.4
Monitoring vital signs			No	58	23.3
Yes	27	10.8	Undecided	43	17.3
No	222	89.2	Total	249	100.0

*: Multiple answers were given.

Table 4. Effects of the perspectives of foreign nursing students on the post-operative care of patients (n=249)

Difficulty in providing care to a foreign patient in the post-operative period	Nursing students' perspectives on foreign nationals						Test	p
	Positive		Negative		Undecided		χ^{2**}	
	n	%*	n	%*	n	%*		
Yes	12	44.4	96	62.7	31	44.9	7.71	0.02
No	15	55.6	57	37.3	38	55.1		
Total	27	100.0	153	100.0	69	100.0		

*%: Row percentage; ** χ^2 : Chi-square test.**Table 5.** Comparison of nursing students' perspectives on foreign nationals according to their introductory characteristics (n=249)

Characteristics	Nursing students' perspectives on foreign nationals						Test	p
	Positive		Negative		Undecided		H*	
	Median (min- max)							
Age	21.70 (19–27)		21.46 (19–34)		21.35 (19–24)		0.10	0.95
	n	%**	n	%**	n	%**	χ ^{2***}	
Gender								
Female	22	81.5	128	83.7	60	87.0	0.58	0.75
Male	5	18.5	25	16.3	9	13.0		
High School								
Regular high school	4	14.8	12	7.8	4	5.8	0.51	0.60
Anatolian High School	19	70.4	128	83.7	58	84.1		
Science High School	1	3.7	6	3.9	2	2.9		
Health Vocational High School	3	11.1	7	4.6	5	7.2		
Academic year								
Second class	10	37.0	49	32.0	28	40.6	0.56	0.47
Third class	11	40.7	48	31.4	20	29.0		
Fourth class	6	22.2	56	36.6	21	30.4		
Did you choose nursing willingly?								
Yes	20	74.1	89	58.2	41	59.4	14.15	<0.001
No	1	3.7	38	24.8	7	10.1		
Undecided	6	22.2	26	17.0	21	30.4		
Where did you lived the longest?								
City	22	81.5	148	96.7	66	95.7	14.82	<0.001
Town	5	18.5	4	2.6	2	2.9		
Villiage	0	0.0	1	0.7	1	1.4		
Have you been abroad?								
Yes	12	44.4	28	18.3	11	15.9	10.83	<0.001
No	15	55.6	125	81.7	58	84.1		
Your foreign language level								
Good	8	29.6	26	17.0	11	15.9	6.98	0.14
Intermediate	16	59.3	78	51.0	41	59.4		
Bad	3	11.1	49	32.0	17	24.6		

*%: Row percentage; ***H: Kruskal–Wallis test; χ^2 : Chi-square test*.

toward refugees, often perceiving them as receiving preferential treatment or disrupting order within healthcare institutions. These attitudes may arise from concerns about cultural differences, job security, and challenging working conditions anticipated after graduation.^[20–23]

In the present study, 64.3% of students reported having provided post-operative care to foreign national patients during clinical practice, while 60.6% indicated that they did not prefer such patients when preparing care plans. The primary reason was limited foreign language proficiency (54.2%). Similarly, Tosun and Sinan^[7] found that 61.5% of students encountered foreign national patients during clinical practice and 48.6% provided care to them, identifying communication barriers as the most significant challenge. Nearly half of their participants preferred to care for Turkish patients for this reason.

Language barriers were the most prominent obstacle preventing students from delivering effective care to foreign patients, particularly during data collection and patient education – two critical components of nursing care. Selçuk and Yanikkerem^[15] also reported that students had difficulty providing breastfeeding education to Syrian women and often relied on demonstration methods to overcome communication barriers, although they were unable to conduct discharge education effectively. In the present study, 70.7% of students stated that they experienced difficulties in post-operative care due to inadequate foreign language skills, while 53% attributed their challenges to cultural differences. Similarly, Karasu et al.^[10] found that 73.4% of nurses experienced language-related problems and 49.8% encountered cultural challenges when caring for foreign patients.

Although most students in this study were graduates of Anatolian high schools and reported intermediate-level foreign language proficiency – usually English, with German or French as secondary languages – the majority of foreign patients spoke Arabic. Thus, the communication barrier likely stemmed from the absence of a shared language rather than a complete lack of foreign language knowledge. Moreover, 59.4% of students expressed a need for training on how to provide post-operative care to foreign patients. Supporting this, Yiğit et al.^[24] found that 83.5% of nursing students required education in intercultural nursing, and Rızalar et al.^[25] reported that 78.8% of students needed training on caring for foreign nationals.

The findings also showed that students with negative perspectives toward foreign nationals experienced greater difficulty in providing post-operative care. Similarly, Konal

Korkmaz et al.^[8] found that 87% of nursing students held negative attitudes toward war victims, while Rızalar et al.^[25] reported that 62% of students had difficulty providing care to foreign patients. Caring for individuals from different cultural backgrounds requires empathy, communication, and understanding skills that may be hindered by prejudice or bias. Negative attitudes can influence professional behavior and make caregiving more challenging. Nonetheless, the findings of this study indicate that students generally provided equitable care regardless of personal opinion, and that their main difficulties stemmed from language barriers rather than factors, such as gender, religion, or ethnicity. Students with negative attitudes appeared to struggle more with communication and interaction, suggesting the need for training programs to enhance intercultural sensitivity and professional confidence while minimizing the effects of bias on patient care.

Another key finding of the present study was that students who chose the nursing profession willingly displayed more positive perspectives toward foreign nationals. Şekerçi and Biçer^[26] similarly reported that students who voluntarily selected their profession and held positive attitudes exhibited higher levels of cultural sensitivity. In addition, this study found that students who had traveled abroad had more positive perspectives, whereas those living in the city tended to have more negative attitudes. Karasu et al.^[10] noted that nurses who had social interactions with people from different cultures and formed cross-cultural friendships showed greater cultural sensitivity. Similarly, students who had lived abroad may have developed more tolerance and acceptance through exposure to diverse cultural experiences.

Karadaş et al.^[27] observed that individuals residing in regions with high immigration rates are more likely to develop xenophobic tendencies. Cities with high immigrant populations and competitive labor markets can generate economic and social anxieties, leading to negative perceptions, such as fear of job competition, cultural conflict, and limited access to healthcare. Negative perceptions of foreign nationals, including xenophobia, often arise from broader social, political, and cultural dynamics.^[28] When such attitudes occur among healthcare professionals, they can adversely affect the quality, safety, and equity of patient care.^[29]

Although this study revealed that many students held negative perceptions of foreign nationals, these views did not manifest as discriminatory behaviors. Students emphasized that their main challenges in caring for

foreign patients arose from language and cultural differences, not from prejudice in their care delivery. These findings highlight the importance of integrating cultural competence and sensitivity training into nursing curricula to promote equitable, patient-centered care and to prepare future nurses to serve increasingly diverse populations.

Limitations

This study was limited to the independent variables included in the data collection form. Other unmeasured factors may influence foreign nationals' cultural sensitivity and perspectives.

Conclusion and Recommendations

The findings revealed that nursing students' negative attitudes toward foreign nationals have increased with the growing diversity of patient populations. Cultural and language barriers hinder effective care delivery and patient education, leading some students to avoid foreign patients when preparing care plans. Students with negative perceptions faced greater challenges in post-operative care, particularly in communication. Although personal opinions did not appear to affect patient selection, language barriers remained a major obstacle. Participants emphasized the need for training on culturally competent care and patient education. Integrating intercultural sensitivity training into nursing curricula may enhance the quality of care for foreign patients. Furthermore, greater involvement of medical translators could help reduce communication barriers. Future studies should assess the impact of intercultural sensitivity training on nursing practice.

Ethics Committee Approval: The Istanbul University-Cerrahpaşa Social and Human Sciences Research Ethics Committee granted approval for this study (date: 06.12.2022, number: 2022/464).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: None declared.

Financial Disclosure: This study has received support from TÜBİTAK (The Scientific and Technological Research Council of Türkiye).

Use of AI for Writing Assistance: Not declared.

Authorship Contributions: Concept: HMA, BT, ESA; Design: HMA, BT, ESA; Supervision: HMA; Resource: HMA, BT, ESA; Materials: HMA, BT, ESA; Data Collection or Processing: HMA, BT, ESA; Analysis or Interpretation: HMA, BT, ESA; Literature Search: HMA, BT, ESA; Writing: HMA, BT, ESA; Critical Review: HMA, ESA.

Acknowledgments: The authors would like to thank all participants for their valuable contributions to this study.

Peer-review: Double blind peer-reviewed.

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Factors Affecting Pregnant Women's Decision-making and Healthy Lifestyle Behaviors via the Internet

 Endam Çetinkaya Ak¹,  Sabriye Uçan Yamaç¹,  Nazife Bakır²

¹Department of Midwifery, Burdur Mehmet Akif Ersoy University, Bucak School of Health, Burdur, Türkiye

²Department of Maternity and Women's Health Nursing, Burdur Mehmet Akif Ersoy University, Bucak School of Health, Burdur, Türkiye

Abstract

Introduction: This study aims to determine pregnant women's access to health information and decision-making through the internet, their healthy lifestyle behaviors, and the factors affecting them.

Methods: This cross-sectional descriptive study was conducted in two public hospitals located in the Mediterranean region of Türkiye. The sample consisted of the volunteer pregnant women aged 18 and over. Data were collected using the "Personal Identification Form, Internet Decision-making in Pregnancy Scale, and Healthy Lifestyle Behaviors in Pregnancy Scale," via face-to-face surveys. Descriptive statistics, independent sample t-test, analysis of variance, and Bonferroni post hoc tests were used in the analysis of data.

Results: The study included 367 pregnant women. The pregnant women's decision-making score through the internet was found to be at a medium level (38.00 ± 7.25), while the healthy life behavior score was found to be at a high level (115.47 ± 15.26). Nutrition had the highest sub-dimension mean, while physical activity had the lowest. Variables such as age, education status, income level, number of pregnancies, prenatal education, and health check-ups significantly affected the scale scores ($p < 0.05$).

Discussion and Conclusion: The research results show that individual and environmental variables during pregnancy affect both access to health-related information and lifestyle behaviors. Therefore, it is important to expand prenatal education for pregnant women, provide targeted health counseling to socioeconomically disadvantaged groups, and direct them to the right digital resources. While previous studies have mainly examined Internet use or healthy living behaviors separately, this study addresses both dimensions simultaneously, thus filling an important gap in the literature.

Keywords: Health behavior; Health literacy; Internet use; Pregnancy

Although pregnancy is a natural process in a woman's life, it is a critical period where physical and psychological changes are experienced intensely. The steps taken during this process directly affect both maternal and fetal health.^[1] Considering that the foundations of health are laid with pregnancy, the

healthy course of this period is closely related to the mother's lifestyle, health attitude, and decision-making processes.^[2] Exhibiting healthy lifestyle behaviors from the pre-pregnancy period not only reduces complications but also protects the mother and baby during birth and postpartum.^[3,4]

Cite this article as: Çetinkaya Ak E, Yamaç SU, Bakır N. Factors Affecting Pregnant Women's Decision-making and Healthy Lifestyle Behaviors via the Internet. Lokman Hekim Health Sci 2026;6(3):401–408.

Correspondence: Endam Çetinkaya Ak. Burdur Mehmet Akif Ersoy Üniversitesi, Bucak Sağlık Yüksekokulu, Ebelik Bölümü, Burdur, Türkiye

E-mail: ecetinkaya@mehmetakif.edu.tr **Submitted:** 09.07.2025 **Revised:** 03.11.2025 **Accepted:** 19.12.2025 **Available Online:** 06.08.2026



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Healthy lifestyle behaviors are key for disease prevention, early diagnosis, and maintaining health.^[5] Adopting these behaviors during pregnancy increases women's control over their health and contributes to life satisfaction. In this context, awareness, knowledge, and decision-making skills gain importance.^[6,7]

With advances in communication technologies, pregnant women use the internet extensively for health information. Studies show that most expectant mothers frequently rely on online sources.^[8–10] The most searched topics include fetal development, birth methods, gestational week changes, baby care, and the postpartum period.^[11,12]

The main reason for this frequent use is the easy and instant access to information.^[13,14] However, the accuracy and reliability of online content cannot always be guaranteed. Especially individuals with low health literacy may have difficulties making decisions when faced with contradictory information, which increases anxiety.^[12,15,16]

Kiarie and Mugambi found that many pregnant adolescents spend more than 4 h daily on the internet.^[17] Similarly, Peragallo Urrutia et al.^[18] and Tori and Evrenol Öçal^[19] reported that women often prefer online resources over professionals. Thus, the internet has become not only a source of information but also a platform for experience sharing among expectant mothers.^[20–22] However, this can lead to disinformation and confusion, highlighting the need for professional guidance.^[5,23]

Midwives and nurses play a key role in evaluating and supporting lifestyle behaviors during pregnancy. Technological advances have expanded their guidance roles, making digital environments effective for support.^[6,14] In this context, directing women to reliable resources is as crucial as professional counseling itself.^[23] However, the literature reveals that while many studies have investigated internet use during pregnancy or healthy lifestyle behaviors, very few have integrated these two aspects. In particular, there is limited evidence from Türkiye examining the combined impact of internet-based decision-making and lifestyle practices. This study was designed to address this gap.

In this study, "decision-making via the Internet" refers to the process by which pregnant women search for, evaluate, and apply online health information in relation to prenatal care, lifestyle behaviors (e.g., nutrition and physical activity), and delivery preferences. It is therefore understood as a multidimensional construct linking digital information seeking with practical health-related decisions during pregnancy. This study aimed to evaluating pregnant women's internet-based decision-making, their healthy lifestyle behaviors, and influencing factors.

Materials and Methods

Study Place, Design and Type

Data were collected for one month in two state hospitals in the Mediterranean Region. This study was designed as a cross-sectional descriptive research to determine pregnant women's internet-based decision-making, healthy lifestyle behaviors, and related factors.

Participants

The study population consisted of pregnant women aged 18 and over who visited the two hospitals where the study was conducted during the study period. Participants were selected using a convenience (non-probability) sampling method. Before data collection, a priori power analysis was conducted with the G*Power 3.1.9.7 program to estimate the approximate number of participants that would ensure sufficient statistical power (Appendix 1: Power Analysis Report). The analysis was based on a confidence level of $\alpha=0.05$, power $(1-\beta)=0.95$, and an effect size of $f=0.20$, which is considered medium-sized according to Cohen's (1988) classification.^[24] This selection was also justified by considering the effect size values used in similar studies in the literature.^[1,5,6] Under these conditions, the required sample size was calculated as $n=312$. In total, data were collected from 367 pregnant women who met the inclusion criteria and agreed to participate. However, since the sample was obtained through convenience sampling, it may not be fully representative of the target population, and this constitutes a limitation of the study.

Data Collection Tools

Individual Diagnostic Form

Prepared by researchers through a literature review, this form included 20 questions on sociodemographic and obstetric characteristics, tobacco, and alcohol use.^[1–10]

Internet Decision-Making Scale in Pregnancy

Developed by Koyun and Erbektaş, this 10-item, two-dimensional scale evaluates self-efficacy and self-control in decision-making processes during pregnancy. It is scored on a five-point Likert scale, where higher scores indicate a greater level of decision-making influenced by the internet (i.e., higher reliance on internet-based information when making pregnancy-related decisions). The minimum score from the scale is 10, and the maximum score is 50. The original Cronbach's alpha coefficient of the scale was 0.85.^[25] In

this study, Cronbach's alpha values were recalculated for this sample (n=367) and found to be 0.85 for the total scale, 0.87 for the self-efficacy subscale, and 0.88 for the self-control subscale.

Healthy Lifestyle Behaviors Scale in Pregnancy

Developed by Yilmaz and Karahan, this 29-item scale includes six subscales: responsibility, hygiene, nutrition, physical activity, travel, and pregnancy acceptance. It is scored on a five-point Likert scale, and higher scores indicate more positive health-promoting behaviors. A minimum of 29 points and a maximum of 145 points can be obtained from the scale. The original Cronbach's alpha coefficient for the total scale was 0.83; 0.71 for pregnancy responsibility, 0.64 for hygiene, 0.72 for nutrition, 0.69 for physical activity, 0.80 for travel, and 0.63 for acceptance of pregnancy for subscales.^[26] In this study, Cronbach's alpha coefficients were recalculated for this sample (n=367) and were found to be 0.77 for the total scale; 0.91 for pregnancy responsibility, 0.90 for hygiene, 0.87 for nutrition, 0.77 for physical activity, 0.78 for travel, and 0.88 for acceptance of pregnancy for subscales.

Data Collection

Pregnant women who met the criteria, gave consent, and completed the forms were included. Surveys were conducted face-to-face and consisted of "Informed Consent Form," "Individual Diagnostic Form," "Internet Decision Making Scale in Pregnancy" and "Healthy Lifestyle Behaviors Scale in Pregnancy." Completion time was 10–15 min.

Statistical Analyses

IBM Statistical Package for the Social Sciences (SPSS) Statistics 25.0 package program (IBM Corp., Armonk, NY, USA) was used for data analysis. Statistical methods such as unit number (n), percentage (%), mean (X), and standard deviation (SD) were used in the analysis of descriptive data of the study. The Kolmogorov–Smirnov test was used to assess whether the data were normally distributed. Since the Skewness and Kurtosis coefficients for all variables were between (–1.5 and +1.5), it was determined that the data met the normality condition. Independent Samples t-test and One-way analysis of variance with Bonferroni post hoc were applied. Bonferroni post hoc tests were performed, and SPSS automatically adjusted p-values to control for Type I error. When the p-value obtained in the comparisons between variables was <0.05, the analysis was considered statistically significant.

Ethical Considerations

Ethics approval was obtained from Burdur Mehmet Akif Ersoy University Non-Interventional Clinical Research Ethics Committee (Decision No: GO 2024/847, Date: 03.12.2024). Written consent was secured; the study complied with the Declaration of Helsinki.

Results

The study included 367 pregnant women. The distribution of pregnant women according to their introductory characteristics is given in Table 1. Of the 367 pregnant women who participated in the study, 38.7% were between the ages of 19 and 25, 38.7% were between the ages of 26 and 32, and 22.6% were between the ages of 33 and 39. When the level of education is examined, it is seen that the highest rate belongs to high school graduates (47.4%), followed by those with university and higher education levels (27.5%). These findings indicate that the sample is relatively homogeneous in terms of education level. The vast majority of women (80.1%) are unemployed and are housewives.

The income of 72.5% of the participants is equal to their expenses; while approximately half live in district centers (49.6%), 42.5% live in the city center, and 7.9% live in rural areas such as villages and towns. This distribution allows for potential comparisons regarding geographical differences in internet access and opportunities to obtain information. When evaluated in terms of family type, it is seen that the nuclear family structure is dominant in 91.6%.

It was seen that 37.9% of the women were in their second pregnancy, 14.7% had experienced a miscarriage/abortion before. In addition, 73.3% were having a planned pregnancy, 68.4% had a pre-pregnancy health check-up, and 67.8% had received prenatal education in their current pregnancy. This may indicate that a considerable portion of pregnant women in the study are relatively conscious and proactive in their health-related decision-making processes. The rates of tobacco and alcohol use among pregnant women are quite low at 12.8% and 4.9%, respectively.

The mean scale scores of the pregnant women are given in Table 2. The mean "Perception of Self-Efficacy" of the sub-dimensions of the scale for decision-making through the internet in pregnancy was found to be 18.57 ± 4.00 , and the mean "Perception of Self-Control" was found to be 19.42 ± 3.73 . The total mean score of the scale was 38.00 ± 7.25 , and the total scores ranged from a minimum of 21 to a maximum of 50 points. These values suggest that pregnant women generally feel moderately

Table 1. Descriptive characteristics of the participants

Individual characteristics	n	%	Individual characteristics	n	%
Age			Number of pregnancies		
19–25	142	38.7	First	124	33.8
26–32	142	38.7	Second	139	37.9
33–39	83	22.6	Three and above	104	28.3
Education status			Number of births		
Primary school	34	9.3	0	138	37.6
Middle school	58	15.8	1	134	36.5
High school	174	47.4	2 and above	95	25.9
University and above	101	27.5	Miscarriage/abortion status		
Working status			No	313	85.3
Yes	73	19.9	Yes	54	14.7
No	294	80.1	Is your pregnancy planned?		
Place of residence			Yes	269	73.3
Village-town	29	7.9	No	98	26.7
District	182	49.6	Pre-pregnancy health check status		
Province	156	42.5	Yes	251	68.4
Years of marriage			No	116	31.6
0–4 years	193	52.6	Prenatal education status during current pregnancy		
5–9 years	133	36.2	Yes	249	67.8
10 and above	41	11.2	No	118	32.2
Family income status			Tobacco and tobacco products usage		
Income is less than expenses	56	15.3	Yes	47	12.8
Income is equal to expenses	266	72.5	No	320	87.2
Income is more than expenses	45	12.3	Alcohol use status		
Family type			Yes	18	4.9
Nuclear family	336	91.6	No	349	95.1
Extended family	31	8.4	Total	367	100.0

competent and in control when obtaining health-related information over the Internet.

The total mean score of the scale for healthy living behaviors in pregnancy was 115.47 ± 15.26 , and the highest mean was seen in the sub-dimension of “Nutrition” (32.60 ± 6.52), and the lowest mean was seen in the sub-dimension of “Physical Activity” (10.58 ± 2.31). This may indicate that pregnant women develop more positive behaviors in terms of nutrition, but their physical activity levels are relatively low. Hygiene (17.46 ± 2.87), pregnancy responsibility (18.29 ± 2.37), pregnancy acceptance (17.14 ± 3.08), and travel (19.38 ± 3.40) scores indicate moderately positive behaviors. The total score average shows that healthy life behaviors are generally at a good level.

Appendix 2 and 3 show the significant differences between the scores of the pregnant women from the two scales

according to their individual and sociodemographic characteristics. These differences are discussed according to the prominent groups as follows:

In the study, as age increases, both the level of decision-making through the internet ($F: 6.285$, $df: 2$, $p < 0.05$) and healthy life behavior scores ($F: 5.562$, $df: 2$, $p < 0.05$) increase significantly. It is seen that especially the 33–39 age group received higher scores than the 19–25 age group. This may suggest that life experience and cognitive awareness, which increase with age, could positively affect decision-making processes.

Women with a middle school education received the highest scores in decision-making through the internet (43.48 ± 6.48) and healthy life behaviors (124.68 ± 18.62). It is seen that differences in education level have a significant effect on both scales ($p < 0.001$). It is noteworthy that high

Table 2. Participants' scale score averages

	Mean	SD	Median	Min	Max
Internet decision-making scale in pregnancy					
Self-efficacy perception	18.57	4.00	18.00	11.00	25.00
Self-control perception	19.42	3.73	19.00	10.00	25.00
Scale total score	38.00	7.25	38.00	21.00	50.00
Healthy lifestyle behaviors scale in pregnancy					
Pregnancy responsibility	18.29	2.37	20.00	11.00	20.00
Hygiene	17.46	2.87	18.00	8.00	20.00
Nutrition	32.60	6.52	32.00	18.00	45.00
Physical activity	10.58	2.31	10.00	3.00	15.00
Travel	19.38	3.40	19.00	8.00	25.00
Acceptance of pregnancy	17.14	3.08	18.00	4.00	20.00
Scale total score	115.47	15.26	113.00	71.00	145.00

SD: Standard deviation; Min: Minimum; Max: Maximum.

school graduates had lower scores on both scales, which may reflect contextual or socio-environmental influences.

Working pregnant women had higher scores for decision-making through the internet (39.71 ± 5.88) ($p < 0.05$), but lower scores for healthy lifestyle behaviors (110.76 ± 11.24) ($p < 0.001$). This could suggest that while working women may have better access to information, they might experience certain limitations in applying healthy behaviors in daily life.

Pregnant women living in rural areas, such as villages/towns, had the highest scores on both scales ($p < 0.001$), especially for healthy life behavior (124.65 ± 20.39). This could indicate that pregnant women in rural areas may adhere more closely to traditional pregnancy practices and routines, which might contribute to more careful behavior, although this interpretation should be approached cautiously.

Those who had been married for 5–9 years had the highest scores in making decisions over the internet ($p < 0.001$), while those married for 0–4 years performed better in healthy life behaviors ($p < 0.05$). These differences may be related to changing roles and responsibilities over the course of marriage.

Number of pregnancies has a significant effects on both internet decision-making and healthy life behaviors ($p < 0.05$). Those who had three or more pregnancies had higher scores than those who had their first pregnancy.

Pregnant women whose income was less than their expenses scored significantly lower in decision-making through the internet (31.96 ± 6.22 , $p < 0.001$). This finding

shows that economic difficulties have a negative impact on digital health decisions and that financial resources can directly affect access to information. However, no significant difference was observed in healthy living behaviors ($p > 0.05$).

It was determined that the total mean score of the internet decision-making scale during pregnancy of pregnant women with a nuclear family structure was statistically significantly higher than that of pregnant women with an extended family structure ($p < 0.05$).

It was determined that the total mean score of the internet decision-making in pregnancy scale of the pregnant women with two or more births was statistically significantly higher than the others ($p < 0.001$). It was determined that the total mean score of the healthy lifestyle behaviors in pregnancy scale of the pregnant women with two or more births was statistically significantly higher than the pregnant women with one birth ($p < 0.05$).

It was determined that the total mean score of the internet decision-making scale in pregnancy of pregnant women who had experienced a miscarriage/abortion was statistically significantly higher than those who had not ($p < 0.05$). However, no significant difference was observed in terms of healthy living behaviors ($p > 0.05$).

Pregnant women who received prenatal education ($p < 0.05$) and went to prenatal health check-ups ($p < 0.05$, $p < 0.001$) had significantly higher scores for both internet decision-making and healthy living behaviors. This finding highlights the potential importance of health education and suggests that such programs may positively influence health-related behaviors.

Pregnant women who used tobacco and alcohol showed significantly lower values in the healthy living behaviors score ($p < 0.05$). This finding is consistent with expectations, as unhealthy habits are likely to negatively affect healthy behavior levels.

Overall, the results suggest that demographic, obstetric, socioeconomic, and behavioral factors have significant effects on pregnant women's decision-making status and healthy life behaviors through the internet. These data may guide the development of individualized counseling and digital health literacy programs for pregnant women. However, the explanations provided should be interpreted as possible interpretations rather than direct statistical conclusions.

Discussion

This study was conducted to examine the decision-making levels of pregnant women through the internet and their healthy lifestyle behaviors, and the individual, sociodemographic, and obstetric factors affecting these. The findings revealed that pregnant women have a moderate level of self-efficacy and control perception in accessing and using digital information about health, and that they exhibit positive attitudes in terms of healthy lifestyle behaviors, especially in the areas of nutrition, hygiene, and pregnancy responsibility, but their physical activity levels are low. Importantly, this study is among the first to evaluate pregnant women's internet-based decision-making together with their healthy lifestyle behaviors in a single framework, offering an integrated perspective that previous research has largely overlooked.

In the study, it was observed that the scores for decision-making and healthy living behaviors via the internet increased with age. This shows that the individual becomes more selective and conscious in seeking health-related information as they get older. Similarly, Rezaee et al.^[5] reported that age and experience have a positive effect on decision-making processes; Jacobs et al.^[10] reported that older pregnant women are more cautious and careful in using online information.

A significant relationship was found between education status and internet usage level. The fact that pregnant women who graduated from secondary school had the highest scores in both decision-making through the internet and healthy living behaviors suggests that digital literacy is not limited to formal education level, and factors such as the individual's habit of accessing digital resources,

environmental support, and motivation to access information are also effective.^[6] Similarly, Özcan et al.^[11] also emphasized the importance of access to information as well as the level of education.

While working women have higher levels of decision-making through the internet, their healthy life behavior scores are lower, indicating that access to information is not always reflected in practice. This finding is consistent with the study conducted by Al-Dahshan et al.^[8] The authors stated that working women can access information more easily, but they have difficulty in changing their behavior due to time constraints.

The fact that women living in rural areas scored higher on both scales suggests that traditional family structure and more planned pregnancy experiences may be effective. Ünal et al.^[4] revealed that women in rural areas spent their pregnancy more carefully and gave more importance to health behaviors.

The fact that women who had experienced more than one pregnancy and birth had higher scores in internet use and healthy living behaviors shows that experience is an important determinant in these processes. This supports the view emphasized by Mecdi and Rathfisch^[3] that the experience gained during pregnancy is reflected in behaviors in later processes.

The fact that pregnant women whose income is less than their expenses have low scores for making decisions through the internet brings the concept of digital inequality to the agenda. Kocademir and Gerçek Öter state that income level is a determinant in basic points such as access to digital resources, device use, and data purchase.^[14] Similarly, Rezaee et al.^[5] showed that economic inadequacies have a direct negative impact on digital health decisions.

In fact, global studies after 2020 also point to the persistence of a "digital divide," especially in maternal health contexts, where disadvantaged groups face more barriers in accessing reliable digital health information and telehealth services.^[27,28] These findings suggest that addressing digital inequalities should be a core priority in designing maternal health interventions.

It was observed that women with a history of previous miscarriage/abortion searched for more information on the internet. This finding is parallel to the study of De Santis et al.,^[13] where researchers emphasized that women who had complications searched for information online more intensely.

The fact that women who received prenatal education and had a prenatal health check-up had high scores on both

decision-making and healthy living behaviors once again revealed the importance of structured education. Ceylan et al.^[7] and Tunca also drew attention to the positive effect of prenatal education on behavioral outcomes.^[11]

It is also known that pregnant women use the Internet extensively in their decision-making processes, but this use can sometimes lead to confusion and information confusion.^[12,15] Therefore, it is important that the process of accessing information is guided by health professionals, reliable sources are recommended, and individualized consultancy services are provided. In addition, from a practical perspective, midwives and nurses should not only direct pregnant women to reliable websites but also integrate digital health counseling into routine antenatal care. Evidence shows that combining online information with professional guidance improves maternal outcomes and reduces anxiety.^[29]

The fact that physical activity is found to be low compared to other behaviors indicates that more support and encouragement are needed in this area. Yılmaz and Karahan,^[26] and Mihiret et al.^[2] similarly revealed that physical activity is the weakest behavior category during pregnancy. This is consistent with international studies showing that despite widespread awareness campaigns, physical activity levels in pregnant women remain insufficient worldwide.^[30] Barriers include cultural norms, lack of safe spaces, and limited digital health content promoting exercise during pregnancy. Digital interventions that include tailored exercise modules and remote coaching have been reported to increase adherence, particularly in high-income countries, but their effectiveness in low- and middle-income contexts remains uncertain.^[31]

In conclusion, internet-based health information seeking stands out as an important factor affecting decision-making processes in pregnant women. However, in order for this process to yield positive results, information literacy needs to be developed, health professionals need to provide active consultancy, and digital content needs to be based on scientific foundations. When these findings are evaluated in a global context, they demonstrate that Turkey shares many similarities with international experiences in digital health use; however, structural inequalities and cultural differences shape the results in unique ways. Indeed, studies in European countries show that pregnant women use the internet primarily to obtain information before consulting with healthcare professionals, while studies in Asian countries reveal that internet use is more often associated with sharing

peer experiences and seeking social support.^[9,10] In our study, however, both trends are observed simultaneously, suggesting that both information seeking and the need for social support shape internet use.

Limitations of the Study

This study has several methodological limitations. Data were collected from two public hospitals in the Mediterranean Region; therefore, the findings cannot be generalized to all pregnant women in Turkey. Although valid and reliable scales were used, focusing solely on internet use may not fully represent today's diversified digital health behaviors. The cross-sectional design limits causal interpretation; thus, it cannot be determined whether internet use affects healthy lifestyle behaviors or the reverse. Social media, mobile health applications, and online platforms were not included, and internet use was examined in a general context.

Conclusion

Pregnant women showed moderate competence in accessing and using digital information, positive behaviors in nutrition, hygiene, and pregnancy responsibility, though low physical activity. Expanding prenatal education and strengthening digital health literacy, especially for low-income and less-educated women, are recommended. Access to online information appears to support healthy behaviors during pregnancy, but this process is shaped by factors such as age, experience, education, and social support, which healthcare providers should consider in planning and practice.

Ethics Committee Approval: The Burdur Mehmet Akif Ersoy University Non-Interventional Clinical Research Ethics Committee granted approval for this study (date: 03.12.2024, number: GO 2024/847).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: Not declared.

Authorship Contributions: Concept: EÇA, SUY, NB; Design: EÇA, SUY, NB; Supervision: EÇA, SUY, NB; Materials: EÇA, SUY, NB; Data Collection or Processing: EÇA, SUY, NB; Analysis or Interpretation: EÇA, SUY, NB; Literature Search: EÇA, SUY, NB; Writing: EÇA, SUY, NB; Critical Review: EÇA, SUY, NB.

Acknowledgments: We thank all pregnant women who agreed to participate in the study.

Peer-review: Double blind peer-reviewed.

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Appendix 1. Power analysis report

An a priori power analysis was conducted using the G*Power 3.1.9.7 program to determine the minimum sample size required for the study. The analysis was based on the following parameters:

Input parameters

Test family	F tests
Statistical test	ANOVA: Fixed effects, omnibus, one-way
Effect size f	0.20
α err prob	0.05
Power (1- β err prob)	0.95
Number of groups	4

According to the power analysis, a minimum of 312 participants was required to achieve sufficient statistical power. However, the study was conducted with 367 volunteer pregnant women, which exceeds the required sample size, thus increasing the reliability of the findings.

Output parameters

Non-centrality parameter λ	59.2800
Critical F	2.6809
Numerator df	3
Denominator df	308
Total sample size	312
Actual power	0.9502

Appendix 2. Internet decision-making scale in pregnancy score averages and influencing factors according to participants' individual characteristics

Individual characteristics	Internet decision-making scale in pregnancy	
	Mean (SD)	Test statistics/p
Age*		
19–25 ^a	36.54 (5.87)	F: 6.285; df: 2; η^2 : 0.033
26–32 ^b	38.29 (7.14)	p=0.002
33–39 ^c	39.98 (8.92)	Significant difference: c>a
Education status*		
Primary school ^a	40.41 (7.53)	F: 19.351; df: 3; η^2 : 0.138
Middle school ^b	43.48 (6.48)	p<0.001
High school ^c	36.02 (6.54)	Significant difference: a,b>c; b>d
University and above ^d	37.44 (7.15)	
Working status**		
Yes	39.71 (5.88)	t: 2.267; df: 136.274; Cohen's d: 0.031
No	37.57 (7.49)	p=0.002
Place of residence*		
Village-town ^a	43.03 (7.42)	F: 12.244; df: 2; η^2 : 0.063
District ^b	38.59 (6.93)	p<0.001
Province ^c	36.37 (7.07)	Significant difference: a>b>c
Years of marriage*		
0–4 years ^a	37.57 (7.03)	F: 8.140; df: 2; η^2 : 0.043
5–9 years ^b	39.62 (7.35)	p<0.001
10 and above ^c	34.73 (6.68)	Significant difference: b>a,c
Family income status*		
Income is less than expenses ^a	31.96 (6.22)	F: 26.097; df: 2; η^2 : 0.125
Income is equal to expenses ^b	39.03 (6.80)	p<0.001
Income is more than expenses ^c	39.40 (7.45)	Significant difference: b,c>a
Family type**		
Nuclear family	38.22 (7.39)	t: 1.923; df: 43.286; Cohen's d: 0.041
Extended family	35.61 (4.97)	p=0.011
Number of pregnancies*		
First ^a	36.52 (6.48)	F: 7.737; df: 2; η^2 : 0.041
Second ^b	37.67 (6.34)	p=0.001
Three and above ^c	40.19 (8.65)	Significant difference: c>a,b
Number of births*		
0 ^a	37.42 (6.92)	F: 9.721; df: 2; η^2 : 0.051
1 ^b	36.67 (5.82)	p<0.001
2 and above ^c	40.70 (8.74)	Significant difference: c>a,b
Miscarriage/abortion status**		
No	37.53 (7.04)	t: -2.958; df: 68.316; Cohen's d: 0.042
Yes	40.66 (7.90)	p=0.008
Is your pregnancy planned?**		
Yes	38.32 (7.49)	t: 1.516; df: 197.307; Cohen's d: 0.017
No	37.11 (6.48)	p=0.131

Appendix 2 (cont.). Internet decision-making scale in pregnancy score averages and influencing factors according to participants' individual characteristics

Individual characteristics	Internet decision-making scale in pregnancy	
	Mean (SD)	Test statistics/p
Pre-pregnancy health check status**		
Yes	38.64 (7.15)	t: 2.527; df: 219.997; Cohen's d: 0.028 p=0.013
No	36.60 (7.29)	
Prenatal education status during current pregnancy**		
Yes	38.75 (6.93)	t: 2.944; df: 210.859; Cohen's d: 0.032 p=0.005
No	36.39 (7.65)	
Tobacco and tobacco products usage**		
Yes	37.80 (6.11)	t: -0.194; df: 67.570; Cohen's d: 0.003 p=0.824
No	38.02 (7.41)	
Alcohol use status		
Yes	38.27 (4.66)	t: -0.166; df: 21.636; Cohen's d: 0.001 p=0.805
No	37.98 (7.36)	

*: One-way analysis of variance; Post hoc test: Bonferroni; **: Independent samples test. Superscript letters (a, b, c, and d) indicate the groups used for post hoc pairwise comparisons. Bold p values indicate statistical significance ($p < 0.05$). SD: Standard deviation.

Appendix 3. Healthy lifestyle behaviors scale in pregnancy score averages and influencing factors according to participants' individual characteristics

Individual characteristics	Healthy lifestyle behaviors scale in pregnancy	
	Mean (SD)	Test statistics/p
Age*		F: 5.562; df: 2; η^2 : 0.030
19–25 ^a	112.81 (14.61)	p=0.004
26–32 ^b	115.61 (12.18)	Significant difference: c>a
33–39 ^c	119.75 (19.67)	
Education status*		F: 11.088; df: 3; η^2 : 0.064
Primary school ^a	115.88 (21.80)	p<0.001
Middle school ^b	124.68 (18.62)	Significant difference: b>a,c,d
High school ^c	111.93 (11.78)	
University and above ^d	116.13 (13.65)	
Working status**		t: -2.973; df: 152,177; Cohen's d: 0.043
Yes	110.76 (11.24)	p<0.001
No	116.63 (15.91)	
Place of residence*		F: 21.869; df: 2; η^2 : 0.107
Village-town ^a	124.65 (20.39)	p<0.001
District ^b	118.74 (15.87)	Significant difference: a,b>c
Province ^c	109.94 (11.04)	
Years of marriage*		F: 7.169; df: 2; η^2 : 0.038
0–4 years ^a	117.19 (14.34)	p=0.001
5–9 years ^b	115.45 (16.57)	Significant difference: a,b>c
10 and above ^c	107.41 (12.55)	
Family income status*		F: 1.216; df: 2; η^2 : 0.007
Income is less than expenses ^a	115.55 (14.37)	p=0.298
Income is equal to expenses ^b	116.01 (16.16)	
Income is more than expenses ^c	112.17 (9.68)	
Family type**		t: 0.413; df: 32.868; Cohen's d: 0.001
Nuclear family	115.57 (14.70)	p=0.757
Extended family	114.38 (20.64)	
Number of pregnancies*		F: 4.359; df: 2; η^2 : 0.023
First ^a	115.50 (12.89)	p=0.013
Second ^b	112.97 (13.78)	Significant difference: c>b
Three and above ^c	118.76 (18.85)	
Number of births*		F: 5.149; df: 2; η^2 : 0.028
0 ^a	114.78 (12.74)	p=0.006
1 ^b	113.24 (13.85)	Significant difference: c>b
2 and above ^c	119.60 (19.34)	
Miscarriage/abortion status**		t: 1.454; df: 71.334; Cohen's d: 0.021
No	115.95 (15.17)	p=0.159
Yes	112.68 (15.62)	
Is your pregnancy planned?**		t: 0.867; df: 149.749; Cohen's d: 0.009
Yes	115.88 (14.49)	p=0.425
No	114.32 (17.32)	

Appendix 3 (cont.). Healthy lifestyle behaviors scale in pregnancy score averages and influencing factors according to participants' individual characteristics

Individual characteristics	Healthy lifestyle behaviors scale in pregnancy	
	Mean (SD)	Test statistics/p
Pre-pregnancy health check status**		
Yes	117.56 (15.64)	t: 3.950; df: 258.779; Cohen's d: 0.060 p<0.001
No	110.93 (13.37)	
Prenatal education status during current pregnancy**		
Yes	116.99 (15.24)	t: 2.805; df: 234.890; Cohen's d: 0.031 p=0.005
No	112.25 (14.87)	
Tobacco and tobacco products usage**		
Yes	108.70 (15.31)	t: -3.299; df: 59.754; Cohen's d: 0.051 p=0.002
No	116.46 (15.02)	
Alcohol use status		
Yes	108.05 (10.13)	t: -2.123; df: 21.277; Cohen's d: 0.060 p=0.006
No	115.85 (15.39)	

*: One-way analysis of variance; post hoc test: Bonferroni; **: Independent samples test. Superscript letters (a, b, c, and d) indicate the groups used for post hoc pairwise comparisons. Bold p values indicate statistical significance ($p<0.05$). SD: Standard deviation.

Assessment of Perceived Food Literacy among Individuals with Diabetes: A Cross-Sectional Study

Çağla Pınarlı Falakacılar, Büşra Günesen

Department of Nutrition and Dietetics, İstanbul Gedik University Faculty of Health Sciences, İstanbul, Türkiye

Abstract

Introduction: Food literacy plays a crucial role in the nutritional behaviors and self-management capacities of individuals with chronic diseases such as diabetes, helping them to manage their conditions and maintain a healthy lifestyle. Understanding the factors influencing food literacy can contribute to more effective interventions. This study aimed to evaluate the perceived food literacy levels of individuals diagnosed with type 1 or type 2 diabetes, examining their associations with sociodemographic and anthropometric characteristics.

Methods: A cross-sectional study was conducted with individuals aged 18–64 years and living in İstanbul, Türkiye, who had been diagnosed with type 1 or type 2 diabetes. Data were collected through an online questionnaire, which included a Sociodemographic and General Information Form (9 items) and the 29-item perceived food literacy scale (PFLS). The results of the study were analyzed using the Statistical Package for the Social Sciences version 20, with a significance level of $p < 0.05$.

Results: The study was completed with 412 individuals. Perceived food literacy levels were significantly higher among women, single participants, and individuals with a university education. Negative correlations were observed between age, body mass index (BMI), and several PFLS subdimensions. In addition, individuals with type 1 diabetes had significantly higher food literacy scores than those with type 2 diabetes.

Discussion and Conclusion: Sociodemographic and anthropometric factors such as BMI, sex, age, education level, and diabetes type are important determinants of food literacy. Tailored nutrition education interventions could improve food literacy and support diabetes self-management. Further research is needed to explore causal relationships and long-term outcomes.

Keywords: Food literacy; Nutrition; Type 1 diabetes; Type 2 diabetes

Diabetes mellitus is a group of metabolic disorders characterized by elevated blood glucose levels (hyperglycemia) due to impaired carbohydrate metabolism, resulting from inadequate utilization of glucose for energy and irregularities in gluconeogenesis and glycogenolysis processes.^[1] Clinically, diabetes is classified into several

subtypes, including type 1 diabetes, type 2 diabetes, gestational diabetes, and other specific forms caused by distinct underlying factors.^[2]

According to the 2025 Diabetes Atlas report by the International Diabetes Federation (IDF), 11.1% of the global adult population aged 20–79, approximately one in

Cite this article as: Pınarlı Falakacılar Ç, Günesen B. Assessment of Perceived Food Literacy among Individuals with Diabetes: A Cross-Sectional Study. Lokman Hekim Health Sci 2026;6(3):409–417.

Correspondence: Çağla Pınarlı Falakacılar. İstanbul Gedik Üniversitesi Sağlık Bilimleri Fakültesi, Beslenme ve Diyetetik Anabilim Dalı, İstanbul, Türkiye
E-mail: cagla.pinarli@gedik.edu.tr **Submitted:** 18.08.2025 **Revised:** 26.12.2025 **Accepted:** 30.12.2025 **Available Online:** 06.08.2026



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every nine individuals, are currently living with diabetes. Alarming, over 40% of these individuals are unaware of their condition. Projections by IDF estimate that by 2050, one in every eight adults will be diagnosed with diabetes.^[3]

Nutrition plays a central role in the prevention and management of diabetes, particularly in regulating blood glucose levels. The type and amount of carbohydrates consumed, as well as the overall macronutrient balance, directly impact glycemic control and long-term metabolic health.^[4,5] In this context, food literacy has emerged as a critical factor influencing dietary behavior. Food literacy empowers individuals to make informed decisions regarding food and nutrition, thereby contributing to better public health outcomes and supporting sustainability goals.^[6,7] It encompasses the knowledge, skills, and behaviors necessary to maintain a healthy dietary pattern and make responsible food choices that benefit both personal and planetary health.^[8,9]

Competence in planning, selecting, preparing, and consuming healthy foods is particularly important for individuals with diabetes, as these skills play a vital role in glycemic regulation. Higher levels of food literacy have been associated with improved blood glucose control and healthier eating habits.^[10] Several factors have been shown to influence food literacy, including age, sex, education level, and environmental, social, economic, and cultural conditions.^[11,12]

Although food literacy has received more attention in recent years, the number of studies investigating its relationship with diabetes in Türkiye is still limited. Unlike previous studies in Türkiye that primarily focused on individuals with type 2 diabetes, the present study included both type 1 and type 2 diabetes patients, providing a broader understanding of food literacy among people with diabetes. Furthermore, most existing studies focus on either the general population or specific dietary behaviors, with very few examining how food literacy differs between individuals with type 1 and type 2 diabetes.^[13,14] Given the cultural and dietary diversity across regions, examining this topic in the Turkish context is particularly important. Istanbul, Türkiye's largest city, is a valuable setting for such research, as it has a diverse population with a wide range of lifestyles that reflect both traditional and modern dietary habits. In light of these considerations, the present study aimed to examine the relationship between sociodemographic characteristics and perceived food literacy levels among individuals diagnosed with different types of diabetes.

Materials and Methods

Study Place and Design

This research was conducted as a descriptive, cross-sectional study. Study was conducted in Istanbul, Türkiye, between January and May 2023. The research was carried out online through Google Forms among adults diagnosed with type 1 or type 2 diabetes to evaluate their perceived food literacy levels and related factors.

Population

The target population was defined as adults with type 1 or type 2 diabetes living in Istanbul. A total of 412 individuals who met the inclusion criteria completed the survey.

In addition, a post hoc power analysis was conducted to assess whether the sample sizes of type 1 and type 2 diabetes participants were sufficient.

Questionnaire

The data collection tool consisted of an online questionnaire composed of two main sections. The first section is the Sociodemographic and General Information Form. The second section comprised the perceived food literacy scale (PFLS).

Data Collection

All data were collected using an online questionnaire hosted on Google Forms. Access to the survey remained open during the data collection period. Only individuals who gave informed consent through the "Voluntary Participation Information Form" were permitted to proceed to the survey. The following tools were used for data collection:

Sociodemographic and General Information Form

This form was developed by researchers and includes questions regarding age, sex, marital status, height, weight, education level, income level, and prior nutrition education status.

PFLS

This scale was developed by Poelman et al.^[15] and adapted to Turkish by Selçuk et al.^[16] in 2020. It consists of 29 items across 8 subdimensions: Food preparation skills, resistance and self-control, healthy snack types, social and mindful eating, reading food labels, daily meal planning, spending on healthy food, and availability of healthy food at home. The items are rated on a 5-point Likert scale ranging from 1 "never" to 5 "always." Higher scores indicate higher food literacy levels.^[16]

Calculation of Body Mass Index (BMI)

The BMI (kg/m^2) value was obtained by dividing body weight by height squared. Individuals' BMI values were evaluated according to the World Health Organization classification.^[17]

Statistical Analysis

The analytical framework of the present study was structured to address the main research question: To describe the level of food literacy among adults with Type 1 and Type 2 diabetes, to identify its associations with sociodemographic and anthropometric variables, and to determine its independent predictors. An independent samples t-test was used to assess group differences between individuals with Type 1 and Type 2 diabetes. Correlation analyses were conducted to examine the relationships between food literacy and quantitative variables. In addition, a regression model was employed to identify the key variables that independently predicted food literacy.

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 20 (SPSS Inc., Chicago, IL, USA) statistical software. Descriptive statistics such as frequency (n) and percentage (%) were used. For group comparisons, Student's t-test was used for normally distributed variables. Pearson correlation was used for normally distributed variables, while Spearman correlation was used for non-normally distributed variables. Shapiro-Wilk and Kolmogorov-Smirnov tests were conducted to assess the normality of the data, and the skewness and kurtosis values (between -1.5 and +1.5) indicated that the data were normally distributed.

To control for multiple comparisons, the Benjamini-Hochberg false discovery rate correction was applied. Effect sizes for between-group comparisons were calculated using Cohen's d.

To test whether diabetes type independently predicted food literacy outcomes, multiple linear regression analyses were performed after adjusting for age, sex, education level, and BMI. The regression results were expressed as unstandardized coefficients (B), standard errors, 95% confidence intervals (CI), and p-values. Statistical significance was set at $p < 0.05$.

Ethical Approval

The study was approved by the Ethics Committee of Istanbul Gedik University (Meeting dated February 08, 2022, decision number: 2022/2, approval number: 301)

and was conducted in accordance with the principles of the Declaration of Helsinki. Participants provided informed consent before completing the online questionnaire. All responses were collected anonymously through a secure Google Forms platform, and no personally identifiable information was recorded or stored.

Results

A total of 433 people participated in the study on the specified dates, and the study was conducted with 412 people who were diagnosed with Type 1 or Type 2 diabetes. To evaluate the adequacy of the sample size, a post hoc power analysis was conducted for the PFLS scores comparison between Type 1 and Type 2 diabetes participants. With an observed effect size of Cohen's $d = 0.46$ and group sizes of 234 and 178, the achieved power was 0.99 at $\alpha = 0.05$ (two-tailed), indicating that the sample size was sufficient to detect the observed group difference. In this study, the post hoc power analysis was used solely to assess feasibility due to the convenience sampling; it does not provide a basis for statistical inference or representativeness.

The mean age of participants was 39.4 ± 13.3 years. The majority of participants were female (63.1%) and classified as overweight according to BMI (47.8%). More than half of the participants (55.3%) had previously participated in at least one form of educational activity related to nutrition, such as a seminar, workshop, or conference (Table 1).

The relationship between participants' PFLS scores and anthropometric measurements such as age, weight, and BMI was examined, and several statistically significant correlations were found ($p < 0.05$), as shown in Table 2. Food preparation skills were weakly and negatively correlated with age ($r = -0.217$), body weight ($r = -0.199$), and BMI ($r = -0.147$). Resilience and resistance showed a weak-positive correlation with age ($r = 0.098$) and weak-negative correlations with weight and BMI. Healthy snack styles demonstrated weak-negative associations with all three anthropometric variables. Social and conscious eating showed no significant correlations ($p > 0.05$). Examining food labels displayed weak-to-moderate negative correlations with age ($r = -0.318$), body weight ($r = -0.299$), and BMI ($r = -0.327$). Daily food planning showed weak-negative correlations with these variables. Healthy budgeting was moderately and negatively correlated with age and weakly with weight and BMI. In contrast, healthy food stockpiling had weak-to-moderate positive correlations with age, weight, and BMI. Finally, the PFLS total score showed weak

Table 1. General characteristics of participants (n=412)

Age (Min–Max/Mean±SD)	18–62/39.4±13.3	
Height (Min–Max/Mean±SD)	1.51–1.90/1.67±8.1	
Body weight (Min–Max/Mean±SD)	46.1–120/71.5±16.2	
PFLS total point (Min–Max/Mean±SD)	58–134/103.6±18.7	
	n	%
Gender		
Male	152	36.9
Female	260	63.1
Marital status		
Married	252	61.2
Single	160	38.8
Type of diabetes		
Type 1	234	56.8
Type 2	178	43.2
BMI classification		
Underweight	12	2.9
Normal weight	184	44.6
Overweight	197	47.8
Obese	19	4.7
Education level		
Primary school	32	7.8
Secondary school	36	8.7
High school	124	30.1
University	184	44.7
Master's degree/doctorate	36	8.7
Income level		
Less than expenditure	128	31.1
Equal to expenditure	188	45.6
More than expenditure	96	23.3
Any nutrition training received		
Yes	228	55.3
No	184	44.7
Total	412	100.0

PFLS: Perceived food literacy scale; Min–Max: Minimum–Maximum; SD: Standard deviation; BMI: Body mass index.

but significant negative correlations with age ($r=-0.186$), body weight ($r=-0.185$), and BMI ($r=-0.176$).

Significant differences in the PFLS total score were observed by sex, education level, and marital status, with higher scores among females, individuals with higher education, and single participants ($p<0.05$), as presented in Table 3.

Participants with type 1 diabetes had significantly higher scores than those with type 2 diabetes in food preparation skills, healthy snack styles, daily food planning, healthy

food stockpiling, and total PFLS score ($p<0.05$) (Table 4). The effect sizes for these subscales ranged from small to moderate (Cohen's $d=0.42$ – 0.49) for Food preparation skills, Daily food planning, and PFLS total score, to large ($d=0.70$) for Healthy snack styles.

After adjusting for age, sex, education level, marital status, and BMI, multiple linear regression analyses were conducted to examine whether diabetes type predicted food literacy outcomes (Table 5). In this study, a multivariable logistic regression analysis was conducted to identify the sociodemographic and eating behavior variables predicting diabetes type (coded as Type 1 diabetes=0, Type 2 diabetes=1). The overall model was statistically significant ($\chi^2=254.686$; $p<0.001$) and explained a substantial proportion of the variance in diabetes type (Nagelkerke $R^2=0.619$). The classification accuracy of the model was 85.4%, correctly predicting 87.6% of individuals with type 1 diabetes and 82.6% of those with type 2 diabetes. Although the Hosmer–Lemeshow test was significant ($p=0.003$), indicating some miscalibration across probability deciles, the model's discriminative ability and the direction of the coefficients remained interpretable.

According to the results, age and body weight were among the strongest predictors of type 2 diabetes. Each 1-year increase in age increased the likelihood of type 2 diabetes by approximately 11% (OR=1.112; 95% CI: 1.072–1.153; $p<0.001$). Likewise, higher body weight was significantly associated with increased odds of type 2 diabetes (OR=1.133; 95% CI: 1.068–1.203; $p<0.001$).

Sex was also a significant determinant. Males had markedly lower odds of type 2 diabetes compared with females (OR=0.115; 95% CI: 0.042–0.321; $p<0.001$), indicating a higher prevalence of type 2 diabetes among women in this sample. Educational level was another significant predictor; individuals with a university-level education or higher had significantly lower odds of type 2 diabetes compared with those with a high-school education or less (OR=0.328; 95% CI: 0.172–0.625; $p=0.001$).

Regarding eating behavior variables, healthy snack styles and daily food planning were found to have protective effects against type 2 diabetes. Higher scores in healthy snack styles reduced the likelihood of type 2 diabetes by approximately 20% (OR=0.795; 95% CI: 0.714–0.885; $p<0.001$). Similarly, higher levels of daily food planning were inversely associated with type 2 diabetes (OR=0.708; 95% CI: 0.575–0.872; $p=0.001$).

Conversely, examining food labels was positively associated with the likelihood of type 2 diabetes (OR=1.402; 95%

Table 2. Relationship between participants' PFLS and anthropometric measurements

	Age		Height		Body weight		BMI (kg/m ²)	
	r	p	r	p	r	p	r	p
Food preparation skills	-0.217**	<0.001**	-0.063	0.293	-0.199*	0.002*	-0.147*	0.003*
Resilience and resistance	0.098*	0.047*	0.016	0.957	-0.146*	0.003*	-0.186	0.06
Healthy snack styles	-0.292**	0.001**	-0.049	0.063	-0.206**	<0.001*	-0.229**	<0.001**
Social and conscious eating	-0.046	0.352	-0.043	0.063	0.015	0.757	0.032	0.515
Examining food labels	-0.318**	0.001**	-0.058	0.081	-0.299**	0.001**	-0.327**	<0.001**
Daily food planning	-0.158**	0.001	-0.037	0.675	-0.197**	0.001**	-0.157	0.054
Healthy budgeting	-0.359**	<0.001**	-0.031	0.495	-0.127*	0.011*	-0.141	0.005
Healthy food stockpiling	0.258**	0.001**	0.034	0.721	0.258**	<0.001**	0.282**	0.018*
PFLS total score	-0.186**	0.001**	-0.093	0.477	-0.185**	<0.001**	-0.176**	0.120

*: Statistical significance at $p < 0.05$; **: Statistical significance at $p < 0.01$. BMI: Body mass index; PFLS: Perceived food literacy scale.

CI: 1.186–1.658; $p < 0.001$). Likewise, higher scores on the behavior of “making a special effort for healthy foods” were associated with increased odds of type 2 diabetes (OR=1.256; 95% CI: 1.025–1.539; $p = 0.028$).

Food literacy was statistically significant ($B = -0.028$; $p < 0.001$). The negative coefficient indicates that higher food literacy decreased the likelihood of type 2 diabetes. The odds ratio (OR=0.972) suggests that each one-point increase in food literacy score reduced the odds of type 2 diabetes by approximately 2.8%. The narrow CI (0.959–0.985) supports the robustness and stability of this effect.

BMI, marital status, food preparation skills, resilience and resistance, healthy food stockpiling, and social and conscious eating were not significant independent predictors in the model ($p > 0.05$).

Discussion

In this study, the perceived food literacy levels of individuals diagnosed with Type 1 or Type 2 diabetes were evaluated in relation to their sociodemographic and anthropometric characteristics.

Most people diagnosed with Type 1 or Type 2 diabetes in this study were female (63.1%). Recent epidemiological data from Türkiye also show a higher prevalence of diagnosed diabetes in women than in men in 2020, suggesting that the gender patterns observed here reflect broader national trends.^[18] Potential explanations for this include sex-specific healthcare-seeking behaviors and greater participation of women in surveys.

Over half of the samples (55.3%) reported attending at least one nutrition-related educational activity, such as a workshop or seminar. While this suggests reasonable public health outreach, approximately half of the participants had

no such exposure. A study on this subject found that 58% of individuals with diabetes were aware of the condition.^[19] It is currently believed that education in general will be important in increasing diabetes awareness.

In this study, several significant correlations were found between participants' anthropometric characteristics (such as age, body weight, and BMI) and various dimensions of PFLS. Age was negatively associated with food preparation skills, healthy snack choices, label reading, and healthy budgeting ($p < 0.05$). These findings are in line with previous literature suggesting that food-related cognitive and behavioral skills may decline with age due to factors such as reduced exposure to updated nutrition information or digital access limitations.^[20] In addition, older adults may rely more on traditional eating patterns, which might not align with current nutrition education messages, thereby lowering their self-perceived competence in areas such as healthy snack choices or reading food labels.

Body weight and BMI also demonstrated several inverse correlations with food literacy components. Higher body weight was associated with lower scores in food preparation, snack choices, and label reading ($p < 0.05$). Individuals with lower food literacy tend to have poorer dietary habits, use food labels less frequently, and have lower awareness of nutritional quality, which contributes to weight gain and an increased risk of obesity.^[21]

In this study, female participants exhibited significantly higher PFLS total scores compared to male participants ($p < 0.05$). This finding is consistent with numerous studies showing that women tend to have greater health consciousness, are more likely to seek nutrition-related information, and often take the lead in household food planning and preparation.^[22,23] These gender-based

Table 3. PFLS score according to participants' sociodemographic characteristics

	Food preparation skills Mean±SD	Resilience and resistance Mean±SD	Healthy snack styles Mean±SD	Social and conscious eating Mean±SD	Examining food labels Mean±SD	Daily food planning Mean±SD	Healthy budgeting Mean±SD	Healthy food stockpiling Mean±SD	PFLS total score Mean±SD
Gender									
Male	18.8±5.2	18.2±3.9	12.6±4.2	10.5±2.6	6.1±2.6	5.9±2.2	6.7±2.4	16.9±3.5	96.1±15.8
Female	23.3±4.6	19.3±4.2	15.0±2.9	11.6±2.4	7.3±2.2	7.0±1.7	8.1±1.8	16.0±3.4	107.9±13.8
p	<0.001*	0.222	0.003*	0.038*	0.013*	0.007*	0.005*	0.232	<0.001*
Effect size	0.932	0.269	0.698	0.444	0.51	0.579	0.686	-0.262	0.81
Education level									
High school and below	20.1±5.3	19.0±5.0	13.2±4.1	10.9±3.1	6.0±2.8	6.1±2.2	7.0±2.5	16.4±3.6	98.8±18.5
University and above	22.9±4.9	18.8±3.3	14.9±3.0	11.5±1.9	7.6±1.8	7.0±1.6	8.1±1.7	16.4±3.36	107.4±11.6
p	0.007*	0.837	0.022*	0.239	0.002*	0.021*	0.018*	0.989	0.008*
Effect size	0.55	-0.048	0.478	0.237	0.69	0.473	0.521	0.1	0.565
Marital status									
Married	21.1±5.7	18.7±4.3	13.3±4.1	11.4±2.5	6.1±2.6	6.0±2.1	7.0±2.2	16.8±3.2	100.7±16.9
Single	22.5±4.4	19.2±3.9	15.4±2.1	11.0±2.6	8.1±1.5	7.5±1.4	8.5±1.7	15.6±3.8	108.1±12.0
p	0.178	0.560	0.001*	0.506	<0.001*	<0.001*	<0.001*	0.079	0.010*
Effect size	0.267	0.12	0.606	-0.158	0.893	0.806	0.742	-0.348	0.487
Income level									
Less than expenditure 1	21.2±5.8	18.5±4.5	13.0±4.5	11.1±3.0	6.1±2.6	6.3±2.3	6.6±2.6	16.5±3.4	99.6±19.2
Equal to expenditure 2	22.0±5.1	18.7±4.1	14.8±3.2	11.1±2.5	7.3±2.2	6.7±2.0	7.8±1.8	16.4±3.6	105.1±14.3
More than expenditure 3	21.5±5.0	19.6±3.7	14.3±2.7	11.6±2.0	7.0±2.4	6.7±1.2	8.5±1.5	16.1±3.3	105.7±11.8
p	0.784	0.603	0.091	0.731	0.097	0.596	0.003*	0.924	0.232
Pairwise comparison	-	-	-	-	-	-	3>1	-	-
q (FDR)	0.882	0.765	0.291	0.835	0.230	0.880	0.027*	0.920	0.522
Effect size	0.004	0.01	0.007	0.046	0.190	0.113	0.560	0.265	0.290
Any nutrition training received									
Yes	21.8±5.6	18.3±3.7	14.3±3.6	11.1±2.7	7.0±2.4	6.6±1.9	7.6±2.2	16.4±3.4	103.5±16.1
No	21.2±4.4	20.0±4.9	13.5±3.7	11.6±2.1	6.5±2.5	6.4±2.1	7.6±2.1	16.2±3.6	103.3±14.5
p	0.576	0.067	0.324	0.313	0.308	0.662	0.946	0.859	0.970
Effect size	-0.118	0.397	-0.219	0.204	-0.246	-0.1	0.01	0.057	0.130

*: Statistical significance at $p < 0.05$. PFLS: Perceived food literacy scale; SD: Standard deviation; FDR: Benjamini–Hochberg false discovery rate.

differences in food-related roles and attitudes may explain why women reported higher competence in food literacy dimensions.

Educational status was also a significant determinant of food literacy. Participants with university-level or higher education reported higher PFLS scores compared to those with high school education or below ($p < 0.05$). This result aligns with previous research indicating that higher educational attainment is positively associated with nutritional knowledge, food label use, and healthy food practices.^[24,25] Educational background likely enhances one's ability to access, interpret, and apply nutrition

information effectively, contributing to better food literacy outcomes.

Marital status emerged as a factor influencing food literacy: Single participants had significantly higher PFLS scores than their married counterparts ($p < 0.05$). When evaluating the literature data, different results are noteworthy. One study has shown that marriage may be associated with health-promoting behaviors.^[26] Similar to the results of this study, another study showed that couples often encourage unhealthy behaviors because they tend to engage in shared activities such as eating and watching television together.^[27]

Table 4. Participants' PFLS score according to the type of diabetes

	Type 1 diabetes Mean±SD	Type 2 diabetes Mean±SD	p	Cohen's d
Food preparation skills	22.4±4.7	20.2±5.7	0.036*	0.42
Resilience and resistance	19.0±4.1	18.4±4.3	0.446	0.14
Healthy snack styles	15.1±3.0	12.7±3.8	<0.001*	0.70
Social and conscious eating	11.2±2.4	11.1±2.8	0.901	0.04
Examining food labels	7.3±2.2	6.5±2.6	0.067	0.33
Daily food planning	7.1±1.7	6.1±2.1	0.016*	0.52
Healthy budgeting	8.0±2.0	7.2±2.8	0.057	0.33
Healthy food stockpiling	15.7±3.7	17.2±3.1	0.033*	-0.44
PFLS total score	106.2±14.5	99.5±15.9	0.035*	0.44

*: Statistical significance at $p < 0.05$. PFLS: Perceived food literacy scale; SD: Standard deviation.

Table 5. The relationship between diabetes type and PFLS score, adjusted for age, sex, marital status, education level, and body mass index

	B	SE	Wald	Sig.	Exp(B)	95% CI for EXP(B)	
						Lower	Upper
Age	0.106	0.018	32.772	<0.001	1.112	1.072	1.153
Body weight	0.125	0.03	17.131	<0.001	1.133	1.068	1.203
Sex (1)	-2.16	0.522	17.142	<0.001	0.115	0.042	0.321
Education level (1)	-1.114	0.329	11.49	0.001	0.328	0.172	0.625
Healthy snack styles	-0.229	0.055	17.49	<0.001	0.795	0.714	0.885
Examining food labels	0.338	0.085	15.626	<0.001	1.402	1.186	1.658
Daily food planning	-0.345	0.106	10.544	0.001	0.708	0.575	0.872
Healthy budgeting	0.228	0.103	4.852	0.028	1.256	1.025	1.539
PFLS total score	-0.028	0.007	17.354	<0.001	0.972	0.959	0.985

B: B coefficient; SE: Standard error; CI: Confidence interval; PFLS: Perceived food literacy scale; Sig: Significance; Binary logistic regression, EXP(B)=Odds ratio. Reference categories (1): Type 2 diabetes for diabetes type, female for sex, high school and below for education level, single for marital status.

The results of this study revealed that individuals with Type 1 diabetes had significantly higher PFLS scores than those with Type 2 diabetes, both in total score and in several subdimensions, including food preparation skills, healthy snack choices, daily food planning, and healthy food stockpiling. These differences may be attributed to the distinct characteristics of diabetes management between the two groups. Type 1 diabetes, often diagnosed at a younger age and requiring intensive insulin therapy, typically demands continuous nutritional education and self-care engagement from early on.^[28] Patients are usually encouraged to monitor carbohydrate intake, read food labels, and plan meals more meticulously, which may contribute to higher food literacy over time.^[29] In addition, the treatment process for individuals with Type 1 diabetes is often carried out with the support of a multidisciplinary team. This facilitates individuals' regular access to accurate information about nutrition and health and encourages knowledge-based behavioral change. In contrast, Type 2 diabetes usually develops at an older age

and is often linked to lifestyle factors, so awareness and knowledge levels regarding nutrition may be lower in these individuals. Therefore, it is recommended that individual education in diabetes management be structured to increase food literacy, particularly in individuals with Type 2 diabetes, and that intervention programs be developed to teach patients skills such as label interpretation, portion control, and healthy meal planning. It is thought that such education could positively influence the course of the disease and strengthen self-management skills.

Furthermore, it was observed that each one-unit increase in the PFLS score reduced the likelihood of having Type 2 diabetes by 0.972 times. This finding suggests that food literacy may play an important role in diabetes management and prevention. The reduction in the likelihood of developing Type 2 diabetes associated with an increase in PFLS scores suggests that promoting nutritional awareness and healthy lifestyle behaviors may be effective in reducing the risk of Type 2 diabetes.

This study has some limitations. The fact that the study is based on individuals' personal responses, and that the study was conducted with a limited number of people are among the limitations of the study. The study was conducted only among individuals with Type 1 and Type 2 diabetes living in Istanbul, which represents an important limitation of the research. Because the exact number of individuals diagnosed with type 1 and type 2 diabetes in Istanbul was unknown, this represented one of the key limitations of the study when determining the sample size. Another major limitation of the study is the absence of data on the duration of diabetes diagnosis, which may influence participants' food literacy levels and their ability to manage the disease. Finally, data were collected online through Google Forms, which may have introduced a selection bias toward younger, digitally literate, and more health-conscious individuals. In addition, since the study was conducted only in Istanbul, the findings may not be fully generalizable to the entire population of Türkiye.

Conclusion

This study demonstrated that perceived food literacy levels among individuals with Type 1 or Type 2 diabetes are influenced by key sociodemographic and anthropometric factors such as sex, education level, marital status, age, and BMI. These findings emphasize the need for targeted nutrition education strategies that consider individual differences to enhance food literacy and support better diabetes self-management outcomes. Further research is needed to explore causal relationships and to assess the effectiveness of tailored interventions aimed at improving food literacy in diabetic populations.

Ethics Committee Approval: The Istanbul Gedik University Ethics Committee granted approval for this study (date: 08.02.2022, number: 301).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: The author declared that AI-supported technologies were not used in the study.

Authorship Contributions: Concept: ÇPF, BG; Design: ÇPF, BG; Supervision: ÇPF, BG; Resource: ÇPF; Materials: ÇPF; Data Collection or Processing: ÇPF, BG; Analysis or Interpretation: ÇPF, BG; Literature Search: ÇPF; Writing: ÇPF; Critical Review: ÇPF.

Acknowledgments: We thank all patients who agreed to participate in the study.

Peer-review: Double blind peer-reviewed.

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Course Dependent Variation of the Vertebral Artery: A Computed Tomography Angiography Study*

 Yusuf Seçgin¹,  Halil Şaban Erkartal²,  Şeyma Toy¹,  Nevin Köremezli Keskin³

¹Department of Anatomy, Karabük University Faculty of Medicine, Karabük, Türkiye

²Department of Anatomy, İstanbul Okan University Faculty of Medicine, İstanbul, Türkiye

³Department of Radiology, Private Medikar Hospital, Karabük, Türkiye

Abstract

Introduction: The primary objective of this study is to determine the variations exhibited by the vertebral artery in the Turkish population when it branches off from the subclavian artery and reaches the cervical vertebrae.

Methods: A retrospective review of computed tomography angiography images from the picture archiving and communication systems (PACS) archive system in the Department of Radiology, between 2000 and 2024, was performed. Digital imaging and communications in medicine (DICOM) format images selected from the PACS archive system according to the exclusion criteria were transferred to Radiant DICOM Viewer (Version 2023.1). The anatomical course of the vertebral artery (right and left) and variations during this course were recorded on the scanned images.

Results: A total of 258 individuals and 516 vertebral arteries (right and left) were analyzed. After analyzing 516 vertebral artery, 3 (0.58%) vertebral artery (1 left, 2 right) entered the transverse foramen at the grade of the 3rd cervical spine, 2 (0.39%) vertebral artery (2 right) at the grade of the 4th cervical spine, 13 (2.52%) vertebral artery (3 left, 10 right) at the grade of the 5th cervical spine, and 498 (96.51%) vertebral artery (254 left, 244 right) at the grade of the 6th cervical spine. As a result of our study, it was observed that the vertebral artery entered the transverse foramen of the 4th and 5th cervical spine, mainly the 3rd cervical spine, outside the normal anatomical course.

Discussion and Conclusion: We believe that our work will contribute to the fundamental anatomical knowledge and treatment approaches in this region.

Keywords: Anatomical variation; Cervical vertebra; Transverse foramen; Vertebral artery

The vertebral artery, which initiates from the subclavian artery, is examined by dividing it into four segments. The first segment (extraosseous, pre-vertebral ostial, pre-foraminal segment) branches off from the subclavian artery and extends to the transverse foramen of the 6th cervical spine, the second segment (transverse, transforaminal, foraminal segment) is from the transverse foramen of the 6th

cervical spine to the transverse foramen of the 1st cervical spine. The third segment (suboccipital, atlantal segment) is the distal extracranial segment from the transverse foramen of the 1st cervical spine to the medial aspect of the condylus occipitalis, and the fourth segment (intradural segment) is the segment that enters the cranium from below through the foramen magnum.^[1,2] The vertebral

*An abstract of this paper was presented orally at the 12th Anatomy Winter Days in 2025.

Cite this article as: Seçgin Y, Erkartal HŞ, Toy S, Köremezli Keskin N. Course Dependent Variation of the Vertebral Artery: A Computed Tomography Angiography Study. Lokman Hekim Health Sci 2026;6(3):418–423.

Correspondence: Yusuf Seçgin. Karabük Üniversitesi Tıp Fakültesi, Anatomi Anabilim Dalı, Karabük, Türkiye

E-mail: yusufseccin@karabuk.edu.tr **Submitted:** 12.09.2025 **Revised:** 22.12.2025 **Accepted:** 30.12.2025 **Available Online:** 06.08.2026



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artery on both sides then merge under the postpontine groove to form the arteria basilaris.^[3]

The vertebral artery provides about 1/3 of the blood supply of the brain's and ensures the supply of the brain's vital parts. The vertebral artery is therefore of critical importance for the human body.^[4]

Anatomically, the vertebral artery may have some variations in its origin and segments.^[5,6] These variations related to the course of the vertebral artery are of great importance in terms of the operational course in invasive interventions in this region (screw applications for pedicle fractures, craniovertebral junction microsurgery, traumatic vertebral artery injury surgery, aneurysm surgery, spinal laryngeal surgery, thyroid gland surgery).^[3,4,6-9] For example, during anterior cervical spine surgery, injury to the vertebral artery occurs at a rate of 0.1–0.5%. However, significant neurological deficits may result from such injury. Injury to the vertebral artery is a common occurrence during posterior cervical spine surgery. Therefore, the course and variations of the vertebral artery must be fully identified before surgery. Cervical pedicle screw vertebral fixation is an important procedure in traumatic, neoplastic, and degenerative diseases of the spine. However, injury to the vertebral artery is frequently encountered during this procedure. In addition to clinical procedures, vertebral damage can occur due to trauma to the head and neck region, which can lead to many clinical conditions, including subarachnoid hemorrhages.^[10-13]

There are some variations according to the segment at which the vertebral artery goes into the transverse foramen of the vertebrae. Among these vertebrae, the cases in which the vertebral artery goes into at the grade of the 3rd cervical spine are <1%.^[14-17]

Computed tomography (CT) angio images, which provide high-resolution images and allow the evaluation of calcification and peripheral structures in the vessels, are prominent in the imaging of vessels. Therefore, CT angio images are an excellent tool used routinely for vascular imaging.^[9]

In recent years, CT angiography has become the gold standard in the investigation of variations. It is noteworthy that there are very limited studies in the literature evaluating vertebral artery variations in the Turkish population with this method, and the number of populations is also limited. The purpose of the study was to define the diversities of the vertebral artery during its course using CT angiography in the Turkish population and to demonstrate the importance of this condition clinically.

Materials and Methods

Study Place and Design

This study was carried out at the Department of Radiology. It was designed as retrospectively analyze CT angiography images. The study was approved by the decision of Karabük University Non-Interventional Local Ethics Committee dated 2024 and numbered 1975. The study was performed in accordance with the Declaration of Helsinki and relevant ethical standards.

A retrospective review of CT angiography images from the picture archiving and communication systems (PACS) archive system in the Department of Radiology, Karabük University Faculty of Medicine, was performed between 2000 and 2024. The inclusion criterion was defined as clear visibility along the course of the vertebral artery. Exclusion criteria were low image quality because of motion artefacts, vascular surgery in the neck and head region, spinal fractures, tumours, or interventional procedures. The system scanned the period between 2000 and 2024, but the images used after the exclusion criteria were applied were from the period between 2018 and 2024.

Digital imaging and communications in medicine (DICOM) format images selected from the PACS archive system according to the exclusion criteria were transferred to Radiant DICOM Viewer (Version 2023.1). The transferred images were converted into 3D using the 3D Volume Rendering console of the programme and examined for vertebral artery variation. The first examination was performed by a radiologist with at least 10 years of experience in the field, and the second examination was performed by an anatomist with at least 5 years of experience in the field.

Data frequency, intraclass correlation coefficient (ICC), and Chi-square test results were presented using the Statistical Package for the Social Sciences 21 software package, and $p < 0.05$ were considered statistically significant.

Results

The study included the 258 individuals' images. A total of 516 vertebral arteries (right and left) were analyzed. Of these 516 vertebral arteries, 3 vertebral arteries were found to go into the transverse foramen at the grade of the 3rd cervical spine (Fig. 1).

Two vertebral arteries were found to go into the transverse foramen at the grade of the 4th cervical spine (Fig. 2).

Thirteen vertebral arteries were found to go into the transverse foramen at the grade of the 5th cervical spine (Fig. 3).



Figure 1. Entrance of the vertebral artery at the grade of the 3rd cervical spine.



Figure 2. Entrance of the vertebral artery at the grade of the 4th cervical spine.

The remaining 498 vertebral arteries were found to go into through the transverse foramen of the 6th cervical spine, which is the normal anatomical position.

The distribution of the variations on which side was also analyzed in the study. According to this distribution, two



Figure 3. Entrance of the vertebral artery at the grade of the 5th cervical spine.

(Female: 2) of the three vertebral arteries going into the transverse foramen from the 3rd cervical spine grade were on the right side and one (Male: 1) was on the left side. Two (Male:1, Female: 1) of the Two vertebral arteries going into the transverse foramen from the grade of the 4th cervical spine were on the right side. Of the 13 vertebral arteries going into the transverse foramen at the grade of the 5th cervical spine, 10 (Male: 4, Female: 6) were on the right side and 3 (Female: 3) were on the left side. The remaining 498 vertebral arteries entered the transverse foramen at the grade of the 6th cervical spine. Of these, 244 entered the transverse foramen from the right side and 254 from the left side (Fig. 4).

The results obtained by radiologists and anatomists specializing in the field were compared in the ICC test, and since the experts obtained the same results according to side and gender, the intraclass correlation was found to be 1.000, and the p-value was 0.000. The variations obtained were evaluated using the Chi-square test in terms of side and gender, and no significant results were obtained ($p>0.05$).

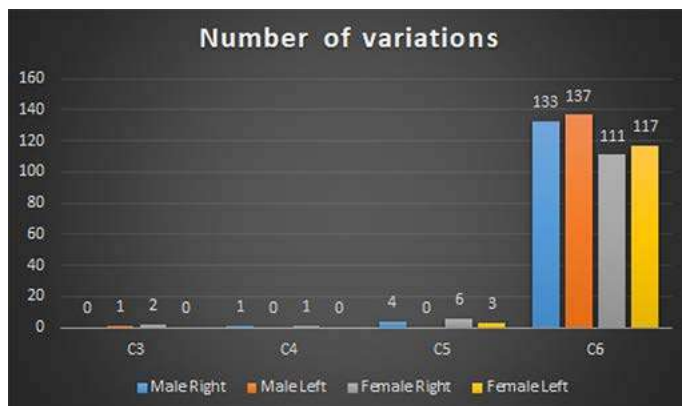


Figure 4. Classification of the degree to which the vertebral artery enters the transverse foramen according to the side of the cervical spine and gender.

Discussion

In this study, 0.58% of the vertebral artery entered from the 3rd cervical spine, 0.39% from the 4th cervical spine, 2.52% from the 5th cervical spine, and 96.51% from the transverse foramen of the 6th cervical spine.

The vertebral artery is a pair of arteries initiating from the subclavian artery, passing inside the transverse foramen of the cervical spine except the 7th cervical spine, going into the head through the foramen magnum, and forming the arteria basilaris.^[18]

The vertebral artery is a vital vascular structure involved in the nutrition of the neck and head. Traumas in the vertebral artery may lead to visual impairment, paralysis, walking, speech, and eating disorders. Therefore, traumas occurring in these regions and incorrect interventions during surgical interventions are of great clinical importance.^[4,8,9,19]

Vertebral artery variations are generally asymptomatic. In rare cases, vertebral artery variations may cause dizziness, ataxia during head rotation, vertebral artery dissection, and aneurysm. However, invasive procedures in this region may cause easy damage to this artery and lead to different clinical presentations.^[20]

Although rare, vertebral artery injury may occur during anterior and posterior surgical procedures in the cervical region. In addition to being rare, when it does occur, it can result in permanent neurological damage and death.^[13] Knowing the location of the vertebral artery is also critically important for surgical procedures, such as thyroidectomy, pharyngeal diverticulum excision, and esophageal surgery.^[2] This situation demonstrates that knowledge of the anatomical structure and variations in this region is critically important.

To understand the embryological origin of the vertebral artery's variation, it is also necessary to have detailed knowledge about the branching pattern of the aortic arch. The aortic arch initially consists of and develops from six embryonic pairs. These embryonic arches then regress and form the large vessels in this region. During this regression, anatomical variations occur in this region. These variations in the aortic arch affect the formation of vertebral variations.^[1,5]

In a study conducted by Uchino and colleagues, CT images of 2,287 individuals were retrospectively evaluated separately for the right and left vertebral arteries. As a result, 1.1% of vertebral arteries were on the right side, 0.7% on the left side at the 4th cervical vertebra, 4.4% on the right side, 4.9% on the left side at the 5th cervical vertebra, 93.8% on the right side and 93.0% on the left side at the 6th cervical vertebra, 0.6% on the right side and 1.2% on the left side at the 7th cervical vertebra level.^[16]

In the study by Woraputtaporn et al.,^[15] 266 cadavers were analysed, and the right and left vertebral arteries were considered separately. One of the 266 left vertebral arteries enters the transverse foramen at the level of the 4th cervical vertebra, 11 enter at the level of the 5th cervical vertebra, and 254 enter at the level of the 6th cervical vertebra. Of the 266 right vertebral arteries, 1 was found to enter the transverse foramen at the level of the 3rd cervical vertebra, 1 at the level of the 4th cervical vertebra, and 264 at the level of the 6th cervical vertebra.

Bruneau et al.^[14] analysed 500 vertebral artery of 250 individuals and found that 0.2% of the vertebral artery entered the transverse foramen at the grade of the 3rd cervical spine, 1% at the grade of the 4th cervical spine, 5% at the grade of the 5th cervical spine, 93.0% at the grade of the 6th cervical spine and 0.8% at the grade of the 7th cervical spine. In a study by Hong et al.^[21] 700 vertebral artery of 350 individuals were analysed by CT scan and it was reported that 1.6% of the vertebral artery entered the transverse foramen at the grade of the 4th cervical spine, 3.3% at the grade of the 5th cervical spine, 94.9% at the grade of the 6th cervical spine and 0.3% at the grade of the 7th cervical spine. In a study by Zibis et al.,^[22] CT images of 50 individuals were retrospectively analysed and the grade at which the vertebral artery entered the transverse foramen was examined; as a result, it was observed that the vertebral artery entered at the grade of the 4th cervical spine in 2% of the individuals, the 5th cervical spine in 8%, the 6th cervical spine in 86%, and the 7th cervical spine in 4%. In a study by Wakao et al.^[23] CT images of 919 individuals were analysed; 0.5% of the 1838 vertebral arteries entered the transverse foramen at the grade of the 4th cervical spine, 3.1% at the

grade of the 5th cervical spine, 95.6% at the grade of the 6th cervical spine, and 0.8% at the grade of the 7th cervical spine. In the study by Kim et al.,^[17] 4414 vertebral arteries of 2207 patients were analysed, and as a result; One vertebral artery from the 3rd cervical spine grade, 52 vertebral arteries from the 4th cervical spine grade, 214 vertebral artery from the 5th cervical spine grade, 4128 vertebral artery from the 6th cervical spine grade, 19 vertebral artery from the 7th cervical spine grade into the transverse foramen. In a study by Eskander et al.^[24] 500 vertebral artery of 250 individuals were analysed and it was observed that 1.8% of them entered the transverse foramen at the grade of the 4th cervical spine, 5.6% at the grade of the 5th cervical spine, 92% at the grade of the 6th cervical spine and 0.6% at the grade of the 7th cervical spine. The study by Tellioglu et al.^[25] showed that 0.45% of the 218 vertebral arteries entered the transverse foramen at the grade of the 4th cervical spine, 1.84% at the grade of the 5th cervical spine, 95.87% at the grade of the 6th cervical spine, and 1.84% at the grade of the 7th cervical spine.

Limitations

The fact that the study could not be conducted in larger populations and did not include different ethnic groups can be stated as a limitation of the study. In future studies, these limitations can be addressed by repeating this study in larger populations and different ethnic groups.

Conclusion

In this study, we aimed to determine at which levels the vertebral artery can enter the transverse foramen in the Turkish population. According to the data obtained from the study, we found that the vertebral artery can enter the transverse foramen of the third vertebra, which is located much lower than the others, and can continue upward. We believe that specialists should consider these variations in vascular approaches, particularly in posterior screw applications during posterior and lateral approach surgeries and adapt the surgical procedure accordingly. Furthermore, our study will support future large-scale prevalence studies.

Ethics Committee Approval: The Karabük University Non-Interventional Local Ethics Committee granted approval for this study (date: 05.11.2024, number: 1975).

Informed Consent: This study is a retrospective study conducted using images scanned from the radiology archive system. Informed consent is not required.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: The author declared that artificial intelligence (AI) supported technologies were not used in the study.

Authorship Contributions: Concept: YS, HŞE; Design: YS, HŞE; Supervision: YS; Resource: YS, NKK; Materials: YS, NKK; Data Collection or Processing: YS, HŞE, NKK; Analysis or Interpretation: YS, HŞE, NKK; Literature Search: YS, HŞE, ŞT; Writing: YS, HŞE, ŞT; Critical Review: YS.

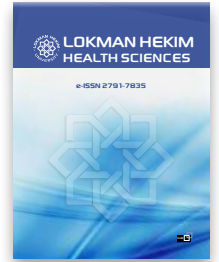
Acknowledgments: We thank everyone who has contributed to science.

Peer-review: Double blind peer-reviewed.

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ORIGINAL ARTICLE

The Silent Saboteur: The Impact of Headaches on Sleep Quality, Central Sensitization, Depression, Anxiety, and Stress

Nagihan Acet

Department of Physiotherapy and Rehabilitation, Atılım University Faculty of Health Sciences, Ankara, Türkiye

Abstract

Introduction: This study aimed to investigate the impacts of primary headaches on sleep quality, central sensitization (CS), and psychological factors, including depression, anxiety, and stress, to provide insights for an integrated management approach in patients with headaches. Headache is a common public health problem. Understanding the multifaceted impact of these conditions on various health aspects is essential for comprehensive headache management.

Methods: This descriptive observational study included individuals with primary headaches and asymptomatic controls. Participants were categorized into two groups based on the presence of headaches: A headache group and a headache-free group. Assessments were conducted in a sequential manner to evaluate sleep quality, CS, and emotional well-being, using the Pittsburgh Sleep Quality Index, CS inventory, and Depression, Anxiety, and Stress Scale-21, respectively. Group differences were analyzed using independent t-tests.

Results: The study included 78 individuals with primary headaches and 54 asymptomatic controls. The headache group showed significantly poorer sleep quality ($p<0.001$), increased CS ($p<0.001$), and higher levels of psychological distress, including depression ($p=0.008$), anxiety ($p<0.001$), and stress ($p<0.001$), compared to the headache-free group.

Discussion and Conclusion: These findings emphasize the compounded impact of headaches on both physical and psychological health parameters. The observed differences in sleep quality, CS, and psychological distress between the headache and headache-free groups highlight the need for a multidisciplinary approach to headache management. Addressing these interconnected aspects may enable improvement in therapeutic outcomes and quality of life in individuals with headaches.

Keywords: Central nervous system sensitization; Depression; Headache; Migraine disorders; Sleep

According to the Global Burden of Disease study, “headache disorders are among the most prevalent and disabling conditions worldwide”, with various types significantly diminishing individuals’ quality of life. Headaches can occur in a wide range from temporary discomfort to chronic problems and can negatively affect individuals’ work performance, social life, and general

health.^[1] In recent years, complaints of headaches have been increasing in society. Therefore, investigating headaches and the factors that affect will provide a solid foundation for treatment algorithms.

Within the framework of the biopsychosocial model, headache disorders should be understood as conditions resulting from the complex interaction between biological,

Cite this article as: Acet N. The Silent Saboteur: The Impact of Headaches on Sleep Quality, Central Sensitization, Depression, Anxiety, and Stress. Lokman Hekim Health Sci 2026;6(3):424–430.

Correspondence: Nagihan Acet. Atılım Üniversitesi Sağlık Bilimleri Fakültesi, Fizyoterapi ve Rehabilitasyon Anabilim Dalı, Ankara, Türkiye

E-mail: nagihan.acet@atilim.edu.tr **Submitted:** 14.08.2025 **Revised:** 23.12.2025 **Accepted:** 30.12.2025 **Available Online:** 06.08.2026



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psychological, and social processes.^[2] This model emphasizes that pain is not solely a neurophysiological experience, but is also shaped by behavioral patterns, emotional responses, and environmental factors. In the context of primary headaches, neurobiological mechanisms, such as central sensitization (CS) may amplify pain transmission, while disturbances in sleep quality and psychological distress (including depression, anxiety, and stress) can further exacerbate pain perception and disability. Considering these interrelated dimensions together provides a more comprehensive understanding of the pathophysiology of headaches and supports a multidisciplinary approach in both research and clinical management.

Sleep quality may be one of the factors most significantly impacted by primary headaches. Sleep disorders consist of various conditions that disrupt normal sleep patterns.

^[3] Inadequate or non-restful sleep may interfere with the normal course of physical, mental, social, and emotional functions.^[3] Impaired sleep quality inhibits the body's process of self-repair and regeneration, which can lead to more serious health problems in the long term. Establishing the relationship between sleep and headache can make a significant contribution to the management of headaches.

Headaches can also serve as a significant trigger for the development of increased central nervous system sensitivity. CS is "a neurophysiological phenomenon that is adaptive, activity-dependent, and dynamic."^[4] This process entails neurobiological alterations in the neurons located in the dorsal horn of the spinal cord.^[4] These changes involve an increase in excitability, a boost in synaptic transmission, and a reduction in inhibition.^[4] In summary, CS represents a condition in which the nervous system exhibits heightened sensitivity, resulting in an exaggerated perception of pain. Particularly in individuals with chronic headache, CS can develop due to persistent stimulation of the central nervous system, potentially leading to a lowered pain threshold and an amplified perception of pain.^[5] In individuals with chronic headaches, the increase in central nervous system sensitivity may reduce quality of life and significantly complicate the treatment process.

The psychological impact of primary headaches should not be overlooked. Primary headaches, such as migraine and tension-type headaches (TTH), may lead to increased levels of psychological distress, including depression, anxiety, and stress.^[6] When pain becomes a constant source of anxiety, it makes it difficult to perform daily activities and negatively affects the general mood of the person.

^[7] Depression and anxiety may increase the severity of headaches, and headaches may trigger these psychological

conditions. Stress may be both a cause and a consequence of headache; especially TTHs are closely related to stress. Therefore, it is important to consider the psychological status in the treatment of primary headaches.

The presence of headaches may affect numerous physical and psychological factors. A comprehensive assessment of these factors together may contribute to more effective headache management strategies. Although previous studies have independently investigated the associations between headaches and sleep quality, psychological distress, or CS, no studies have comprehensively examined these factors simultaneously within a single conceptual framework. Moreover, there is a lack of studies addressing this issue among university students in Türkiye, a population with increasing vulnerability to stress and irregular sleep patterns. Therefore, this study was designed to provide a holistic evaluation of sleep quality, CS, and psychological factors in individuals with and without headaches, within the context of the biopsychosocial model of pain.

Considering the multidimensional interaction between biological, behavioral, and psychological mechanisms within the biopsychosocial model, this study aimed to examine how primary headaches influence sleep quality, CS, and psychological distress. It was hypothesized that individuals with primary headaches would exhibit poorer sleep quality, higher levels of CS, and greater psychological distress (depression, anxiety, and stress) compared to asymptomatic controls.

Materials and Methods

Study Place and Design

The study was carried out at the Atılım University between October 2024 and January 2025.

This study was designed as a descriptive observational study and reported in adherence with the strengthening the reporting of observational studies in epidemiology guidelines. The study was registered with ClinicalTrials.gov (NCT 06603493).

Ethical Statement

Approval for this study was obtained from the Atılım University Ethics Committee (Date: 25.09.2024, Decision no: 606.01.02.268), and the study was conducted in accordance with the Declaration of Helsinki. All participants were informed about the purpose and procedures of the study and provided written informed consent before participation.

Participants

Participants were recruited from the Atılım University campus using a convenience sampling method. Participants were recruited through a convenience sampling method using an announcement poster on the university website and notice boards. Participation was voluntary. Participants who responded to the invitation completed an online screening form to confirm eligibility criteria. Eligible participants were then contacted and scheduled for assessment sessions. The included subjects were allocated into two groups: A headache group and a headache-free group. Individuals diagnosed with migraine and TTHs according to the International Classification of Headache Disorders (International Classification of Headache Disorders, 3rd edition), were placed in the headache group, while other participants were assigned to the headache-free group. Each participant was assessed in a one-time, face-to-face evaluation.

Inclusion Criteria

Individuals aged 18–65 who were located on the university campus were included.

Exclusion Criteria

Exclusion criteria included neurological disorders, musculoskeletal diseases, chronic pain conditions, and psychiatric disorders.

One hundred and forty-four participants were evaluated for eligibility. Twelve participants were excluded due to the exclusion criteria. A total of 132 participants took part in the study. Seventy-eight individuals diagnosed with either migraine or TTH comprised the headache group, whereas the headache-free group included 54 participants. Of the 78 participants in the headache group, 68 were diagnosed with TTH and 10 with migraine.

Data Collection

Assessment of Sleep Quality

Sleep quality was assessed using the Turkish version of the Pittsburgh Sleep Quality Index (PSQI) developed by Buysse et al. (1989).^[8] The Turkish validity and reliability study was conducted by Ağargün et al. (1996; good internal consistency).^[9] It is a 19-item questionnaire designed and consists of 7 components: (1) Subjective sleep quality, (2) sleep latency, (3) sleep duration, (4) habitual sleep efficiency, (5) sleep disturbances, (6) use of sleep medication, and (7) daytime dysfunction, (8) each

component is scored between 0 and 3, yielding a global score ranging from 0 to 21. Higher scores indicate poorer sleep quality, and a global score >5 reflects clinically significant sleep disturbance.^[8]

Assessment of CS

CS was assessed using the CS inventory (CSI), developed by Mayer et al. (2012).^[10] The Turkish version was validated by Keleş et al.^[11] (2018 Cronbach's $\alpha=0.92$, intraclass correlation coefficient=0.93). The CSI includes 25 items evaluating symptoms, such as sensitivity to bright light, pain all over the body, fatigue, poor concentration, and unrefreshing sleep.^[10] Each item is scored from 0 ("never") to 4 ("always"), with total scores ranging from 0 to 100. A score of 40 or higher indicates the presence of CS.^[10]

Assessment of Psychological Factors

Psychological distress (depression, anxiety, and stress) was measured using the depression anxiety stress scale (DASS-21), developed by Lovibond and Lovibond (1995).^[12] Depression, anxiety, and stress levels were assessed using the Turkish version of the DASS-21 validated by Yıldırım et al. (2017; Cronbach's $\alpha=0.87$).^[13] It consists of three subscales - depression, anxiety, and stress-, each with 7 questions, evaluating emotional and physiological symptoms.^[12] A maximum of 42 points can be obtained for each component (the first score is multiplied by two).^[12] Higher scores indicate the severity of the respective disorder.

Power Analysis

A post hoc power analysis was conducted using G*Power 3.1.9.7 to determine the achieved power of the study based on the comparison of sleep quality (PSQI) between the headache and headache-free groups. With an effect size of $d=0.64$, an alpha level of 0.05, and group sample sizes of 78 and 54, the achieved power (1- β error probability) was calculated as 0.948. This indicates that the study had a high statistical power (94.8%) to detect significant differences between the groups.

Statistical Analysis

All statistical analyses were performed using IBM Statistical Package for the Social Sciences Statistics version 23.0 (IBM Corp., Armonk, NY, USA). Categorical variables were presented with frequencies and percentages, while continuous variables were summarized as mean, standard deviation, minimum, and maximum values. The normality of distribution for continuous variables within

Table 1. The number, percentage, and gender distribution of the participants according to headache status

Presence of headache	Gender	Frequency	Percent	χ^2	p ^a
No pain	Female	38	70.4	2.818	0.244
	Male	16	29.6		
	Total	54	100.0		
Tension type headache	Female	40	58.8		
	Male	28	41.2		
	Total	68	100.0		
Migraine	Female	8	80.0		
	Male	2	20.0		
	Total	10	100.0		

^a: p-value calculated by Pearson Chi-square test.

each group was assessed using the Kolmogorov-Smirnov test and skewness and kurtosis values. A skewness and kurtosis range of ± 2 was considered acceptable for normal distribution.^[14] Between-group comparisons for continuous variables were conducted using Independent Samples t-test. For categorical variables, such as gender distribution among headache groups, the Pearson Chi-square test was

applied. Effect sizes were reported using Cohen's d for t-tests. Statistical significance was set at $p < 0.05$.

Results

The study included 78 individuals with primary headaches and 54 asymptomatic controls. As shown in Table 1, among the 132 participants, 54 reported no headache, 68 had TTH, and 10 had migraine. The proportion of females varied across groups: 70.4% in the no-pain group, 58.8% in the TTH group, and 80.0% in the migraine group. Although female participants were predominant in all groups, a Pearson Chi-square test revealed that the difference in gender distribution among headache types was not statistically significant ($\chi^2 = 2.818$, $p = 0.244$), indicating comparable gender distribution across groups.

Demographic characteristics of the participants in both groups were similar in terms of age, height, weight, and body mass index ($p > 0.05$). Comparisons of the demographic characteristics of the participants are shown in Table 2.

In the intergroup comparison, the headache group had significantly higher levels of sleep disturbance, CS, depression, anxiety, and stress than the headache-free group. Comparisons between groups were presented in Table 3 ($p < 0.05$).

Table 2. Demographic characteristics of the participants

Variables	Headache Group mean $\pm$ SD (min;max) (n=78)	Control group mean $\pm$ SD (min;max) (n=54)	Mean difference	t	Cohen's d	p ^t	95% CI of the difference	
							Lower	Upper
Age (year)	23.07 $\pm$ 2.01 (20; 30)	22.65 $\pm$ 0.92 (21; 25)	-0.44	-1.52	-0.26	0.480	-1.02	0.13
Height (cm)	1.71 $\pm$ 0.83 (1.56; 1.90)	1.69 $\pm$ 0.09 (1.54; 1.92)	-0.01	-0.91	-0.16	0.543	-0.04	0.01
Weight (kg)	68.14 $\pm$ 13.63 (42; 964)	66.96 $\pm$ 12.38 (49; 93)	-0.51	-0.21	-0.39	0.694	-5.14	4.12
BMI (kg/m ²)	23.02 $\pm$ 3.23 (16.82; 29.07)	23.08 $\pm$ 3.02 (17.3; 29.3)	0.05	0.10	0.01	0.387	-1.06	1.16

n: Number of participants; BMI: Body mass index; SD: Standard deviation; CI: Confidence interval; cm: centimeter; kg: kilogram; kg/m²: kilogram/meter²; t: Independent samples t-test.

Table 3. The comparison of sleep disorders, central sensitization, depression, anxiety, stress between groups

Variables	Headache group (n=78) mean $\pm$ SD (min; max)	Control group (n=54) mean $\pm$ SD (min; max)	Mean difference	t	Cohen's d	p ^t	95% CI of the difference	
							Lower	Upper
Sleep quality via PSQI	7.84 $\pm$ 3.35 (2; 16)	5.77 $\pm$ 3.01 (1; 12)	2.06	-3.62	0.64	<0.001*	0.94	3.19
Central sensitization via CSI	30.46 $\pm$ 16.17 (1; 66)	19.92 $\pm$ 17.54 (1; 81)	10.53	-3.55	0.62	<0.001*	4.66	16.4
Depression via DASS-21	7.02 $\pm$ 5.89 (0; 21)	4.25 $\pm$ 5.76 (0; 20)	2.76	-2.67	0.47	0.008*	0.72	4.81
Anxiety via DASS-21	6.76 $\pm$ 5.61 (0; 21)	3.59 $\pm$ 5.09 (0; 21)	3.17	-3.31	0.58	<0.001*	1.28	5.07
Stress via DASS-21	6.38 $\pm$ 5.01 (0; 17)	3.11 $\pm$ 4.31 (0; 18)	3.27	-3.90	0.69	<0.001*	1.31	5.03

*: $p < 0.05$. SD: Standard deviation; CI: Confidence interval; PSQI: Pittsburgh sleep quality index; CSI: Central sensitization inventory; DASS-21: Depression, anxiety, and stress scale-21; n: Number of participants; t: Independent samples t-test.

Discussion

Migraine and TTH are the most common primary headache disorders.^[15] While migraine ranks 2nd among neurological disorders causing disability, TTH ranks 28th.^[16] When examining the prevalence of these two significant types of headaches, migraine affects 14.4% of the population, whereas the prevalence of TTH ranges from 26.1% to 86.0%.^[16,17] The burden posed by these headache disorders remains a major issue globally. Reducing the burden of headache disorders requires a better understanding of the factors that increase headache-related impacts.^[18]

In this study, the complex impacts of headache presence on sleep quality, CS, depression, anxiety, and stress were thoroughly investigated. These factors were examined within the framework of the biopsychosocial model of pain, which emphasizes that pain is not merely a physiological phenomenon, but a multidimensional experience shaped by biological, psychological, and social interactions. From this perspective, the present study provides an integrated understanding of how headaches affect multiple interconnected domains rather than focusing on a single physiological outcome. This holistic approach highlights the importance of considering cognitive, emotional, and behavioral aspects in the assessment and management of primary headaches.

The results of the present study demonstrated statistically significant group differences in sleep quality, CS, depression, anxiety, and stress levels ($p < 0.001$) for all parameters. In addition, the effect size analysis revealed that these differences were moderate to large in magnitude, indicating that the observed associations are not only statistically but also clinically meaningful. The largest effect size was observed for stress (Cohen's $d = 0.69$), followed by sleep quality ($d = 0.64$) and CS ($d = 0.62$), suggesting that psychological distress, particularly stress, exerts a strong influence in individuals with headaches, alongside biological mechanisms, such as CS. This finding underscores the robust biopsychosocial impact of headache disorders and highlights the need for integrative assessment strategies that address both physiological and psychological domains.

The findings of this study indicate that individuals experiencing headaches demonstrated lower sleep quality. This finding is consistent with previous studies in the literature demonstrating that individuals with both migraine and TTHs have lower sleep quality compared to the headache-free.^[19–22]

Clinically, this highlights the importance of evaluating sleep quality in patients with headaches. In headache

management, incorporating strategies aimed not only at pain relief but also at improving sleep quality may contribute to more effective symptom control. Clinicians should adopt a multidisciplinary approach to address sleep issues in patients with headaches, thereby reducing headache frequency and severity.

According to the results of the present study, CS was found to be increased in individuals with headaches compared to the headache-free group. The impact of the presence of primary headaches on CS is consistent with previous studies.^[5,23,24] CS occurs when there is a functional increase in circuits within nociceptive pathways, leading to abnormal sensitivity. According to the International Association for the Study of Pain, "CS is characterized by an increased sensitivity of nociceptive neurons within the central nervous system to normal or subthreshold afferent stimuli."^[25] For example, patients with chronic headaches frequently present with pressure pain hypersensitivity, pericranial muscle tenderness, and cutaneous allodynia - clinical indicators of CS that contribute to pain persistence.

^[26,27] CS is particularly associated with neurological disorders, such as migraine, which cause important level of disability. In migraine pathogenesis, CS is believed to contribute to the development of cutaneous allodynia and the progression of migraine into a chronic condition.

^[5] Although genetic predisposition and activation of the trigeminal vasculature are considered the main pathophysiological factors of migraine,^[28] CS is believed to contribute to the persistence of pain. Therefore, the management of CS-related pain and symptoms is crucial in primary headaches, such as migraine or TTH. The presence of CS in individuals with headaches may lead to significant functional impairment in their daily lives. In light of the present study's findings, the importance of treatment approaches targeting CS in individuals with headaches is once again emphasized.

In the present study, depression and anxiety levels were statistically higher in individuals with headaches compared to the asymptomatic group. Considering the increased disability caused by chronic headaches, this finding is not surprising. Because of headaches, accompanying symptoms, and comorbidities, headache sufferers experience reduced quality of life and face impediments in daily life activities, including school, work, and family responsibilities.^[29,30]

Previous studies in the literature have reported that migraineurs suffer from more severe depression than non-migraineurs,^[31,32] furthermore, when migraineurs experience depression, their migraine symptoms are more severe than those in migraineurs without depression. In

addition, a “bidirectional comorbidity” has been observed in longitudinal studies, migraineurs had an increased risk of developing depression after an 11-year follow-up,^[33] while patients with depression similarly showed an increased risk of developing migraines. In the literature, another study conducted on individuals with TTH reported that 53.4% of these individuals had anxiety and 36.9% had depression.^[34] Similarly, another study reported that anxiety and depression were more prevalent in individuals with TTH than in those without headaches.^[35]

From a clinical perspective, these results emphasize the need to assess depression in individuals suffering from migraine or TTHs. The bidirectional relationship between depression and migraine highlights the need for a holistic approach in headache management that considers psychosocial factors. For clinicians, evaluating the risk of depression in patients with headaches can play a crucial role in enhancing both pain management and overall quality of life for these patients. This study has some limitations. The descriptive observational design reflects only the state at a particular point in time and does not allow for the observation of changes over time. Therefore, the participants were assessed only once, and no follow-up was conducted. In addition, self-report questionnaires were utilized to assess physical and psychological factors. Since self-reported data may involve recall bias, it is recommended that these parameters be evaluated with objective measurement methods in future studies. Furthermore, due to the limited number of participants with migraine, it was not possible to statistically compare subtypes of primary headache (i.e., migraine and TTH) separately. Finally, as the sample of this study was limited to a single institution (Atılım University), the generalizability of the results may be restricted. Future studies should aim to include larger populations covering multiple institutions, and long-term follow-up is recommended to more comprehensively assess the effects of headaches.

Despite these limitations, the study has several strengths. This study is one of the few to comprehensively examine the multifaceted effects of headache on sleep quality, CS, depression, anxiety, and stress within a single framework. The use of standardized and widely validated measurement tools enhances the reliability of the findings. In addition, the multidisciplinary approach emphasized in this research highlights the importance of addressing both physiological and psychological factors in headache management, offering a holistic perspective that may benefit clinical practice.

Conclusion

The study demonstrated that individuals with headaches experience poorer sleep quality, increased CS, and higher levels of psychological distress compared to headache-free individuals. These results highlight the necessity of addressing headache management through a biopsychosocial and multidisciplinary framework, focusing not only on clinical symptoms but also on improving sleep quality, psychological well-being, and stress regulation. Considering these interconnected domains together may enhance treatment outcomes and overall quality of life for individuals suffering from headaches.

Ethics Committee Approval: The Atılım University Ethics Committee granted approval for this study (date: 25.09.2024, number: 606.01.02.268).

Informed Consent: All participants were informed about the purpose and procedures of the study and provided written informed consent before participation.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: Not declared.

Acknowledgments: I would like to express my gratitude to all the participants who contributed their time and effort to this study.

Peer-review: Double blind peer-reviewed.

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ORIGINAL ARTICLE

Primary Central Nervous System Lymphomas: A Descriptive Study

 Davut Eren¹,  Mustafa Çetin²

¹Department of Nephrology, Kayseri City Hospital, Kayseri, Türkiye

²Hematology and Hematopoietic Stem Cell Unit, MEDSTAR Antalya Hospital, Antalya, Türkiye

Abstract

Introduction: Primary central nervous system lymphomas (PCNSL) are relatively uncommon, aggressive tumors of B-cells localized within the central nervous system and eye, without systemic involvement. In this study, we present the clinical characteristics, treatments, pathological and immunohistochemical features of PCNSL patients treated in a single center over a period of 6 years.

Methods: This study included patients diagnosed with PCNSL between January 2013 and December 2019. Clinical-pathological and immunohistochemical characteristics were recorded. 1-year overall survival and 1-year progression-free survival rates were analyzed. The International Extranodal Lymphoma Study Group (IELSG) score was used to predict prognosis.

Results: A total of 18 patients were included in the study: 11 women (61.1%) and 7 men (38.9%). The median age was 54 years (range 22–81). Multifocal involvement was detected in 8 patients (44.4%), deep involvement in 6 patients (33.3%), and deep plus multifocal involvement in 4 patients (22.2%). Age (<60 years) ($p=0.017$), low IELSG score ($p=0.011$), and autologous hematopoietic stem cell transplantation (aHSCT) ($p=0.049$) were associated with 1-year overall survival. Surgical resection ($p=0.038$) and radiotherapy ($p=0.045$) were factors associated with 1-year progression-free survival.

Discussion and Conclusion: PCNSL is characterized by its aggressive nature and extranodal involvement. The effectiveness of current treatment options for this disease is limited, and clinical outcomes are generally poor. While age (<60 years), low IELSG scores, and the use of aHSCT therapy have been shown to be associated with improved 1-year overall survival outcomes, conversely, surgical treatment was negatively associated with progression-free survival.

Keywords: Hematopoietic stem cells; Lymphoma; Nervous system

Primary central nervous system lymphoma (PCNSL) is an aggressive B-cell malignancy. It is localized to leptomeninges, brain, eyes, and spinal cord without systemic involvement at the time of diagnosis. PCNSL accounts for around 2–5% of all brain tumors and 4–6% of extranodal lymphomas. Its annual incidence is estimated

at 0.4–0.7 cases/100,000 people. It generally appears at an advanced age (average of 60 years). Symptom manifestation varies according to the specific region of the nervous system affected. The most prevalent presentations include cognitive and behavioral changes, indications of elevated intracranial pressure, and focal neurological deficits. In

Cite this article as: Eren D, Çetin M. Primary Central Nervous System Lymphomas: A Descriptive Study. Lokman Hekim Health Sci 2026;6(3):431–437.

Correspondence: Davut Eren. Kayseri Şehir Hastanesi, Nefroloji Kliniği, Kayseri, Türkiye

E-mail: dr.davuteren@gmail.com **Submitted:** 15.10.2025 **Revised:** 06.01.2026 **Accepted:** 12.01.2026 **Available Online:** 06.08.2026



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contrast, patients with leptomeningeal involvement may be asymptomatic. Diagnosis involves the use of stereotactic biopsy along with neuroimaging, while cerebrospinal fluid (CSF) analysis may be useful in some patients. Histologically, PCNSL is identified as a highly cellular tumor with a diffuse growth pattern that infiltrates cerebral blood vessels, disrupting reticulin fiber structure. This characteristic vessel wall change and perivascular space infiltration usually occur at the periphery of the tumor.^[1]

Treatment advancements over the last two decades, particularly with high-dose methotrexate (HD-MTX)-based chemotherapy, have improved outcomes, with survival rates reaching 60–70% among younger patients with good performance status. There are debates about the most appropriate treatment method despite all these developments. There are opposing views on surgery, radiotherapy, additional chemotherapy, and chemotherapy to be applied directly to the CSF.^[2]

This study aims to compare the demographic characteristics, clinical features, staining characteristics of pathology specimens, treatments received, and treatment responses of patients diagnosed with PCNSL in Erciyes University between 2013 and 2019.

Materials and Methods

This study included 18 adult patients diagnosed with PCNSL at Erciyes University between January 2013 and December 2019. However, two patients died due to rapid disease progression before any treatment could be initiated. Therefore, while demographic and clinical characteristics at admission are reported for all 18 patients, the analyses for treatment response, 1-year overall survival, and progression-free survival were conducted on the remaining 16 patients who received treatment. The study protocol was designed to collect demographic information, clinical and laboratory findings, pathological staining characteristics, treatment regimens, complications, and survival criteria. The International Extranodal Lymphoma Study Group (IELSG) score was used to determine prognosis in patients. The components of this scoring system are: Eastern Cooperative Oncology Group (ECOG) performance status >1, age >60, high blood lactate dehydrogenase (LDH) levels, high CSF protein levels, and deep-seated tumors (involving the brainstem, corpus callosum, cerebellum, or basal ganglia). In this system, each positive finding is assigned 1 point. Low risk is defined as 0–1 points, intermediate risk as 2–3 points, and high risk as 4–5 points.

Patients received chemotherapy according to the MATRix or MPV regimens. MATRix Protocol: Methotrexate (3500 mg/m²) on day 1, followed by folinic acid every 6 h between days 2 and 4, cytarabine (ARA-C, 2×2000 mg/m²) on days 2 and 3, tiotepa (30 mg/m²) on day 4, and rituximab (375 mg/m²) on day 0. MPV Protocol: Methotrexate (3500 mg/m²), followed by folinic acid every 6 h on days 2 and 4, vincristine (1.4 mg/m²) on day 1, procarbazine (100 mg/m² orally) on days 1–7, intrathecal methotrexate (12 mg on day 1), and dexamethasone (16 mg/day). As consolidation therapy, patients underwent whole brain radiotherapy (WBRT) and/or autologous hematopoietic stem cell transplantation (aHSCT). In addition, aHSCT was used as a rescue regimen in patients with recurrent disease.

Remission was defined as the absence of contrast-enhancing lesions or a >50% reduction in tumor size on imaging. Refractory disease was defined as a <50% reduction or a <25% increase in tumor size. Relapse was defined as the detection of new foci during follow-up in patients considered to be in remission. Survival time and progression-free survival time were measured based on a 1-year period from the date of diagnosis. The concept of deep involvement was defined as involvement of the brainstem, basal ganglia, cerebellum, and corpus callosum. The term multifocal involvement was used to indicate involvement in more than one focus detected on radiological imaging.

Ethical Approval

The current study received approval from the Erciyes University Ethics Committee (approval date: January 29, 2020, protocol number 2020/49) and was carried out in compliance with the principles outlined in the Declaration of Helsinki.

Statistical Analysis

In this study, statistical analyses were conducted with the Statistical Package for the Social Sciences 22.0 program (International Business Machines Corp.; Armonk, New York, USA). Continuous variables were expressed as mean±standard deviation or median (minimum-maximum) after evaluating for normality using the Shapiro-Wilk test. Categorical variables were presented as frequencies and percentages. Since the sample size was small and several cells in the contingency tables had expected counts <5, Fisher's exact test was used for all categorical comparisons. The Student's t-test was used for variables showing a normal distribution, whereas the Mann-Whitney U test was applied to variables that were not normally distributed. A

$p < 0.05$ was considered statistically significant. Multiple comparisons were performed without formal adjustment; thus, these results should be interpreted as exploratory.

Results

This study included 18 adult patients diagnosed with PCNSL. Eleven (61.1%) of the patients were female, and seven (38.9%) were male. The median age of the patients was 54 years (range 22–81). Causes for hospital admission were focal neurological deficit symptoms in nine patients, symptoms related to increased intracranial pressure (headache, dizziness, nausea-vomiting, etc.) in six patients, and vision loss in one patient. The mean time from symptom onset to diagnosis was 3.5 (1–15) months. At the time of diagnosis, 15 patients had an ECOG status below 2, while three patients had a status of 2 or higher. The demographic and clinical characteristics of the patients are presented in Table 1.

Deep located lesions were detected in six patients (33.3%), while multifocal involvement was present in eight patients (44.4%). The most common site of involvement was the cerebral hemispheres (13 patients, 66%); in the remaining patients, involvement was detected in the pituitary gland, putamen, cerebellopontine junction, retro cerebellar region, and fourth ventricle. At the time of diagnosis, LDH levels were above 215 (our laboratory cutoff value) in 8 patients and below 215 in 10 patients. At the time of diagnosis, the absolute lymphocyte count was above $0.9 \times 10^3/\mu\text{L}$ (our laboratory cutoff value) in 14 patients.

According to the IELSG scoring system, eight patients were in the intermediate risk category, and 10 were in the low-risk category.

It revealed that subtotal or total resection surgery was performed in 14 patients, while surgery was performed in four patients for stereotactic biopsy. The pathology results of 17 patients were diffuse large B-cell lymphoma, while the pathology of one patient was consistent with Burkitt lymphoma.

A total of 16 patients received induction chemotherapy, 13 of whom were treated with the MPV protocol and 3 with the MATRix protocol. The MATRix regimen was used in a total of 7 patients, while in six patients it was administered as consolidation therapy or rescue therapy in cases of relapse. Seven patients received radiotherapy in addition to chemotherapy.

Sixteen patients who received treatment after diagnosis were evaluated for 1-year overall survival (Table 2). Total mortality during the follow-up period was observed in 11 patients (including two patients who died before treatment).

Table 1. Characteristics of all patients

Variable	Statistics*
Age (years), Median (min-max)	54 (22–81)
	n (%)
Sex	
Male	7 (38.9)
Female	11 (61.1)
Symptoms at admission**	
Focal neurological deficit	9 (56.3)
Signs of increased intracranial pressure	6 (37.5)
Loss of vision	1 (6.3)
Tumor localization	
Deep	6 (33.3)
Multifocal	8 (44.4)
Deep+Multifocal	4 (22.2)
Laboratory findings	
Creatinine (mg/dL) (mean $\pm$ SD)	0.67 $\pm$ 0.16
ALT (IU/L) (mean $\pm$ SD)	27.8 $\pm$ 23.6
LDH > 215 (IU/L)	8 (44.4)
Lymphocyte count <900/ μL	4 (22.2)
IELSG score	
Low risk (0–1)	10 (55.6)
Intermediate risk (2–3)	8 (44.4)
High risk (4–5)	0 (0.0)
Surgical procedure	
Resection (Total/Subtotal)	14 (77.8)
Biopsy	4 (22.2)

*: $p < 0.05$ was considered statistically significant; **: Symptom data were available for 16 patients. Statistical analyses were performed using Student's t-test or Mann-Whitney U test for continuous variables, and Fisher's exact test for categorical variables. SD: Standard deviation; ALT: Alanine aminotransferase; LDH: Lactate dehydrogenase; IELSG: International Extranodal Lymphoma Study Group.

Among the 16 patients evaluated for 1-year overall survival, six deaths occurred within the 1st year. The 1-year overall survival rate was 62.5%, and the longest survival time was determined to be 50 months. In addition, the 1-year progression-free survival rate was calculated as 43.8%.

Factors associated with 1-year overall survival included being under 60 years of age ($p = 0.017$), low IELSG score ($p = 0.011$), and aHSCt ($p = 0.049$). Surgical treatment ($p = 0.038$) was negatively associated with 1-year progression-free survival, while radiotherapy ($p = 0.045$) was associated with improved progression-free survival. Factors associated with 1-year progression-free survival are shown in Table 3.

Among the seven patients who developed relapse after treatment, the median survival time was 4 months (range

Table 2. Factors associated with 1-year overall survival (n=16)

Variable	Survivor (n=10) n (%)	Non-survivor (n=6) n (%)	p*
Age			0.017
<60 years	9 (90.0)	2 (33.3)	
≥60 years	1 (10.0)	4 (66.7)	
Sex (Male)	5 (50.0)	2 (33.3)	0.635
ECOG score ≥ 2	1 (10.0)	2 (33.3)	0.531
Comorbidities	2 (20.0)	4 (66.7)	0.119
Lesion location			1
Deep	3 (30.0)	3 (50.0)	
Multifocal	5 (50.0)	3 (50.0)	
IELSG risk score			0.011
Low risk	8 (80.0)	1 (16.7)	
Intermediate risk	2 (20.0)	5 (83.3)	
LDH> 215 IU/L	3 (30.0)	4 (66.7)	0.301
Lymphocyte <900/μL	1 (10.0)	3 (50.0)	0.098
Surgery	7 (70.0)	6 (100.0)	0.25
Chemotherapy regimen			
MPV	7 (70.0)	5 (83.3)	1
MATRix	8 (80.0)	2 (33.3)	0.118
Rituximab	8 (80.0)	3 (50.0)	0.299
aHSCT (Consolidation)	6 (60.0)	0 (0.0)	0.049
Radiotherapy	6 (60.0)	1 (16.7)	0.145
Immunophenotype			
Bcl-2 positive	7 (70.0)	3 (50.0)	0.604
Bcl-6 positive	8 (80.0)	6 (100.0)	0.5
Mum-1 positive	6 (60.0)	2 (33.3)	0.608
CD-10 positive	3 (30.0)	0 (0.0)	0.25
Ki67 ≥50%	9 (90.0)	6 (100.0)	1

*: p<0.05 was considered statistically significant. All categorical comparisons were analyzed using Fisher's Exact Test. LDH: Lactate dehydrogenase; aHSCT: Autologous hematopoietic stem cell transplantation; ECOG: Eastern Cooperative Oncology Group.

Table 3. Factors Associated with 1-year progression-free survival (n=16)

Variable	Survivor (n=7) n (%)	Non-survivor (n=9) n (%)	p*
Age			0.615
<60 years	5 (71.4)	5 (55.6)	
≥60 years	2 (28.6)	4 (44.4)	
Sex (Male)	3 (42.9)	4 (44.4)	1
ECOG Score ≥ 2	1 (14.3)	2 (22.2)	1
Comorbidities	2 (28.6)	4 (44.4)	0.635
Lesion location			
Deep	2 (28.6)	4 (44.4)	0.635
Multifocal	2 (28.6)	6 (66.7)	0.165
IELSG risk score			0.344
Low risk	5 (71.4)	4 (44.4)	
Moderate risk	2 (28.6)	5 (55.6)	
LDH> 215 IU/L	3 (42.9)	4 (44.4)	1
Lymphocyte <900/μL	1 (14.3)	3 (33.3)	0.588
Surgery	4 (57.1)	9 (100.0)	0.038
Chemotherapy			
MPV	5 (71.4)	7 (77.8)	1
MATRix	5 (71.4)	5 (55.6)	0.635
Rituximab	5 (71.4)	6 (66.7)	1
Radiotherapy	5 (71.4)	2 (22.2)	0.045
Immunophenotype			
Bcl-2 positive	4 (57.1)	6 (66.7)	1
Bcl-6 positive	5 (71.4)	9 (100.0)	0.165
Mum-1 positive	4 (57.1)	4 (44.4)	1
CD-10 positive	2 (28.6)	1 (11.1)	0.544
Ki67 ≥50%	6 (85.7)	9 (100.0)	0.438

*: p<0.05 was considered statistically significant. All categorical comparisons were analyzed using Fisher's Exact Test. LDH: Lactate dehydrogenase; IELSG: International Extranodal Lymphoma Study Group; ECOG: Eastern Cooperative Oncology Group.

1–6 months). The median survival time in the four patients who experienced refractory disease was also found to be 4 months (1–8 months). Pneumonia (56.3%) was identified as the most common chemoradiotherapy-related complication among treatment-related complications. Table 4 presents details regarding treatment-related complications.

Discussion

This study highlights the aggressive course and poor prognosis of PCNSL. Our findings show that advanced age, high IELSG score, and the absence of aHSCT were associated with poorer 1-year overall survival. Surgical excision was

negatively associated with progression-free survival, while radiotherapy was associated with improved outcomes.

We observed that being under 60 years of age at diagnosis was associated with better 1-year overall survival. Literature review reveals conflicting information regarding the effect of advanced age on survival. Although most studies indicate advanced age as a negative factor in survival, there are also studies that present conflicting findings.^[3,4] Increase in comorbidities with age, decrease in organ function, and decrease in treatment tolerability may affect this situation. The fact that the patient with the longest survival time (50 months) in our study was 81 years old suggests that the

Table 4. Complications related with treatment		
Category and complication	n	%
Infectious complications (n=16)*		
Pneumonia	9	56.3
Febrile neutropenia	7	43.8
Bacteremia	7	43.8
Invasive fungal infection	4	25.0
Urinary tract infection	3	18.8
Neutropenic colitis	2	12.5
Surgery-related complications (n=14)		
Neurological deficit	4	28.6
Surgical site infection	2	14.3
Central hypothyroidism	1	7.1
Diabetes insipidus	1	7.1
Thromboembolic events (n=16)*		
Deep vein thrombosis	2	12.5
Pulmonary thromboembolism	1	6.3
Ischemic cerebrovascular events	1	6.3
*: Percentages were calculated based on the 16 patients who received chemoradiotherapy. p<0.05 was considered statistically significant.		

negative effects of advanced age on survival may stem from increasing organ dysfunction, chronic diseases, and low performance status rather than chronological age. The fact that this patient had no organ dysfunction or chronic disease at the time of diagnosis and tolerated all treatments well supports this hypothesis. Among ten patients without comorbidities at diagnosis, the 1-year overall survival rate was 80%, while among the six patients with comorbidities, this rate was 33%. Although this finding is not statistically significant, it shows that current health conditions may negatively affect the course of the disease. When classifying patients into risk groups, considering performance status, underlying health conditions, and organ dysfunction may be more useful than chronological age.

In our study, there was no significant difference in 1-year overall survival or 1-year progression-free survival between patients with an ECOG performance score below 2 and those with a score of 2 or above. In contrast, when patients were classified according to the IELSG scoring system, the 1-year overall survival rate was higher in the low-risk group compared with the intermediate-risk group (88.9% vs. 28.6%). There are studies in the literature showing that a low performance score has negative effects on survival.

[5] High LDH and deep involvement were not associated with 1-year overall survival. At this point, it was thought that the age and CSF protein levels in scoring system

were more dominant. PCNSL's low annual incidence and the similarity of its presenting symptoms (increased intracranial pressure symptoms, focal neurological deficits, etc.) with many other common neurological diseases can delay the diagnostic process. The fact that patients' initial presentations are usually to neurology clinics and that various treatments (especially steroids) are administered during the period before a PCNSL diagnosis is made may lead to changes in CSF protein and serum LDH levels. Therefore, when creating risk scoring systems for PCNSL, it may be a more accurate approach to use patient-specific and disease-specific factors rather than biochemical parameters that may change with treatment. Recent studies comparing scoring systems and radiology-supported models support our findings.^[6,7]

The role of surgery in PCNSL treatment is a controversial topic in the literature. Most studies have shown that total or subtotal resection does not contribute to survival and may have negative effects due to post-operative complications.^[8] A smaller number of studies have reported that gross surgery in selected patients has a positive effect on survival.^[9] The presence of tumor infiltrates even in areas without radiological involvement in autopsy series of PCNSL patients indicates that total resection is not possible in most patients, even if surgical margins are wide.

[10] In our study, the 1-year overall survival rate was 100% in three patients diagnosed with stereotactic biopsy and who did not undergo total or subtotal surgical resection, while this rate was 53.8% in 13 patients who underwent surgery. However, this result is not statistically significant. Progression-free survival was 100% in the group that did not undergo surgery, while it was 30.8% in those who underwent surgery, and this difference was found to be statistically significant. In addition, four patients developed neurological deficits, two patients developed wound site infections, and one patient each developed diabetes insipidus and central hypothyroidism as a result of surgery.

Although there is no standard chemotherapy regimen for PCNSL treatment, evidence-based guidelines are primarily based on regimens containing HD-MTX.^[11] In our study, all patients receiving chemotherapy were administered regimens containing HD-MTX. Thirteen patients received MPV chemotherapy, and three patients received MATRix chemotherapy as induction chemotherapy. Seven patients received the MATRix regimen, and six patients received aHSCT as rescue or consolidation therapy. The 1-year overall survival rate was 80% in patients treated with the MATRix regimen and 58.3% in those receiving the MPV regimen. However, these results are not statistically

significant. The absence of a group of patients treated with regimens not containing HD-MTX in our study prevented us from performing a reliable analysis.

The modern PCNSL treatment approach involves administering consolidation therapy to reduce the risk of relapse after achieving a complete or partial response to HD-MTX-based induction.^[12] In our study, aHSCT administered as consolidation therapy was found to be associated with improved 1-year overall survival. The 1-year overall survival rate was 100% in the 6 patients who received aHSCT, while it was 40% in the 10 patients who did not receive it. This finding is consistent with studies showing that aHSCT has curative potential in the treatment of PCNSL, especially in young and suitable patients.^[13] The latest European Hematology Association-European Society for Medical Oncology (2024) guidelines recommend consolidation strategies, including aHSCT, for eligible patients. Overall, these data further support the view that aHSCT may offer curative potential in selected patients with PCNSL.^[1]

In our study, progression-free survival was found to be statistically significantly longer in the group of patients who had radiotherapy. In PCNSL treatment, WBRT is considered an effective treatment method that provides high local control rates. However, complications such as persistent neurocognitive disorders, which are observed particularly in patients over 60 years of age and significantly reduce quality of life, limit the use of this treatment.^[14]

Among the limitations of the study, its retrospective design may lead to natural biases in the data collection process. Second, the small sample size reduces statistical power and complicates subgroup analyses; in addition, survival was assessed as a categorical outcome rather than a time-to-event measure, which may not fully capture disease dynamics. In particular, the limited number of events precluded the use of multivariate analysis to identify independent prognostic factors, and multiple comparisons were performed without adjustment, increasing the risk of spurious findings. The main reason for failing to reach meaningful results in the comparison of treatment regimens is this. Finally, the single-center nature of the study limits the generalizability of the results, and the findings should therefore be interpreted as exploratory and hypothesis-generating.

Conclusion

PCNSLs are aggressive tumors with a poor prognosis. Advanced age has been considered a risk factor for poor prognosis in studies, but the absence of comorbidities may be an indicator of good prognosis regardless of age.

aHSCT treatment has been shown to improve survival outcomes. Patients receiving radiotherapy had a higher 1-year progression-free survival rate. However, due to the complications, its use in elderly patients should be approached with caution. Surgical resection is mentioned in the literature as a treatment option, but its place in PCNSL treatment is controversial due to post-operative complications, and it has been found to have no significant association with survival.

Patient symptoms at presentation, ECOG performance score, deep or multifocal tumor involvement, gender, presence of comorbidities, absolute lymphocyte count, high serum LDH levels, tumor phenotypic characteristics, and chemotherapy regimens administered were not significantly associated with 1-year overall survival and 1-year progression-free survival.

Ethics Committee Approval: The Erciyes University Ethics Committee granted approval for this study (date: 29.01.2020, number: 2020/49).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: The authors affirm that they have no competing interests in relation to this study.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: Not declared.

Authorship Contributions: Concept: DE, MÇ; Design: DE; Supervision: MÇ; Data Collection or Processing: DE; Analysis or Interpretation: DE; Literature Search: MÇ; Writing: DE; Critical Review: DE, MÇ.

Peer-review: Double blind peer-reviewed.

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The Development and Psychometric Evaluation of the Individualized Developmentally Supportive Care Scale for Neonatal Nurses

 Rukiye Nur Çelik¹,  Dilek Konukbay²

¹Department of Newborn Intensive Care Unit, Konya City Hospital, Konya, Türkiye

²Department of Pediatric Nursing, University of Health Sciences Türkiye, Gülhane Faculty of Nursing, Ankara, Türkiye

Abstract

Introduction: Individualized developmentally supportive care (IDSC) is a critical nursing approach essential to providing effective care for pre-term newborns. This study aims to develop the IDSC scale for neonatal nurses and to evaluate its psychometric properties.

Methods: This study was conducted in a methodological, comparative, and correlational design with the neonatal nurses employed in the neonatal intensive care units. The content validity of the scale was evaluated by consulting with 11 specialists in pediatric nursing. Data were analyzed using descriptive statistics (numbers and percentages), t-tests, correlation analysis, criterion-related validity, exploratory and confirmatory factor analyses, and Cronbach's alpha reliability coefficient.

Results: The study included 558 neonatal nurses. The Cronbach's alpha reliability coefficient was 0.96 for the entire scale, 0.91 for the knowledge subdimension, and 0.96 for the attitude subdimension. According to the explanatory factor analysis, the scale explained 72.92% of the total variance, and the factor loads of the items were between 0.58 and 0.91. The confirmatory factor analysis concluded that the scale was acceptable with the root mean square error of approximation=0.078, goodness of fit index (GFI)=0.844, adjusted GFI=0.806, comparative fit index=0.918, and $\chi^2/df=2.754$ values ($p<0.001$).

Discussion and Conclusion: The "Individualized Developmentally Supportive Care Scale" comprising two subdimensions and 24 items, was found to be a valid and reliable measurement tool.

Keywords: Individualized developmentally supportive care; Neonatal nurse; Newborn; Scale

The World Health Organization and the American Academy of Pediatrics define newborns born before 37 weeks of gestation as pre-term.^[1] Each year, approximately one million infants die due to complications of pre-maturity.^[2] The earlier a baby is born, the higher the risk of morbidity

and mortality.^[3] Pre-term newborns, unable to adapt to the external environment after birth, require advanced medical intervention and specialized nursing care in neonatal intensive care units (NICUs) to survive. Although scientific and technological advances in treatment and

Cite this article as: Çelik RN, Konukbay D. The Development and Psychometric Evaluation of the Individualized Developmentally Supportive Care Scale for Neonatal Nurses. Lokman Hekim Health Sci 2026;6(3):438–447.

Correspondence: Dilek Konukbay. Sağlık Bilimleri Üniversitesi, Gülhane Hemşirelik Fakültesi, Çocuk Sağlığı ve Hastalıkları Hemşireliği Anabilim Dalı, Ankara, Türkiye

E-mail: dilek.konukbay@yahoo.com **Submitted:** 25.03.2025 **Revised:** 24.12.2025 **Accepted:** 13.01.2026 **Available Online:** 06.08.2026



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nursing have reduced mortality rates in NICUs, morbidity such as neurodevelopmental delays, impaired motor skills, and long-term learning and behavioral disorders has increased.^[4] Brain development continues in the NICU, where conditions differ significantly from the protective intrauterine environment, and pre-term infants are exposed to stressors such as pain, light, noise, and frequent handling. These stressors can negatively impact brain structure and function, contributing to neurodevelopmental impairments. Research has shown that exposure to painful procedures, noise, and light adversely affects future development, underscoring the importance of developmentally supportive care.^[5,6] In the late 2000s, key concepts of developmentally supportive care for pre-term infants began to emerge. Studies have demonstrated its positive effects on brain structure, motor development, and long-term cognitive and behavioral outcomes in NICU settings.^[7–9] Individualized developmentally supportive care (IDSC), based on the Synactive Theory, promotes the development of high-risk, hospitalized newborns. Within this framework, the Newborn Individualized Developmental Care and Assessment Program was developed.^[9–11] Developmentally supportive nursing practices are vital for conducting neurobehavioral and observational assessments of pre-term infants before, during, and after care, enabling nurses to interpret their strengths, vulnerabilities, and responses to the NICU environment.^[12] Providing such care requires a high level of professional competence, which can be fostered through targeted training and increased awareness of the importance of IDSC implementation in NICUs.^[5,13] Recent studies indicate that nurses often lack sufficient knowledge of developmental care, with limited awareness being the primary barrier to effective practice.^[2,5,10,14–16] A review of the literature reveals few studies evaluating neonatal nurses' knowledge, attitudes, and behaviors regarding IDSC, most of which rely on researcher-developed questionnaires. Therefore, there is a need for standardized, psychometrically validated tools to assess the implementation of IDSC by neonatal nurses.^[11,14,15] In this context, this study aims to develop the IDSC scale (IDSCS) for neonatal nurses and to evaluate its psychometric properties.

Materials and Methods

Study Place and Design

This methodological, comparative, and correlational study aimed to develop the IDSCS for neonatal nurses. The study was conducted with neonatal nurses working in NICUs in Türkiye between January and October 2022.

Population and Sample

The sample size for scale development studies was proposed as a minimum of 300 by Norusis (Norusis 2005).^[17] A purposive sampling method was used to define the target population, namely neonatal nurses working in NICUs across Türkiye who met the inclusion criteria. Within this population, convenience sampling was employed to recruit participants who were accessible and willing to take part in the study. Accordingly, the sample of the study consisted of the nurses working in the NICUs who volunteered to participate in the study and met the inclusion criteria. The inclusion criteria of the study were working as a nurse in the NICU for at least 6 months and volunteering to participate in the study.

Data Collection Tools

Sociodemographic Data Form

The form was prepared by the researchers based on the literature and consisted of 11 questions inquiring about the personal and professional characteristics of the nurses.^[11,14] It included questions about age, gender, marital status, having children, educational background, institution employed, years of nursing experience, years of working in the NICU, level of the NICU, and having received training on IDSC.

IDSCS

The IDSCS, developed within the scope of this study and determined to be a valid and reliable instrument, has been uploaded to the system as a supplementary file. The scale consisted of 24 items and two subdimensions to evaluate the IDSC levels of nurses working in the NICU. It was a five-point Likert-type scale. Each item was scored as "1=Strongly Disagree," "2=Disagree," "3=Moderately Agree," "4=Agree," and "5=Strongly Agree." The knowledge subdimension of the scale included items 1, 2, 3, 4, 7, 8, and 10, and items 11, 12, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, and 29 belonged to the attitude subdimension. The maximum and minimum scores that could be obtained from the scale were 120 (24×5) and 24 (24×1), respectively. An increase in the total scale score indicated high knowledge and attitude levels in nurses.

Developmental Support Competency Scale for Nurses (DSCS-N)

The DSCS-N was utilized for the convergent validity of the IDSCS. DSCS-N was developed by Kim and Shin in 2016 to evaluate the competence of neonatal intensive care nurses in developmental supportive care practices, and the Turkish

validity and reliability study was conducted by Kahraman and Ceylan in 2020.[7,14] It was a 4-point Likert-type scale, consisting of 19 items and 6 subdimensions scored between 1 and 4 (1=Never, 2=Sometimes, 3=Often, and 4=Almost always). The lowest and highest scores that could be obtained from the scale were 19 and 76, respectively. In the original study by Kim and Shin (2016), the Cronbach's alpha coefficient for the overall scale was reported as 0.83, with subscale reliability coefficients ranging from 0.60 to 0.76. In the Turkish adaptation by Kahraman and Ceylan (2020), the overall Cronbach's alpha was 0.90, and the values for the six subscales ranged from 0.67 to 0.85.[7,14]

Data Collection

The content validity of the scale was assessed by 11 pediatric nursing experts, resulting in revisions based on their feedback. Eight items were removed from the initial 38-item draft, yielding a final version of 30 items. A Turkish language specialist reviewed the scale for grammar and spelling. The 30-item draft was piloted with 31 eligible nurses, who reported no issues regarding readability or clarity. Their data were excluded from the main analysis. Subsequently, the scale was administered to nurses working in the NICU.

The study was conducted with neonatal nurses working in NICUs in Türkiye between January and October 2022, face-to-face (190) and online through Google Forms (368). A questionnaire created online through Google Forms was delivered to the nurses working in the NICU in Türkiye through a questionnaire link on social networks (WhatsApp, Instagram, Facebook, etc.). The nurses were informed about the purpose of the study and shared an information text containing a letter of assurance that their personal information would remain confidential. Nurses who agreed to participate in the survey online were granted access to the questionnaire after approving the informed consent text. In the face-to-face group, the scale was readministered to 182 nurses 15 days following the first administration. This subsample consisted of participants who completed the initial assessment and consented to participate in the retest phase. The correlation between the test and retest scores was calculated to assess test-retest reliability.

Statistical Analysis Process

The data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) Statistics for Windows, Version 23.0 (IBM Corp., Armonk, NY, USA) and IBM SPSS Amos, Version 23.0. Data entry was made by the researchers, and statistical analyses were conducted in collaboration with a biostatistician. Data were expressed using descriptive

statistics (number, percentage, mean, and standard deviation). The content validity index (CVI) was calculated to evaluate specialist opinions using the Davis technique.^[18]

The dataset was randomly split into two subsamples to perform exploratory factor analysis (EFA, $n=267$) for examining item-factor relationships and confirmatory factor analysis (CFA, $n=291$) for testing the factor structure. EFA was conducted using principal component analysis (PCA) with Varimax rotation. In the CFA, model fit was evaluated using multiple goodness-of-fit indices, including the Chi-square to degrees of freedom ratio (χ^2/df), the root mean square error of approximation (RMSEA), the goodness of fit index (GFI), the adjusted GFI (AGFI), the comparative fit index (CFI), the normed fit index, the incremental fit index, and the Tucker–Lewis index. Modification indices were examined, and theoretically justified modifications were applied to improve model fit. The Kaiser–Meyer–Olkin (KMO) test was used to assess the adequacy of the sample size for factor analysis, and Bartlett's Test of Sphericity was used to determine whether the correlation matrix significantly differed from the identity matrix. The Cronbach's Alpha, Split Half, Sperman–Brown, and Guttman coefficients and test-retest analysis were used for reliability analysis of the scale. A 27% lower-upper item analysis was performed for item discrimination analysis. An independent samples t-test was used to compare the item scores of the upper and lower 27% groups. Test-retest results were examined by Pearson correlation analysis.

Ethic Approval

Ethics committee approval was obtained from the University of Health Sciences Gülhane Scientific Research Ethics Committee (Meeting No: 2020/421, Decision No: 2020–471) for the study. The necessary institutional permissions were obtained. All of the participants were informed about the purpose and content of the study, and written informed consent was obtained from those who agreed to participate in the study. Volunteering nurses were included in the study, and they were informed that they could abandon the study at any time. In the study, the Helsinki Declaration of Human Rights was complied with from the beginning to the end of the process, paying careful attention to the protection of personal rights.

Results

Demographic Data

The study included 558 neonatal nurses. When the distribution of the nurses included in the study was

examined according to their demographic characteristics, the mean age of the participants was 29.00 ± 5.42 . Among the participants, 97.3% were female, 51.8% were married, and 35.5% had children. The rate of participants with a bachelor's degree was 75.7%, and 40.7% worked in the city hospital. In terms of experiences, 45.3% of the participants had been working as nurses for 4–9 years, and 39.2% had between 4 and 9 years of experience in the NICU. It was observed that 69.7% were employed in Level 3 and 22.4% were in Level 4 NICUs. Among the nurses, 40.7% had been trained in IDSC (Table 1).

Validity Analysis

The Content Validity

Eleven persons specialized in Pediatric Health and Diseases Nursing were consulted to evaluate the content validity. After obtaining specialist opinions, the CVI was calculated using the Davis technique, and eight items below 0.80 (2, 4, 5, 8, 10, 13, 16, and 35) were excluded from the scale. The CVI values of the draft form, consisting of 30 items, ranged between 0.81 and 1.00, and it was determined that the content validity was achieved for the scale according to the CVI value calculated. Following the EFA, the scale was reduced to 24 items. The mean CVI of the final 24-item scale was 0.89 (I-CVI range: 0.81–1.00), indicating that the content validity of the final scale was adequate.^[18]

Convergent Validity

The convergent validity of the scale was evaluated using the DSCS-N, which had been tested for validity and reliability by Kahraman and Ceylan. Convergent validity analyses were conducted using the CFA subsample ($n=291$), as the assessment of associations with a related scale is recommended to be performed on a sample in which the factor structure of the newly developed scale has been confirmed.^[19] A statistically significant and positive correlation was determined between the IDSCS and the DSCS-N in terms of the total and sub-dimension scores (Table 2).

Construct Validity

Explanatory factor analysis

Before the EFA, the KMO test value was found as 0.95 and Bartlett's Test of Sphericity value as ($\chi^2[956]=7729.073$, $p<0.01$). After confirming the suitability of the data for factor analysis, EFA was performed using PCA with Varimax rotation to examine the factor structure of the scale. In the EFA ($n=267$), the overlapping items (5, 6, 9, 13, 14, and 30) were excluded from the analysis, and the EFA was repeated

Table 1. Sociodemographic characteristics of the participants ($n=558$)

Characteristics	Mean $\pm$ SD	
Age	29.00 $\pm$ 5.42	
	n	%
Gender		
Female	543	97.3
Male	15	2.7
Marital status		
Married	289	51.8
Single	269	48.2
Having children		
Yes	198	35.5
No	360	64.5
Education		
High school	43	7.7
Associate degree	43	7.7
Bachelor's degree	422	75.7
Master's degree	46	8.2
PhD	4	0.7
Institution of employment		
City hospital	227	40.7
Training and research hospital	65	11.6
Private hospital	52	9.3
University hospital	125	22.4
State hospital	89	15.9
Nursing experience		
<1 year	37	6.6
1–3 years	155	27.8
4–9 years	253	45.3
10 years and longer	113	20.3
Working experience in the NICU		
<1 year	72	12.9
1–3 years	204	36.6
4–9 years	219	39.2
10 years and longer	63	11.3
Level of the NICU		
Level 1	18	3.2
Level 2	26	4.7
Level 3	389	69.7
Level 4	125	22.4
Having received training on IDSC		
Yes	227	40.7
No	331	59.3

SD: Standard deviation; IDSC: Individualized developmentally supportive care; NICU: Neonatal intensive care unit.

Table 2. Convergent validity correlations of the individualized developmentally supportive care scale and the developmental support competency scale for nurses (n=291)

	IDSCS	Knowledge	Attitude
DSCS-N			
r	0.629	0.479	0.609
p	0.000**	0.000**	0.000**
Environmental support			
r	0.498	0.358	0.490
p	0.000**	0.000**	0.000**
Parental support			
r	0.363	0.320	0.324
p	0.000**	0.000**	0.000**
Partnership			
r	0.461	0.370	0.431
p	0.000**	0.000**	0.000**
Professional support			
r	0.470	0.420	0.416
p	0.000**	0.000**	0.000**
Interaction			
r	0.455	0.337	0.442
p	0.000**	0.000**	0.000**
Critical thinking			
r	0.520	0.401	0.496
p	0.000**	0.000**	0.000**

**: p<0.01. IDSCS: Individualized developmentally supportive care scale; DSCS-N: Developmental support competency scale for nurses; r: Pearson correlation coefficient.

multiple times. It was determined that the factor loads of the 24 items remaining in the scale ranged from 0.58 to 0.91 and were grouped under two subdimensions. According to the results of the EFA, the scale explained 72.92% of the total variance, the knowledge subdimension explained 23.41%, and the attitude subdimension 49.50% (Table 3).

CFA

The two-factor model obtained from the EFA was tested using CFA on the second subsample (n=291) (Fig. 1). The goodness-of-fit indices of the model indicated an overall acceptable fit (RMSEA=0.078, $\chi^2/df=2.754$, CFI=0.918), whereas some indices demonstrated relatively lower fit values (GFI=0.844; AGFI=0.806) (Table 4) (p<0.001).^[20,21] Although the AGFI value was slightly below the recommended threshold of 0.85, the model was considered acceptable based on the collective evaluation of multiple fit indices.

In addition, the reliability and convergent validity of the measurement model were further examined using average

variance extracted (AVE) and composite reliability (CR) values. For the knowledge subdimension, the AVE and CR values were 0.50 and 0.94, respectively. For the attitude subdimension, the AVE and CR values were 0.62 and 0.76, respectively, indicating adequate convergent validity and construct reliability.^[20,21]

Reliability

Item analysis based on correlations

The item-total test correlation values of the participants' answers to the scale questions were examined, and it was determined that there were no items below 0.30. Item-total test correlation values of all items varied between 0.45 and 0.80. As presented in the item-total test correlation table, all items were found to be related to each other (Table 5).

Internal consistency analysis

The Cronbach's alpha coefficient was calculated as 0.91 and 0.96 for the knowledge and attitude subdimensions of the scale, respectively. The overall Cronbach's alpha coefficient of the scale was calculated as 0.96, and it was found to be very highly reliable. The analysis was conducted using the full dataset (n=558). The items were divided into two halves: Part 1 included items 1, 3, 7, 10, 12, 16, 18, 20, 22, 24, 26, and 28 (Cronbach's alpha=0.92) Part 2 included items 2, 4, 8, 11, 15, 17, 19, 21, 23, 25, 27, and 29 (Cronbach's alpha=0.92). The correlation coefficient between the split halves was calculated as 0.95, the Spearman-Brown coefficient as 0.97, the Guttman coefficient as 0.97, and the tool was found reliable. These results are presented in the text and not tabulated.

Test-retest reliability

The scale was readministered to 182 nurses 15 days after the first administration. The correlation was calculated between the two tests after the first test and the retest. The correlation values of the knowledge and attitude subdimensions were calculated as r=0.96 (p<0.001) and r=0.97 (p<0.001), respectively. The overall correlation value of the IDSCS was calculated as r=0.97 (p<0.001). According to the results, it was determined that consistent results were obtained within the period. In addition to Pearson correlation coefficients, test-retest reliability was evaluated using the intraclass correlation coefficient (ICC). The overall scale demonstrated good test-retest reliability (ICC=0.84, p=0.001). These results are presented in the text and not tabulated.

Discussion

The IDSCS was developed to assess neonatal intensive care nurses' knowledge and attitudes toward IDSC. Content

Table 3. Explanatory factor analysis results (n=267)

Factors and items	Factor load	Explained variance (%)	Eigenvalue
Factor 1 knowledge			
Item 2. I have the knowledge necessary for providing individualized developmentally supportive care.	0.909	23.418	2.420
Item 1. I know the concept of individualized developmentally supportive care.	0.884		
Item 10. I think I am competent in providing individualized developmentally supportive care.	0.837		
Item 3. Individualized developmentally supportive care supports the neuro-motor, sensory, and emotional development of the pre-term newborns	0.713		
Item 4. Individualized developmentally supportive care has positive outcomes for the pre-term newborn (preventing stress, reducing oxygen demand, supporting postural development, etc.).	0.669		
Item 7. I know the recommended lighting standards for the neonatal intensive care unit.	0.612		
Item 8. I know the recommended sound level standards for the neonatal intensive care unit.	0.608		
Factor 2 attitude			
Item 24. I protect the newborn from sound and light by covering the incubator in the neonatal intensive care unit with a sheet.	0.910	49.508	15.082
Item 22. I support the self-soothe of the pre-term newborn (holding the baby's finger, placing its hand in its mouth/face, supporting its foot, placing it to the midline, etc.).	0.893		
Item 21. I provide the pre-term newborn with positive sensory stimuli, such as using a soft tone of voice and making eye contact, according to the gestational week.	0.889		
Item 28. I encourage the newborn to be breastfed by providing breast milk and breastfeeding training to the family from the first moment of its admission to the unit	0.887		
Item 20. I avoid touching the pre-term newborn unnecessarily, frequently, fast, and inappropriately.	0.885		
Item 18. I use non-pharmacological methods (wrapping, positioning, breast milk, etc.) in the pain management of the newborn.	0.862		
Item 27. I use kangaroo care according to the condition of the pre-term newborn.	0.860		
Item 25. I reduce the sound level and lighting at certain hours to ensure the sleep-wake cycle of the newborn.	0.854		
Item 19. I apply the feeding technique according to the cues of the pre-term newborn before, during, and after feeding.	0.849		
Item 15. I use support equipment (pillows, blankets, etc.) for the postural support of the pre-term newborn.	0.815		
Item 29. I support the family to participate in care and make decisions about it from the admission of the newborn to the neonatal intensive care unit.	0.791		
Item 16. I perform total care to stimulate the newborn minimally and prevent stress.	0.790		
Item 12. I work collaboratively with other nurses and healthcare professionals in individualized developmentally supportive care practices.	0.701		
Item 11. I determine my care approaches and priorities according to the developmental needs of the newborn.	0.667		
Item 17. I assess the skin integrity of the newborn daily with the help of a scale.	0.657		
Item 23. I prevent the spread of odors such as perfume, disinfectant, and alcohol in the neonatal intensive care unit.	0.635		
Item 26. I use pacifiers to support the feeding of the pre-term newborn, facilitate its transition to oral feeding, and calm it down.	0.586		
Kaiser-Meyer-Olkin=0.956 X ² (276)=7729.073. Bartlett's test of sphericity (p)=0.000. Rate of total explained variance=72.92.			

validity refers to the extent to which a scale covers all relevant subtopics and adequately represents the item universe. One common method to establish content

validity is through expert consultation. The recommended number of experts ranges from 3 to 20.^[22] In this study, content validity was evaluated using the Davis technique

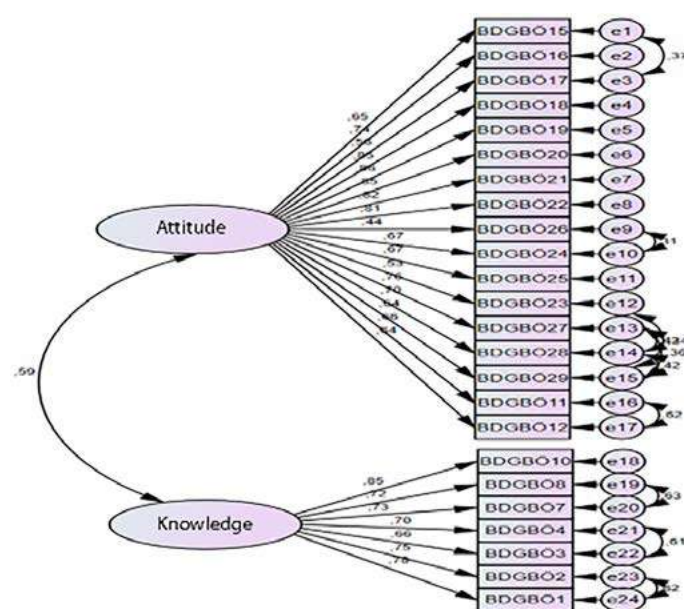


Figure 1. Adjusted CFA model diagram of the Individualized Developmentally Supportive Care Scale (IDSCS).

with 11 experts, and the CVI was calculated. A CVI of 0.80 or above indicates strong content validity.^[22–24] Based on expert feedback, eight items with CVI values below 0.80 were removed. The remaining 30 items had CVIs ranging from 0.81 to 1.00, indicating acceptable content validity. Convergent validity is established when a measurement tool shows similar results to a validated instrument. In this study, the DSCS-N, whose Turkish validity and reliability were confirmed by Kahraman and Ceylan, was used for convergent validity.^[7] Since the developed scale included subdimensions, appropriate tests were applied separately for each. A significant positive correlation was found between the IDSCS and DSCS-N scores and their respective subdimensions, confirming convergent validity.

Item-total correlation reflects the relationship between individual item scores and the total scale score, indicating each item’s distinctiveness. Items with correlations ≥ 0.30 effectively discriminate among participants.^[25] In this study, all items had item-total correlations between 0.45 and 0.80, with none below 0.30, demonstrating good internal consistency.

Factor analysis is a construct validity technique used to reveal whether there is a specific relationship between the reactions of the participants to the items in the measurement tool being developed. The sample size must be large enough to predict the relationships reliably. Prior to conducting the EFA, the KMO test was conducted to assess sample adequacy, and Bartlett’s Test of Sphericity was used to determine whether the correlation matrix significantly differed from the identity matrix.^[25–27] In this study, it was determined that the KMO value was 0.95 according to the result of the analysis. The sample size was found to be perfectly sufficient. The results of Bartlett’s Test of Sphericity showed a significant Chi-square value ($\chi^2[956]=7729.073, p<0.01$), indicating that the correlation matrix significantly differs from the identity matrix and that the data are suitable for factor analysis.

A high factor loading (≥ 0.30) in EFA indicates structural validity.^[26,28] Items must form a coherent whole consistent with factor analysis results.^[22,26] In this study, the total explained variance was 72.92%. Overlapping items (5, 6, 9, 13, 14, 30) were removed to ensure homogeneity and dimension clarity. The remaining items had factor loadings between 0.58 and 0.91, indicating good validity. Items 1, 2, 3, 4, 7, 8, and 10 loaded on Factor 1 (Knowledge), whereas items 11, 12, 15–29 loaded on Factor 2 (Attitude). Thus, the scale was confirmed to have two theoretically consistent dimensions with an acceptable factor structure.

Table 4. Individualized developmentally supportive care scale first level multi-factor model confirmatory factor analysis fit indices			
Index	Perfect fit	Acceptable fit	After modification
χ^2/SD	$0 \leq \chi^2/df \leq 3$	$3 \leq \chi^2/df \leq 5$	2.754
RMSEA	0.00 0.05	0.05	0.078
SRMR	0.00 0.05	0.05	0.068
CFI	$0.95 \leq CFI$	$0.85 \leq CFI$	0.918
GFI	$0.90 \leq GFI$	$0.85 \leq GFI$	0.844
AGFI	$0.90 \leq AGFI$	$0.85 \leq AGFI$	0.806
IFI	0.90 1.00	0.80	0.919
TLI	$0.90 \leq TLI$	$0.80 \leq TLI$	0.906
NI	$0.90 \leq NFI$	$0.80 \leq NFI$	0.878

Hooper et al.,^[20] Lomax and Schumacker^[21]. RMSEA: Root mean square error of approximation; SRMR: Standardized root mean square residual; CFI: Comparative fit index; GFI: Goodness of fit index. AGFI: Adjusted Goodness of Fit; IFI: Incremental Fit Index; TLI: Tucker-Lewis Fit Index; NI: Normed Fit Index.

Table 5. Item analysis results of the scale items (n=291)

Item	Item total correlation (r)	Alpha value when the item was deleted	Lower 27%-Upper 27% ** (t)	Lower 27%-Upper 27% (p)
Knowledge				
Item 1	0.794	0.888	19.241	0.000*
Item 2	0.783	0.890	22.745	0.000*
Item 3	0.678	0.901	14.051	0.000*
Item 4	0.691	0.901	13.992	0.000*
Item 7	0.703	0.899	16.230	0.000*
Item 8	0.706	0.898	14.468	0.000*
Item 10	0.754	0.893	16.899	0.000*
Attitude				
Item 11	0.683	0.935	12.300	0.000*
Item 12	0.659	0.936	12.338	0.000*
Item 15	0.625	0.937	13.540	0.000*
Item 16	0.689	0.935	13.087	0.000*
Item 17	0.564	0.939	12.862	0.000*
Item 18	0.786	0.934	13.430	0.000*
Item 19	0.809	0.933	17.346	0.000*
Item 20	0.785	0.934	15.727	0.000*
Item 21	0.771	0.934	16.450	0.000*
Item 22	0.770	0.934	14.215	0.000*
Item 23	0.533	0.939	12.090	0.000*
Item 24	0.670	0.936	11.758	0.000*
Item 25	0.666	0.936	13.643	0.000*
Item 26	0.459	0.942	9.883	0.000*
Item 27	0.763	0.934	13.611	0.000*
Item 28	0.711	0.935	14.070	0.000*
Item 29	0.679	0.936	15.716	0.000*

*, p<0.001; **, n1=n2=79. r: Item total score correlation.

The aim of CFA is to validate the factor structure identified by EFA. The two-factor structure derived from EFA was confirmed in a second sample using CFA (n=291). CFA assesses the alignment between factors and associated variables using multiple fit indices.^[28] These indices showed acceptable values. A good model fit is indicated by fit indices above 0.80, $X^2/df < 5$, and RMSEA < 0.08 .^[20,21,29,30] The CFA results supported the model, confirming the two-factor structure, correlations between subdimensions and the overall scale, and adequate factor loadings.^[28] Reliability was further assessed through AVE and CR, with acceptable thresholds being AVE>0.50 and CR>0.70. The obtained values met these criteria.^[31]

Whether the items measure a specific conceptual structure consistently using a single measurement tool and

measuring at a single time should be investigated, and the tools with high internal consistency are deemed reliable.^[22] In this study, the Cronbach's alpha coefficient was used first for evaluating the internal consistency. The coefficient of 0.80 and above indicates very strong reliability.^[25,27] The Cronbach's alpha coefficient was calculated as 0.91 and 0.96 for the knowledge and attitude subdimensions of IDSCS, respectively. The Cronbach's alpha coefficient was found to be 0.96 for the overall scale, and the scale was found to be very highly reliable.

Second, the split-half method was utilized to evaluate internal consistency. In this method, the form is split into two equal parts, enabling reliability estimation according to the correlation between the scores of the subjects from the halves after the two halves are administered to the subjects

simultaneously. According to the method, the internal consistency is determined based on the similarity of the scores obtained from both halves of the sample, provided that the measurement tool is reliable. The reliability coefficient of the Split-Half Spearman–Brown and Guttman reliability should be at least 0.70.^[24,27] In the present study, Cronbach's alpha value was calculated as 0.92 for Part 1 with 12 items and 0.92 for Part 2 with 12 items. The internal consistency coefficient between the two halves was calculated as 0.95, the Spearman–Brown coefficient as 0.97, and the Guttman Split-Half coefficient as 0.97. Therefore, it was concluded that the scale was sufficiently reliable.

The test–retest method entails administering the same measurement tool to the same group twice under similar conditions, with intervals long enough to prevent recall but short enough to avoid changes in the measured construct. While interval recommendations vary, a 15-day gap is commonly used in paper-based tests.^[32] If the measured feature is a continuous variable and the developed scale is an equal range or ratio scale, the Pearson Product-Moment Correlation coefficient (r) is calculated. When the correlation coefficient and p -value results between the two tests were examined in this study, the p -values were found to be below 0.05 for the knowledge and attitude sub-dimensions of IDSCS. In addition, statistically significant, positive, and very high levels of relationships were obtained ($p < 0.05$). As a result, the measurements made with IDSCS were accepted as stable and consistent.

Limitations

The fact that the scale was filled in by NICU nurses who volunteered to participate in the study may have caused selection bias. Furthermore, collecting data using two different methods, including face-to-face interviews and online, to reach all neonatal nurses working in NICUs in Türkiye is a limitation of the study.

Nurses should have a high level of knowledge and awareness about IDSC to implement it effectively in the NICUs. There is a limited number of studies evaluating the knowledge, attitudes, and behaviors of nurses regarding IDSC. Accordingly, measurement tools tested for reliability and validity are needed to evaluate the IDSC performed by neonatal nurses. In this sense, it is a pioneering study in the field. According to the results obtained from the validity and reliability analysis of the study, the IDSCS for Neonatal Nurses is a valid and reliable measurement tool. The scale can be easily administered as a measurement tool by conducting validity and reliability studies in different cultures.

Conclusion

According to the validity and reliability analyses, the IDSCS developed for neonatal nurses was accepted as a valid and reliable measurement tool. This scale can be effectively used to evaluate the knowledge and attitudes of nurses working in the NICU toward IDSC.

Ethics Committee Approval: The University of Health Sciences Gülhane Scientific Research Ethics Committee granted approval for this study (date: 30.11.2020, number: 2020–471).

Informed Consent: Nurses who agreed to participate in the survey online were granted access to the questionnaire after approving the informed consent text.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: The authors declared that artificial intelligence (AI) supported technologies were not used in the study.

Authorship Contributions: Concept: RNÇ, DK; Design: RNÇ, DK; Supervision: RNÇ, DK; Resource: RNÇ, DK; Materials: RNÇ, DK; Data Collection or Processing: RNÇ, DK; Analysis or Interpretation: RNÇ, DK; Literature Search: RNÇ, DK; Writing: RNÇ, DK; Critical Review: RNÇ, DK.

Peer-review: Double blind peer-reviewed.

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Effects of Breathing Exercises Applied to Coronary Angiography Patients on Anxiety, Pain, and Vital Signs: A Randomized Controlled Trial

 Yasemin Sazak,  Sevinç Meşe

Department of Nursing, Kahramanmaraş İstiklal University Faculty of Health Sciences, Kahramanmaraş, Türkiye

Abstract

Introduction: Coronary angiography patients may experience pain and anxiety due to the invasiveness of the procedure and its involvement with a vital organ such as the heart. This study was conducted to determine the effects of breathing exercises on pain, anxiety, and vital signs in patients who underwent coronary angiography.

Methods: The study was conducted as a single-blind randomized controlled trial between September and November 2024. Patients in the intervention group performed breathing exercises in accordance with the application protocol 30 min before the coronary angiography. Patients in the control group were only given standard treatment and care. Data on anxiety and vital signs were assessed before and after the intervention, and pain levels data were collected after the intervention.

Results: The study was finished with 87 patients (43 in the control group and 44 in the intervention group). After the breathing exercise intervention, the post-test results showed that the pain levels, blood pressure, and anxiety levels of patients in the intervention group were lower than those in the control group ($p<0.05$). The results of the mixed-design analysis of variance test for repeated measures showed that the mean scores for blood pressure, pulse rate, and anxiety levels were significantly affected by the group-time interaction ($p<0.001$).

Discussion and Conclusion: The results of this research show that the breathing exercises applied reduce pain and anxiety in patients and have a positive effect on vital signs. The importance of the routine application of breathing exercises in angiography clinics is also demonstrated.

Keywords: Anxiety; Breathing exercises; Coronary angiography; Nursing; Pain; Vital signs

Coronary artery diseases cause mortality and morbidity among cardiovascular diseases worldwide.

^[1] Interventions made with advancing technology support diagnosis and assist in treatment planning.

^[2] Coronary angiography is a frequently preferred and applied intervention for diagnosing and managing

diseases among invasive methods.^[3] Patients may experience stress before and during the procedure due to the invasiveness of the procedure, possible complication risks, and its relation to a vital organ. The anxiety and stress experienced by patients may affect their vital signs and pain levels.^[4,5]

Cite this article as: Sazak Y, Meşe S. Effects of Breathing Exercises Applied to Coronary Angiography Patients on Anxiety, Pain, and Vital Signs: A Randomized Controlled Trial. Lokman Hekim Health Sci 2026;6(3):448–457.

Correspondence: Yasemin Sazak. Kahramanmaraş İstiklal Üniversitesi Sağlık Bilimleri Fakültesi, Hemşirelik Anabilim Dalı, Kahramanmaraş, Türkiye
E-mail: yaseminsazak44@gmail.com **Submitted:** 07.08.2025 **Revised:** 05.01.2026 **Accepted:** 13.01.2026 **Available Online:** 06.08.2026



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Patients feel pain due to the invasiveness of the procedure, pressure dressing, and having to lie still for a certain period.^[6] The body gives a neurohormonal response to stressful stimuli such as anxiety and pain. This response activates sympathetic systems, increasing heart rate, rate of breathing, and blood pressure.^[1,7] Consequently, the need for the heart's pumping power increases, which increases the demand for myocardial oxygen. This poses a risk, especially for cardiovascular patients.^[8] Furthermore, it is known that anxiety leads to a higher perception of pain intensity and reduces the pain threshold by affecting pain perception.^[7]

Nurses have important roles in managing patients' pain and anxiety. This role is important, especially when considering nurses' intense interactions with patients undergoing interventional procedures.^[5] Therefore, nurses must develop comprehensive nursing practices intended to reduce and prevent patients' pain and anxiety.^[4] In addition to pharmacological interventions, non-pharmacological methods are frequently preferred during and after interventional procedures. Such methods are indicated to affect patients' complaints of pain and anxiety after invasive procedures.^[9]

Breathing exercises represent a relaxation technique with strong positive effects on physical and mental health. Their application before interventional procedures affects the management of patients' physiological symptoms.^[10,11] Deep, controlled breathing activates the autonomic nervous system's parasympathetic branch, putting the body into "rest and digest" mode, which lowers stress hormone (e.g., cortisol) levels. When anxiety starts, the average time it takes for the body to relax and focus is 20 min. Therefore, doing breathing exercises 10–15 min before high-stress interventions may be useful in preventing the potential physiological effects of anxiety.^[12] Breathing exercises may help balance heart rate and blood pressure, increase tissue oxygenation, and regulate pulmonary artery and aortic pressure.^[12,13]

Three-part breathing (full yogic breathing, Dirgha) and square breathing are remarkable breathing exercises. The three-part breathing exercise induces deep breathing and follows the steps of deep breathing to the abdomen, chest, and collarbone, respectively.^[14,15] The three-part breathing exercise enables deep and slow breathing that involves different parts of the body compared to standard diaphragmatic breathing and pursed-lip breathing. This helps patients increase their breathing awareness and concentration.^[14] Square breathing consists of a cycle of

breathing through the nose for 4 s, holding the breath for 4 s, exhaling for 4 seconds, and holding the breath again for 4 s. These simple, cheap, and easily applicable breathing techniques are effective in an individual's relaxation by reducing anxiety and pain.^[16]

Despite the positive effects of breathing exercises applied to angiography patients on pain and anxiety levels reported in the literature, these studies are limited. Pain and anxiety are common symptoms experienced during coronary angiography. In light of these findings, the present study was conducted to ascertain the impact of breathing exercises on pain intensity, anxiety levels, and vital signs in patients who underwent coronary angiography.

Materials and Methods

Research Design and Sample Selection

This study was a randomized, controlled, parallel-group, single-blind experimental trial. It was conducted at a cardiology clinic in a state hospital located in the Mediterranean region of Türkiye from September to November 2024.

The Study Hypotheses were Followed

- H₁: There is a significant difference in anxiety levels between patients who underwent breathing exercises and patients in the control group
- H₁₂: There is a significant difference in pain levels between patients who underwent breathing exercises and patients in the control group
- H₁₃: There is a significant difference in systolic blood pressure levels between patients who underwent breathing exercises and patients in the control group
- H₁₄: There is a significant difference in diastolic blood pressure levels between patients who underwent breathing exercises and patients in the control group
- H₁₅: There is a significant difference in heart rate between patients who underwent breathing exercises and patients in the control group
- H₁₆: There is a significant difference in saturation values between patients who underwent breathing exercises and patients in the control group.

The study sample consisted of patients who met the inclusion criteria, volunteered to participate, and would undergo coronary angiography. The sample size was computed using the G*Power 3.1.9.7 program. A study evaluating the effects of breathing exercises in coronary

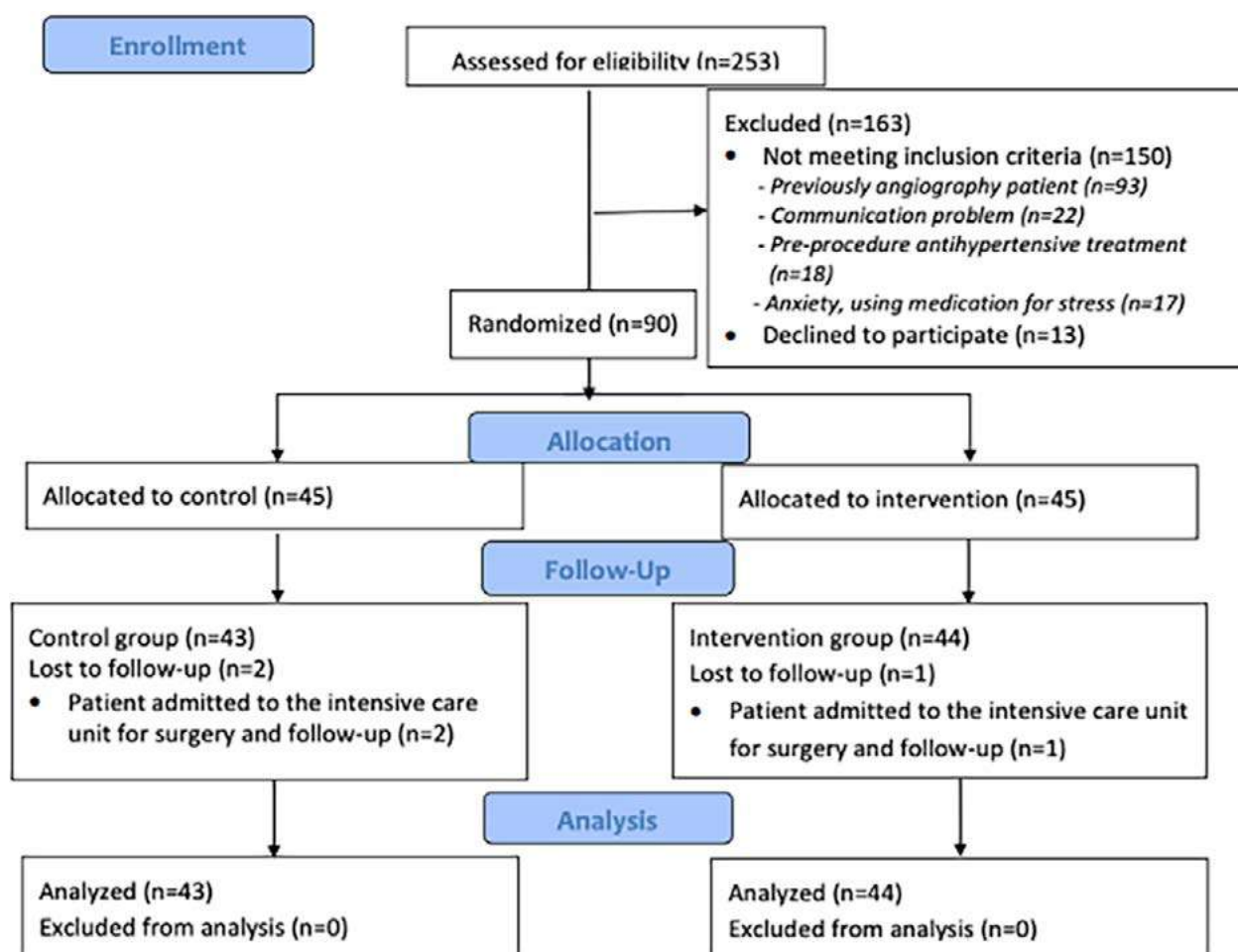


Figure 1. Consolidated Standards of Reporting Trials flow diagram of the study.

angiography patients was found in the literature. Therefore, this study was used as a reference in the sample calculation. The smallest effect size value was used according to the referenced study.^[10] Accordingly, the sample size in each group was 41, with an effect size of 0.96, power of 99%, error of 5%, and confidence interval of 95% (Means: Difference between two independent means, two-tailed). Considering data losses and ensuring the application of parametric tests, it was concluded that the sample size would be 45 individuals for the intervention group and 45 individuals for the control group. The study was conducted with a total of 87 patients (Fig. 1).

Randomization and Blinding

The study used a simple randomization method to ensure a random and equal allocation of patients to both groups. The researchers performed randomization using a website (<https://www.randomizer.org/>). As a result of randomization, two groups of number lists, ranging from 1 to 90, were determined. The numbers drawn by

an independent person formed the intervention group. Based on the inclusion criteria, patients were assigned to either group according to the order in which they applied to the clinic. The researcher collected the pre-test data for the study. A nurse who worked the day shift in the clinic and was independent of the study collected post-test data. The nurse was not informed of which patients were included in which group. Thus, blinding was performed when collecting the post-test data. The Consolidated Standards of Reporting Trials 2010 checklist was followed in reporting the study.^[17]

Inclusion and Exclusion Criteria

Patients over the age of 18 years who underwent coronary angiography for the 1st time, had no respiratory distress, no communication problems, and were willing to participate in the study were included. Patients who were using any medication that suppressed anxiety symptoms and pain, underwent emergency coronary angiography, and/or complained of chest pain, were treated with

anti-hypertensive therapy before the procedure due to hypertension, or were diagnosed with a psychiatric illness by a specialist physician, were not included in the study. Patients who underwent emergency intervention during coronary angiography and were transferred to the intensive care unit for surgical procedures and follow-up were excluded from the study (Fig. 1).

Data Collection Forms

Patient Descriptive Form

This form was prepared by researchers based on studies in the literature.^[4,5] It included 17 questions to determine the participants' sociodemographic and disease-related characteristics.

Vital Signs Record Form

The researchers prepared the form to record patients' blood pressure, saturation, and pulse values.

Visual Analog Scale (VAS)

This scale represents a 10 cm ruler that can be used to determine the minimum and maximum levels of pain. "0" indicates no pain, and "10" refers to unbearable pain. Research indicates that this tool is valid and reliable for assessing acute pain.^[18]

State-Trait Anxiety Inventory (STAI)

The inventory developed by Spielberger et al.^[19] consists of two subscales: STAI-Trait (STAI-T) and STAI-State (STAI-S). Each subscale consists of 20 items on a four-point Likert scale. STAI-S determines how an individual feels at a specific moment under specific conditions. STAI-T, on the other hand, expresses how an individual generally feels, regardless of their current situation.^[19] The scale was adapted into Turkish by Öner and Le Compte, and its validity and reliability were assessed.^[20] In this study, the STAI-S was used. The scores obtained from each scale range from 20 to 80. The 10 items in the STAI-S are reverse-scored. A high score indicates a high level of anxiety.^[19,20] The reliability of the scale in Turkish was assessed using the test-retest method. The correlation coefficient for the STAI-S was found to be between 0.26 and 0.68. In the Turkish validity and reliability study, the internal consistency coefficient for the STAI-S was found to be between 0.83 and 0.87.^[20] This study calculated Cronbach's alpha coefficient as 0.79 in the pre-test and 0.96 in the post-test. Accordingly, in this study, Cronbach's alpha value was found to be acceptable in the pre-test and excellent in the post-test.

Breathing Exercises Applied

The first researcher had an internationally recognized and university-approved breathing technique application certificate. In this study, three-part and square-breathing techniques were applied to patients. Expert opinions were received from a breathing techniques trainer, a faculty member with a breathing technique application certificate, and a cardiologist on the applicability of the breathing exercise protocol. The breathing technique application protocol was finalized based on expert opinions. The application steps of the breathing techniques are presented in the breathing technique application protocol (Supplemental file).

A pilot study was conducted with three patients who met the inclusion criteria before the study's initiation to evaluate the applicability of the breathing exercise protocol and data collection forms. Patients who underwent a pilot study were not included. There have been no changes to the data collection form or application protocol.

Application and Data Collection

Patients in the intervention group were informed of the study's purpose, and their consent to participate was obtained both verbally and in writing. Vital signs were recorded on the form created by the researcher by measuring blood pressure, saturation values, and pulse. Measurements were performed with the calibrated devices used in the hospital. Pre-test data were collected from patients face-to-face using the patient descriptive form and STAI-S measurement tool by the data collection forms. It took approximately 10 min to collect the pre-test data. The application was performed in a separate room in the clinic so that the patient could concentrate and not be affected by other patients. Patients were asked to sit halfway up and lie down in a comfortable position during the procedure. Before the application, the researchers showed the breathing exercise techniques to the patients using a demonstration method to ensure the correct application of the breathing exercises. Half an hour before the coronary angiography, breathing exercises were performed with patients following the breathing exercise protocol. The application took 15–20 min in line with the protocol. Post-test data (VAS, STAI-S, and vital signs) were collected within 15 min after the patient was taken to bed after the coronary angiography procedure. The data from the post-test were collected by a nurse working the day shift in the clinic and independent of the study. The nurse was not informed about which patients were included in which group, so blinding was ensured when collecting post-test data.

Patients in the control group were informed of the study's purpose, and their consent to participate was obtained both verbally and in writing. Thirty minutes before the coronary angiography, vital signs, blood pressure saturation values, and pulse were measured and recorded on the form prepared by the researcher. The pre-test data were collected in person from the patients using the patient descriptive form and STAI-S in line with the data collection forms. The patients in the control group continued to receive routine hospital care and treatment. The researchers performed no intervention. After the procedure, the post-test data (vital signs, VAS, and STAI-S) were collected face-to-face by a nurse independent of the study within 15 min after the patient was taken to bed. Breathing exercises were administered to patients in the control group after the study if there were no contraindications.

Statistical Analysis

The IBM Statistical Package for the Social Sciences (SPSS) 25 software package (The SPSS, IBM Corp., Armonk, NY, USA) was utilized for data analysis. Individuals' descriptive characteristics were presented as numbers, percentages, means, and standard deviations. The exact method of Fisher's Chi-square test was used in 2x2 and rxc tables to compare the study groups with categorical variables.

^[21] The normality of the data was assessed using the Shapiro-Wilk test, histograms, Q-Q plots, and skewness and kurtosis values. The data were observed to follow a normal distribution. An independent samples t-test was used for between-group comparisons at each time point, and a paired samples t-test was used for within-group pre-posttest comparisons. Effect sizes were computed as Cohen's d with 95% confidence intervals. According to the value of Cohen's d, a value of 0.2 was considered a small effect, 0.5 a medium effect, and 0.8 or higher a strong effect.^[22] Repeated measurements were evaluated using a mixed-design analysis of variance (ANOVA) test to determine changes according to time and groups. Partial eta squared (η^2) was employed as the effect size in the evaluation of the mixed-design ANOVA (small effect: 0.01, medium effect: 0.06, and large effect: 0.14).^[22] In statistical analyses, the level of significance was considered as $p < 0.05$.

Ethical Considerations of the Study

Approval was obtained from the Non-Invasive Research Ethics Committee of Kahramanmaraş İstiklal University before the study (Decision No. 2024/10-02, dated June 28, 2024). Approval was obtained in writing from the institution where the study took place. Scale usage permissions were

obtained. The patients were informed about the study's protocol, and written and verbal consent was obtained from the volunteers who were willing to participate. This study was conducted in accordance with the principles of the Helsinki Declaration and the rules of publication ethics. No adverse events occurred in any patient concerning this research.

Results

The study was completed with a total of 87 patients (study group 44 and control group 43). The mean age of patients in the control group was 61.21 ± 7.83 years, and the mean age of patients in the intervention group was 60.39 ± 7.43 years. There were no significant differences in the descriptive characteristics of the patients between the groups (Table 1).

In the initial measurements before intervention, there were no differences between the groups in terms of vital signs or STAI-S mean scores $p > 0.05$ (Table 2). The patients did not experience pain because they had not undergone coronary angiography before the intervention. Thus, patients' pain was not assessed in the pre-test.

In the post-test, the mean systolic blood pressure and diastolic blood pressure of the patients in the control group were found to be significantly higher than in the pre-test, while their mean STAI-S scores were lower ($p < 0.05$). The pulse rate and saturation values of patients in the control group were found to be similar in the initial and final tests $p > 0.05$ (Table 2).

The mean post-test pulse rate and STAI-S score of patients in the intervention group were found to be lower than those in the pre-test ($p < 0.05$). In the intragroup comparison, no significant difference was observed between the baseline saturation values, systolic and diastolic blood pressure values, and values after intervention in the intervention group ($p > 0.05$). When comparing the post-test scores between groups, it was observed that the heart rate, systolic blood pressure, diastolic blood pressure, STAI-S, and VAS mean scores of patients in the breathing exercise group were lower than those in the control group that did not undergo breathing exercises ($p < 0.05$). It was also determined that this significant difference had a medium effect size for blood pressure values. There was a large effect size for pulse rate, STAI-S, and VAS scores. Saturation values were similar in both groups post-test $p = 0.129$ (Table 2).

According to the mixed-design ANOVA results obtained from repeated tests, the effects of systolic and diastolic blood pressure, STAI-S, and pulse rate are significant in terms of group and time interaction mean scores ($p < 0.001$, Table 3). The intervention group showed higher reductions in systolic

Table 1. Comparison of descriptive characteristics of patients (n=87)

Variables	Control group (n=43) Mean±SD	Intervention group (n=44) Mean±SD	t	p
Age (min-max)	61.21±7.83 (40-73)	60.39±7.43 (46-72)	0.503	0.616
BMI (min-max)	30.36±4.41 (21.50-42.74)	29.90±4.41 (22.19-42.81)	0.445	0.657
Variables	n (%)	n (%)	p [†]	
Gender			0.825	
Female	15 (34.9)	17 (38.6)		
Male	28 (65.1)	27 (61.4)		
Marital status			0.484	
Married	38 (88.4)	41 (93.2)		
Single	5 (11.6)	3 (6.8)		
Education			0.853	
Non-literate	6 (14.0)	9 (20.5)		
Literate	5 (11.6)	5 (11.4)		
Primary education	27 (62.8)	24 (54.5)		
High school and above	5 (11.6)	6 (13.6)		
Family type			0.542	
Nuclear family	36 (83.7)	39 (88.6)		
Extended family	6 (14.0)	3 (6.8)		
Living alone	1 (2.3)	2 (4.5)		
Occupation			0.630	
Not working/homemaker	5 (11.6)	7 (15.9)		
Working	13 (30.2)	16 (36.4)		
Retired	25 (58.1)	21 (47.7)		
Socio-economic status			0.772	
Income less than expenditure	36 (83.7)	38 (86.4)		
Income equal to expenditure	7 (16.3)	6 (13.6)		
Has health insurance			1.000	
Yes	38 (88.4)	38 (86.4)		
No	5 (11.6)	6 (13.6)		
Smoking status			0.828	
Current smoker	10 (23.3)	13 (29.5)		
Quitted smoking	16 (37.2)	15 (34.1)		
Never smoked	17 (39.5)	16 (36.4)		
Alcohol use			0.594	
Drinking alcohol	2 (4.7)	0 (0)		
Quitting	2 (4.7)	3 (6.8)		
Never alcohol	39 (90.7)	41 (93.2)		
Previous surgery status			0.663	
Yes	18 (41.9)	16 (26.4)		
No	25 (58.1)	28 (63.6)		
Knowledge about coronary angiography			0.493	
Yes	12 (27.9)	16 (36.4)		
No	31 (72.1)	28 (63.6)		
Chronic disease			0.314	
Yes	37 (86.0)	41 (93.2)		
No	6 (14.0)	3 (6.8)		
Artery used in the procedure			0.783	
Radial artery	7 (16.3)	9 (20.5)		
Femoral artery	36 (83.7)	35 (79.5)		
Procedure status in chronic angiography (drug-eluting stent, PTCA balloon)			0.811	
Yes	11 (25.6)	13 (29.5)		
No	32 (74.4)	31 (70.5)		

†: Ki kare Fisher's exact test or Fisher-Freeman-Halton exact test, t: Independent sample t test. SD: Standard deviation.

Table 2. Comparison of vital signs, STAI-S, and VAS scores intragroup and intergroup (n=87)

	Control (n=43)		Intervention (n=44)		Intergroup		Effect size
	Mean±SD	p ^a	Mean±SD	p ^a	t	p ^b	Cohen's d (95% CI)
Systolic blood pressure							
Pre-test	119.77±12.44	<0.001	121.59±12.00	0.075	-0.696	0.488	-0.15 (-0.57 to 0.27)
Post-test	125.58±13.15		118.18±8.96		3.073	0.003	0.66 (0.23 to 1.09)
Mean difference (pre-post test)	-5.81±9.32		3.41±12.38		-3.920	<0.001	-0.84 (-1.28 to -0.40)
Diastolic Blood Pressure							
Pre-test	71.63±7.21	<0.001	72.73±7.88	0.198	-0.678	0.500	-0.14 (-0.57 to 0.28)
Post-test	76.60±8.19		70.91±6.76		3.540	<0.001	0.76 (0.32 to 1.19)
Mean difference (pre-post test)	-4.98±8.06		1.81±9.21		-3.656	<0.001	-0.78 (-1.21 to -0.34)
Pulse rate							
Pre-test	77.86±8.85	0.090	81.55±10.68	<0.001	-1.750	0.084	-0.37 (-0.80 to 0.05)
Post-test	79.86±8.15		73.52±6.73		3.957	<0.001	0.85 (0.41 to 1.29)
Mean difference (pre-post test)	-2.00±7.55		8.02±9.98		-5.275	<0.001	-1.13 (-1.59 to -0.67)
Saturation							
Pre-test	95.44±2.20	0.165	94.98±1.99	0.684	1.033	0.304	0.22 (-0.20 to 0.64)
Post-test	95.00±1.90		94.84±1.76		0.405	0.687	0.09 (-0.33 to 0.50)
Mean difference (pre-post test)	0.44±2.05		0.14±2.21		0.669	0.505	0.14 (-0.27 to 0.56)
STAI-S							
Pre-test	60.98±3.94	<0.001	62.55±5.46	<0.001	-1.533	0.129	-0.33 (-0.75 to 0.09)
Post-test	55.19±6.90		34.68±5.13		15.752	<0.001	3.38 (2.72 to 4.03)
Mean difference (pre-post test)	5.79±7.24		27.86±7.56		-13.905	<0.001	-2.98 (-3.60–2.37)
VAS							
Post-test	2.77±2.01	–	0.66±0.99	–	6.232	<0.001	1.34 (0.87–1.80)

p<0.05 are in bold. a: Paired samples t-test; Comparison within groups; b: Independent Sample t-test, Comparison between groups. SD: Standard deviation; STAI-S: The State-trait anxiety inventory-state; VAS: Visual analogue scale

blood pressure ($F(1,85)=15.363$, $p<0.001$), diastolic blood pressure ($F(1,85)=13.366$, $p<0.001$), STAI-S ($F(1,85)=193.37$, $p<0.001$), and pulse rate ($F(1,85)=27.827$, $p<0.001$), over time compared to the control group. It was also determined that this significant difference had a medium effect size for diastolic blood pressure values. There was a large effect size for systolic blood pressure, pulse rate, and STAI-S (Table 3).

Discussion

This study is a randomized controlled trial examining the effects of breathing exercises administered to angiography patients before the procedure on stress, pain, and vital signs. The present study has demonstrated that breathing exercises performed before angiography have a significant effect in reducing anxiety levels, blood pressure, pulse rate, and pain levels in individuals after angiography.

Breathing exercises are frequently preferred practice in stress management. Effective and systematic breathing leads to a higher parasympathetic response to high

sympathetic activity that causes stress and anxiety. This leads to a positive effect on the autonomic nervous system and the brain, reducing individuals' anxiety levels. [23,24] According to the findings of the study, the anxiety levels of participants in both groups were high before the intervention, and this was thought to be related to factors such as the invasive procedure process, complications, and fear of surgical intervention. Both groups showed a decrease in anxiety levels after the intervention. However, the anxiety levels of patients who performed breathing exercises were significantly lower than those who did not. It was determined that this statistically significant difference had a very high effect size. Although studies on breathing exercises have been conducted in the literature, the number of studies on patients with angiography is limited. Similar studies have also shown that breathing exercises reduce anxiety in patients and have a high effect size. [4,10] It is possible to say that the completion of the angiography procedure reduces anxiety in patients. It is thought that the elimination of stress

Table 3. Comparison of the change in vital signs and STAI-S mean scores of intervention and control groups over time (n=87)

Variables	F	p	Partial η^2
Systolic blood pressure			
Group	F(1,85)=1.572	0.213	0.018
Time	F(1,85)=1.044	0.310	0.012
Group*Time	F(1,85)=15.363	<0.001	0.153
Diastolic blood pressure			
Group	F(1,85)=3.027	0.086	0.034
Time	F(1,85)=2.888	0.093	0.033
Group*Time	F(1,85)=13.366	<0.001	0.136
Pulse rate			
Group	F(1,85)=0.677	0.413	0.008
Time	F(1,85)=10.048	0.002	0.106
Group*Time	F(1,85)=27.827	<0.001	0.247
Saturation			
Group	F(1,85)=0.771	0.383	0.009
Time	F(1,85)=1.602	0.209	0.018
Group*Time	F(1,85)=0.447	0.505	0.005
STAI-S			
Group	F(1,85)=121.00	<0.001	0.587
Time	F(1,85)=499.44	<0.001	0.841
Group*Time	F(1,85)=193.37	<0.001	0.695

p<0.05 are in bold. F: Mixed-ANOVA test; η^2 : Eta squared; ANOVA: Analysis of variance; STAI-S: State-trait anxiety inventory-state.

factors in patients on completion of the procedure makes the results of our breathing exercise program more effective and is associated with our high effect size results.

Patients may experience pain after angiography due to the procedure, vascular sensitivity, and staying in a fixed position for a long time. The pain felt after coronary angiography is related not only to the procedure but also to stress. The anxiety level of patients before the intervention may trigger and increase the perception of pain.^[25] In this regard, breathing exercises may reduce anxiety and indirectly affect the perception of pain. Some studies have reported that breathing exercises reduce pain.^[26,27] However, it can be said that breathing exercises are effective non-pharmacological methods in relieving pain after minimally invasive procedures, such as angiography. The current study has demonstrated that breathing exercises performed before angiography have a significant effect on reducing post-procedure pain. These results indicate that breathing exercises are one of the non-pharmacological methods that nurses can use in the clinical setting to reduce pain.

Pain and stress cause an increase in heart rate, blood pressure, and oxygen saturation levels through activation of

the sympathetic system and release of stress hormones.^[25] It is believed that breathing exercises, which are considered the first step of relaxation, indirectly stimulate the release of endorphins. Thus, relief may occur in the patient's pain level. Reduced pain and anxiety indirectly impact vital signs.^[10] The literature indicates a strong relationship between pain, anxiety, and vital signs.^[28] The results of a study conducted with breathing exercises indicated that the exercises reduced the person's stress level and, accordingly, provided balance in the pulse rate.^[29] In the study by Naik et al.,^[30] a group of participants performed breathing exercises for 30 min a day, 5 times a week. At the end of 12 weeks, it was stated that the perceived stress, blood pressure, and pulse rate of the intervention group decreased. In this study, it was observed that the heart rate and blood pressure values of the group that performed breathing exercises were at a better level. Despite this, no significant difference was observed in oxygen saturation levels between the groups. In this respect, it can be stated that breathing exercises can effectively reduce physiological changes, but they alone may not provide a sufficient solution.

According to the results of the study, breathing exercises administered to patients before coronary angiography have positive effects on anxiety, pain, and vital signs.

Limitations

The fact that the study was conducted at only one center reduces the applicability of the results to other regions. Pain and anxiety were assessed with subjective information obtained from patients. Factors such as the patient's environment, cultural structure, and individual factors may be confounding factors in these results. In addition, the inability to blind the patients participating in the study, with only the nurse collecting data in the final test being blinded, is among the limitations of the study.

Conclusion

Patients scheduled for coronary angiography often experience significant pre-procedure anxiety. Patients also experience pain after the procedure because it is invasive. The present study found that breathing exercises effectively reduced physiological symptoms of pain and anxiety in patients after angiography. Considering these results, we conclude that it is of great importance to apply breathing exercises in angiography clinics. We recommend that these exercises, which are easy to apply and cost-free for nurses, be included as a part of nursing care. Further research on this topic is recommended in the future, using different sample groups and clinics, to evaluate its effectiveness.

Ethics Committee Approval: Kahramanmaraş İstiklal University Non-Invasive Research Ethics Committee granted approval for this study (date: 28.06.2024, number: 2024/10-02).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: The author declared that artificial intelligence (AI) supported technologies were not used in the study. Clinical Trials. Registration number and date (NCT06602128).

Authorship Contributions: Concept: YS, SM; Design: YS, SM; Supervision: YS, SM; Materials: YS, SM; Data Collection or Processing: YS, SM; Analysis or Interpretation: YS, SM; Literature Search: YS, SM; Writing: YS, SM; Critical Review: YS, SM.

Peer-review: Double blind peer-reviewed.

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Chemotherapy Effectiveness in Human Epidermal Growth Factor Receptor 2-Negative Metastatic Breast Cancer after Third-Line or Later Treatment: An Overtreatment Concern in Everyday Clinical Practice

 Mustafa Ersoy

Department of Internal Medicine, Kütahya University of Health Sciences Faculty of Medicine, Kütahya, Türkiye

Abstract

Introduction: Despite the availability of numerous novel targeted therapies in our daily clinical practice, chemotherapy remains a predominant treatment modality for patients with human epidermal growth factor receptor 2-negative metastatic breast cancer, often extending beyond the third line. This study aimed to evaluate the efficacy and safety of third-line and subsequent chemotherapies, with the intent of contributing to the existing literature and addressing concerns regarding potential overtreatment in this patient population.

Methods: This retrospective, two-center study analyzed data from 35 chemotherapy protocols administered to 21 patients who received third, fourth, and fifth-line chemotherapy regimens. We evaluated the objective response rates (ORRs), progression-free survival (PFS), and rates of Grade 3–4 toxicities in this patient population.

Results: The ORR in this study was 14.2%. The PFS was 3.7 months, and 45.7% of patients experienced Grade 3 or 4 toxicities.

Discussion and Conclusion: Consistent with existing literature, our small, retrospective, two-center cohort demonstrated a low ORR, short PFS, and a high incidence of severe adverse events. These descriptive findings lack statistical power and cannot be generalized, but highlight the need for careful consideration of the risk–benefit ratio in heavily pre-treated patients. In this context, clinicians should thoughtfully evaluate best supportive care alongside chemotherapy, or consider alternative approaches such as hormonal therapy or novel targeted agents.

Keywords: Breast cancer; Chemotherapy; Overtreatment

Breast cancer is the most common cancer among women, with approximately 85% of patients being human epidermal growth factor receptor 2 (HER2)-negative.^[1] Despite the emergence of new treatment approaches, one of the most common challenges encountered in

routine clinical practice is the need for multiple lines of chemotherapy in relatively young patients with a relatively long life expectancy.^[2–4]

Metastatic chemotherapy regimens, particularly those consisting of three or more lines, continue to be frequently

Cite this article as: Ersoy M. Chemotherapy Effectiveness in Human Epidermal Growth Factor Receptor 2-Negative Metastatic Breast Cancer after Third-Line or Later Treatment: An Overtreatment Concern in Everyday Clinical Practice. Lokman Hekim Health Sci 2026;6(3):458–465.

Correspondence: Mustafa Ersoy. Kütahya Sağlık Bilimleri Üniversitesi Tıp Fakültesi, İç Hastalıkları Anabilim Dalı, Kütahya, Türkiye

E-mail: mustafa.ersoy@ksbu.edu.tr **Submitted:** 30.06.2025 **Revised:** 12.01.2026 **Accepted:** 15.01.2026 **Available Online:** 06.08.2026



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utilized in everyday clinical practice for HER2-negative breast cancer patients.^[5] As chemotherapy regimens progress across successive treatment lines, patients often experience a rising tumor burden and more pronounced cumulative toxicity from prolonged treatment.^[6] This leads to a worsening risk–benefit ratio due to the diminishing potential for benefit, resulting in an overtreatment problem that becomes a significant clinical challenge, particularly among patients with good performance status.^[7] This challenge arises because clinicians may be inclined to continue therapy in these patients, despite the diminishing therapeutic returns.^[8]

Cancer overtreatment is particularly problematic in younger patients with good performance status and slow-growing cancers, where the toxicity of treatment can outweigh the benefits.^[9] This clinical dilemma is frequently encountered in routine clinical practice and constitutes a substantial challenge in the palliative management of patients with advanced cancer.^[10]

The aim of our study was to share our two-center experience on the efficacy of continued chemotherapy beyond the third line and beyond in HER2-negative patients, who often receive such treatment in routine clinical practice. We also sought to evaluate the rates of significant toxicity and overall efficacy in these patients to draw attention to the efficacy-toxicity profile. By presenting these real-world data, we aim to underscore the risk of overtreatment in incurable stage IV breast cancer and advocate for the consideration of therapeutic alternatives beyond conventional chemotherapy. Ultimately, these findings may facilitate future research initiatives and guide evidence-based decision-making in routine clinical practice.

Materials and Methods

Study Design and Setting

This was a retrospective, two-center study conducted at the Department of Medical Oncology, University of Health Sciences Training and Research Hospital, and City Hospital, both of which are tertiary care institutions affiliated with the University of Health Sciences. Data from patients treated between January 2015 and March 2024 were collected from hospital archives, medical records, and electronic databases.

Ethics Approval

This study was approved by the Non-Interventional Research Ethics Committee of Kütahya University of

Health Sciences (Decision No: 2025/05-18, Date: April 7, 2025). The study was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. Because of the retrospective nature of the study, the requirement for informed consent was waived.

Patients and Data Collection

Patients aged ≥ 18 years with histologically confirmed HER2-negative metastatic breast cancer (MBC) who received at least third-line chemotherapy were included. Data on demographics, hormone receptor status, treatment regimens, line of therapy, treatment response, progression-free survival (PFS), and adverse events were collected.

Inclusion Criteria

- Histologically confirmed HER2-negative MBC,
- Received $\geq$ third-line chemotherapy during the metastatic stage,
- Documented treatment response and progression data available,
- Completed at least one full cycle of chemotherapy protocol.

Exclusion Criteria

- HER2-positive breast cancer,
- Patients who discontinued treatment for reasons other than disease progression,
- Missing data regarding response or toxicity evaluation.

Definitions

- Line of therapy: Each distinct chemotherapy regimen administered for disease progression was considered one line of therapy.
- Response categories: Complete response (CR), partial response (PR), stable disease (SD), and progressive disease (PD), based on imaging 8–16 weeks after treatment initiation.
- PFS: Time from treatment initiation to documented progression or death from any cause.

Clinical and Laboratory Investigations

All patients underwent baseline and follow-up radiological assessments (computed tomography (CT)/magnetic resonance imaging/positron emission tomography-CT)

at 8–16 week intervals. Hematological and biochemical profiles were routinely monitored during treatment. Adverse events were graded according to the common terminology criteria for adverse events (version 5.0).

Statistical Analysis

All statistical analyses were performed using IBM Statistical Package for the Social Sciences Statistics for Windows, Version 23.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro–Wilk test. As most variables did not follow a normal distribution, non-parametric tests were applied where appropriate. Descriptive statistics were reported as median (interquartile range, [IQR]) for continuous variables and as number (percentage) for categorical variables.

PFS was estimated using the Kaplan–Meier method, with median values and 95% confidence intervals (CIs) reported. Survival curves were compared using the log-rank (Mantel–Cox) test. Cox proportional hazards regression analyses were performed to evaluate prognostic factors for PFS, and hazard ratios (HR) with 95% CI were reported. Due to the limited sample size, multivariable Cox regression analyses were considered exploratory.

All statistical tests were two-sided, and a $p < 0.05$ was considered statistically significant.

Results

The study included 21 patients, with a total of 35 third-, fourth-, or fifth-line chemotherapy administrations. The median age was 52 years (IQR: 46–60; range: 32–75), and the cohort comprised 33 women (94.3%) and 2 men (5.7%). Fifteen patients (42.9%) had hormone receptor-positive disease, whereas 20 (57.1%) had triple-negative disease. Eastern Cooperative Oncology Group performance status was 0 in 7 patients (20.0%), 1 in 21 (60.0%), and 2 in 7 (20.0%). The treatment regimens and baseline characteristics are summarized in Table 1.

Overall, 23 of 35 treatment courses (65.7%) resulted in PD, 7 (20.0%) in SD, and 5 (14.3%) in PR, yielding an objective response rate (ORR) of 14.3%. No CRs were observed. Comparative response distributions by line of therapy, hormone status, and regimen are shown in Table 2. There was a trend toward different response distributions across treatment lines (Pearson χ^2 $p=0.060$), whereas differences according to hormone status ($p=0.292$) or regimen ($p=0.151$) were not statistically significant.

Median PFS for the entire cohort was 3.7 months (95% CI: 2.5–4.9). Kaplan–Meier analyses by subgroups are

Table 1. Patient demographics, clinical characteristics, and treatment protocols (n=35)

Variables	n (%) or median (IQR) (range)
Age (years)	52 (46–60) (32–75)
Gender	
Female	33 (94.3)
Male	2 (5.7)
Hormone receptor status	
Positive	15 (42.9)
Negative	20 (57.1)
ECOG performance status	
ECOG 0	7 (20.0)
ECOG 1	21 (60.0)
ECOG 2	7 (20.0)
Line of therapy	Median: 3 (IQR: 3–4)
3 rd line	21 (60.0)
4 th line	10 (28.6)
5 th line	4 (11.4)
Treatment regimens	
Gemcitabine	11 (31.4)
Taxane	1 (2.9)
Platinum combination	4 (11.4)
AC	2 (5.7)
Liposomal doxorubicin	2 (5.7)
Vinorelbine	6 (17.1)
Ixabepilone	2 (5.7)
Eribulin	1 (2.9)
Capecitabine	6 (17.1)

ECOG: Eastern Cooperative Oncology Group; AC: Anthracycline-cyclophosphamide. Values are presented as n (%) or median (IQR) (range). n: Number of patients for demographics and disease characteristics; n: Number of treatment protocols for chemotherapy regimens; IQR: Interquartile range.

presented in Table 3 and illustrated in Figure 1. By line of therapy, median PFS was 5.0 months (95% CI: 2.0–7.9) in the third-line, 2.8 months (95% CI: 2.2–3.1) in the fourth-line, and 2.1 months (95% CI: 1.0–3.3) in the fifth-line group, with a statistically significant difference (log-rank $\chi^2=9.48$, $df=2$, $p=0.009$). According to hormone receptor status, median PFS was 2.8 months (95% CI: 2.2–3.5) in HR-positive and 3.0 months (95% CI: 2.9–3.1) in HR-negative patients (log-rank $\chi^2=1.62$, $df=1$, $p=0.204$). Among regimens, platinum combinations (median PFS 6.0 months) and capecitabine (median PFS 5.3 months; 95% CI: 2.1–8.5) achieved numerically longer PFS compared with other agents, with overall differences reaching statistical significance (log-rank $\chi^2=18.06$, $df=8$, $p=0.021$).

Table 2. Comparison of treatment responses by line of therapy, hormone status, and regimen

Group	Progressive disease n (%)	Stable disease n (%)	Partial response n (%)	Complete response n (%)	p
Line of therapy					0.060
3 rd line (n=21)	10 (47.6)	6 (28.6)	5 (23.8)	0	
4 th line (n=10)	10 (100.0)	0	0	0	
5 th line (n=4)	3 (75.0)	1 (25.0)	0	0	
Hormone status					0.292
Positive (n=15)	12 (80.0)	2 (13.3)	1 (6.7)	0	
Negative (n=20)	11 (55.0)	5 (25.0)	4 (20.0)	0	
Regimen					0.151
Gemcitabine (n=11)	9 (81.8)	2 (18.2)	0	0	
Taxane (n=1)	1 (100.0)	0	0	0	
Platinum combo (n=4)	0 (0.0)	2 (50.0)	2 (50.0)	0	
AC (n=2)	1 (50.0)	1 (50.0)	0	0	
Liposomal doxo (n=2)	2 (100.0)	0	0	0	
Vinorelbine (n=6)	6 (100.0)	0	0	0	
Ixabepilone (n=2)	1 (50.0)	0	1 (50.0)	0	
Eribulin (n=1)	1 (100.0)	0	0	0	
Capecitabine (n=6)	2 (33.3)	2 (33.3)	2 (33.3)	0	

p-values were calculated using Pearson chi-square test (two-sided). Fisher's exact test was considered in subgroups with low expected cell counts. AC: Anthracycline-cyclophosphamide; n: Number of treatment protocols.

Table 3. Kaplan–Meier analysis of progression-free survival by line of therapy, hormone status, and regimen

Group	Median PFS (months, 95% CI)	Events (n)	Censored (n)	p
Line of therapy				0.009
3 rd line (n=21)	5.0 (95% CI: 2.0–7.9)	21	0	
4 th line (n=10)	2.8 (95% CI: 2.2–3.1)	10	0	
5 th line (n=4)	2.1 (95% CI: 1.0–3.3)	4	0	
Hormone status				0.204
Positive (n=15)	2.8 (95% CI: 2.2–3.5)	15	0	
Negative (n=20)	3.0 (95% CI: 2.9–3.1)	20	0	
Regimen				0.021
Gemcitabine (n=11)	3.0 (95% CI: 2.9–3.1)	11	0	
Taxane (n=1)	3.0 (–)	1	0	
Platinum combo (n=4)	6.0 (–)	4	0	
AC (n=2)	3.0 (–)	2	0	
Liposomal doxo (n=2)	2.1 (–)	2	0	
Vinorelbine (n=6)	2.8 (95% CI: 2.6–3.1)	6	0	
Ixabepilone (n=2)	2.1 (–)	2	0	
Eribulin (n=1)	2.0 (–)	1	0	
Capecitabine (n=6)	5.3 (95% CI: 2.1–8.5)	6	0	

PFS: Progression-free survival; CI: Confidence interval; AC: Anthracycline-cyclophosphamide. p-values were calculated using the log-rank (Mantel–Cox) test. n: number of treatment protocols.

Cox proportional hazards regression analyses were performed to evaluate prognostic factors for PFS, and the results are summarized in Table 4. In univariate analysis,

patients receiving chemotherapy in the $\geq 4^{\text{th}}$ line setting had a significantly higher risk of progression compared with those treated in the 3rd line (HR=3.07, 95% CI: 1.33–

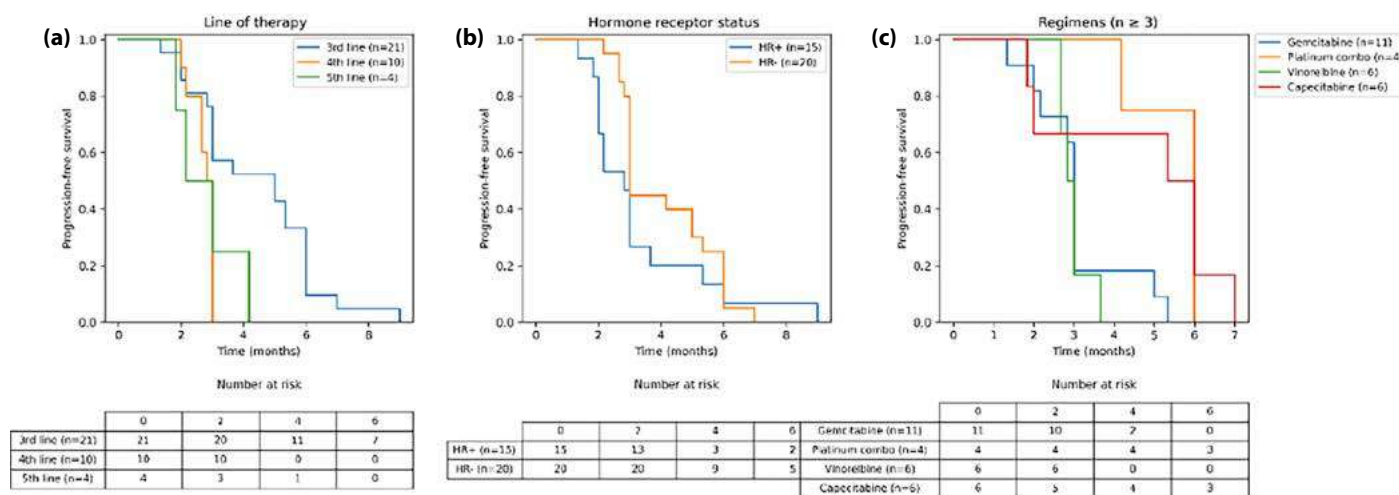


Figure 1. Kaplan–Meier curves for progression-free survival according to (a) line of therapy (3rd, 4th, and 5th line), (b) hormone receptor status (hazard ratios [H]R+ vs. HR–), and (c) treatment regimen. Number-at-risk tables are presented below each panel.

Table 4. Univariate and multivariable cox proportional hazards regression analysis for progression-free survival

Variable	HR	95% CI	p
Univariate analysis			
≥4 th line versus 3 rd line	3.07	1.33–7.10	0.009
Line of therapy (ordinal)	1.90	1.15–3.16	0.013
Hormone receptor positive versus negative	1.47	0.74–2.93	0.271
Multivariable analysis			
≥4 th line versus 3 rd line	3.06	1.32–7.08	0.009
Hormone receptor positive versus negative	1.44	0.72–2.87	0.299

*: Multivariable Cox model adjusted for hormone receptor status. Analyses were exploratory due to the limited sample size. HR: Hazard ratio; CI: Confidence interval.

7.10; $p=0.009$). When the line of therapy was analyzed as an ordinal variable, each subsequent treatment line was associated with a 1.9-fold increase in the risk of progression (HR=1.90, 95% CI: 1.15–3.16; $p=0.013$). Hormone receptor status was not significantly associated with PFS (HR=1.47, 95% CI: 0.74–2.93; $p=0.271$).

In an exploratory multivariable Cox model adjusted for hormone receptor status, late-line chemotherapy (≥4th line vs. 3rd line) remained independently associated with shorter PFS (adjusted HR=3.06, 95% CI: 1.32–7.08; $p=0.009$). Regimen-based variables were not included in the Cox models due to small subgroup sizes and the risk of model instability. Notably, all treatment courses experienced disease progression by the data cutoff date; therefore, no observations were censored, and censor counts are reported as zero across all survival analyses.

Grade 3/4 toxicities occurred in 16 of 35 treatment courses (45.7%), whereas 19 (54.3%) had no severe toxicity. Hematologic toxicities were most common

Table 5. Incidence of grade 3/4 toxicities and toxicity profile

Variables	n	%
Grade 3/4 toxicity		
Present	16	45.7
Absent	19	54.3
Toxicity type		
Hematologic (total)	13	72.2
Neutropenia	8	44.4
Anemia	3	16.7
Thrombocytopenia	2	11.1
Diarrhea	1	5.6
Neuropathy	1	5.6
Mucositis	1	5.6

n: Number of treatment protocols; %: Percentage.

(72.2% of grade 3/4 events), followed by diarrhea (5.6%), neuropathy (5.6%), and mucositis (5.6%). The toxicity profile is summarized in Table 5.

Discussion

The low overall response rate and short PFS observed in this cohort are consistent with previously reported data. In a similar patient population of the EMBRACE phase 3 open-label study, eribulin achieved a PFS of 3.7 months, compared to 2.2 months for other chemotherapies. The ORR was 12% for eribulin, whereas it was 5% for the other treatment regimens.^[11] Similarly, a pivotal phase II study evaluating ixabepilone monotherapy in 126 patients – most of whom had received at least two prior lines of metastatic therapy – reported an ORR of 11.5% and a median PFS of 3.1 months.^[12] These findings align closely with the outcomes observed in our real-world cohort.

While our study looked at treatment responses and PFS, overall survival was not evaluated. However, the literature has established that PFS is an important prognostic indicator of overall survival, particularly in the third-line setting and beyond.^[13] Given the importance of overall survival as an endpoint in this patient population, future studies should aim to collect and report this outcome data as well.

In our study, the median PFS for patients receiving third-line therapy was 5 months, whereas those receiving fourth-line treatment had a median PFS of 2.8 months, and patients on fifth-line therapy had a median PFS of 2.1 months. Due to the small sample size and the fact that this was not the primary objective of the study, no statistical analysis was performed. However, while the literature generally suggests that efficacy may decrease as the lines of chemotherapy increase, there is a lack of clear data demonstrating that the decline continues beyond the third-line setting compared to the third-line itself.^[13,14]

In this cohort, PFS was numerically longer, at 3.1 months, in the hormone receptor-negative group compared to 2.7 months in the positive group. Although no formal statistical analysis was performed due to the small sample size, this suggests that the hormone receptor-positive patients may derive greater benefit from more intensive attempts to utilize hormonal therapy as part of their treatment regimen. While the existing literature has not demonstrated significant differences in outcomes between these two subgroups, this observation may suggest that, for the hormone receptor-positive patients in particular, a greater emphasis on hormonal therapy rather than cytotoxic chemotherapy may be a more appropriate treatment strategy.^[14] This approach could potentially help optimize outcomes and minimize the need for more aggressive chemotherapeutic interventions in this population.

Despite excluding patients who were unable to continue treatment due to toxicity and those with unclear treatment responses and progression timelines due to toxicity, a significant proportion of the remaining patients who received treatment still experienced Grade 3 or 4 adverse events. The most commonly observed toxicities were hematologic in nature. Similarly, the literature has reported a high rate of adverse events, particularly hematologic, in heavily pre-treated patient populations receiving chemotherapy.^[11]

In our cohort, platinum-based combinations (median PFS: 6 months) and capecitabine (median PFS: 5.3 months) appeared numerically more effective than other regimens. This observation is consistent with other small retrospective series, which also reported somewhat longer disease control with platinum regimens and oral capecitabine in the late-line setting.^[15,16] Nonetheless, these findings should be interpreted with caution due to the small numbers and retrospective design, and they remain descriptive and hypothesis-generating.

Furthermore, the availability of novel agents such as sacituzumab govitecan complicates decisions regarding conventional chemotherapy in the late-line setting.^[17] Clinical trials have demonstrated improved response rates and PFS with sacituzumab govitecan compared with standard chemotherapy, albeit with hematologic toxicities.^[18] The very limited efficacy and substantial toxicity observed with conventional regimens in our study further support the idea that novel agents may offer a more favorable risk–benefit profile. This also reinforces the concern of overtreatment when less effective cytotoxic drugs are used while more effective targeted therapies are available.

Another important clinical consideration is endocrine resistance in hormone receptor–positive patients. Various strategies, including combinations with CDK4/6 inhibitors, PI3K/AKT/mTOR inhibitors, or new selective estrogen receptor degraders, have been investigated to overcome resistance.^[19–21] Our results, although limited, support the prioritization of maximizing endocrine approaches before resorting to cytotoxic chemotherapy, as this may help improve outcomes and avoid unnecessary toxicity.

In patients with advanced-stage disease, particularly younger individuals with preserved performance status who have undergone extensive prior therapy, clinicians should exercise careful judgment when considering additional cytotoxic chemotherapy. As observed in our cohort, such patients often experience high toxicity with limited clinical benefit, underscoring the need for a thoughtful evaluation of the risk–benefit balance. Overtreatment remains a significant concern in heavily

pre-treated populations, and treatment decisions should incorporate not only survival-related endpoints but also quality-of-life considerations.^[7] For hormone receptor-positive patients, endocrine therapy should be prioritized whenever feasible,^[22] and for all HER2-negative patients, novel targeted agents such as sacituzumab govitecan should be considered when available.^[17,23]

Limitations

The retrospective, two-center design and the very small sample size (21 patients, 35 treatment courses) represent major limitations of our study. Therefore, the findings should be considered descriptive and exploratory, lacking statistical power and not generalizable to broader patient populations. To obtain more reliable evidence, larger multicenter prospective studies are needed, ideally comparing chemotherapy with best supportive care and incorporating both PFS and overall survival as well as quality-of-life outcomes. In addition, although next-generation sequencing was not performed in our cohort, its integration into future studies may help identify actionable genomic alterations, personalize treatment strategies, and minimize the risk of overtreatment in heavily pre-treated HER2-negative MBC patients.

Conclusion

In routine clinical practice, patients with HER2-negative MBC who have received two or more lines of chemotherapy constitute a significant proportion of the patient population. However, in our small, retrospective, two-center cohort, the low efficacy and high rate of severe adverse events resulted in an unfavorable risk-benefit ratio, raising concerns about potential overtreatment. These findings are descriptive in nature, lack statistical power, and cannot be generalized, but are consistent with existing literature. Therefore, before deciding on cytotoxic chemotherapy in such heavily pre-treated patients, clinicians should carefully weigh the balance between efficacy and adverse effects, and the option of best supportive care should also be considered. For eligible patients, alternative strategies – including hormonal therapy, novel targeted therapies, and personalized approaches guided by next-generation sequencing – may be evaluated.

Ethics Committee Approval: The Kütahya University of Health Sciences Non-Interventional Research Ethics Committee granted approval for this study (date: 07.04.2025, number: 2025/05-18).

Informed Consent: As this was a retrospective study, no written informed consent was obtained from the patients.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: Not declared.

Peer-review: Double blind peer-reviewed.

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Attitudes of Nursing Students toward Pain Assessment: A Descriptive Cross-Sectional Study

 Sümeyye Akçoban¹,  Hafize Dağ Tüzmen²,  Hümeysra Yüksel³

¹Department of Health Services, Kırıkhan Vocational School, Hatay Mustafa Kemal University, Hatay, Türkiye

²Department of Midwifery, KTO Karatay University Faculty of Health Sciences, Konya, Türkiye

³Department of Orthopedics and Traumatology, Kütahya Evliya Çelebi Training and Research Hospital, Kütahya, Türkiye

Abstract

Introduction: The aim of this study was to determine nursing students' attitudes toward pain assessment.

Methods: This descriptive and cross-sectional study was conducted between June 19 and June 30, 2025, with the participation of nursing students. Data were collected online using the "Student Nurse Introductory Information Form" and the "Nursing Students' Attitudes Scale Toward Pain Assessment (NSASPA)."

Results: The study was completed with 234 nursing students. The mean age of the participants was 20.82±2.04 years; 70.9% were female, and 40.6% were 2nd-year students. The students' mean total NSASPA score was 61.29±9.38. Statistically significant differences were found in attitude scores based on variables, such as having received pain-related training, attending theoretical courses, having clinical experience with patients in pain, and feeling competent in pain assessment ($p<0.05$).

Discussion and Conclusion: Nursing students were found to have generally positive attitudes toward pain assessment. However, these attitudes varied depending on their level of knowledge, clinical experience, and educational background.

Keywords: Attitude; Nursing students; Pain; Pain assessment

Pain is a complex and multidimensional experience that significantly affects an individual's quality of life. The International Association for the Study of Pain defines pain as "an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage."^[1,2] This definition emphasizes that pain is not solely a physiological phenomenon but also involves psychological and emotional dimensions.^[2] As a fundamental survival mechanism, pain alerts individuals

to potential harm and promotes protective behaviors. However, its inherently subjective nature makes accurate assessment and effective management challenging. Therefore, the ability of healthcare professionals—particularly nurses—to competently assess and manage pain is critically important in clinical practice.^[3]

Nurses play a key role in identifying, assessing, and managing patient pain. Accurate pain assessment contributes to the development of appropriate treatment

Cite this article as: Akçoban S, Dağ Tüzmen H, Yüksel H. Attitudes of Nursing Students toward Pain Assessment: A Descriptive Cross-Sectional Study. Lokman Hekim Health Sci 2026;6(3):466–473.

Correspondence: Sümeyye Akçoban. Hatay Mustafa Kemal Üniversitesi, Kırıkhan Meslek Yüksekokulu, Sağlık Hizmetleri Bölümü, Hatay, Türkiye

E-mail: sumeyyea2016@gmail.com **Submitted:** 05.09.2025 **Revised:** 16.01.2026 **Accepted:** 21.01.2026 **Available Online:** 06.08.2026



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plans and the improvement of patients' quality of life.^[4] Moreover, a positive attitude toward pain assessment facilitates the timely recognition of pain, supports the development of effective treatment strategies, and enhances patients' quality of life. Across the development of empathetic communication skills, nurses can also better understand patients' pain experiences and provide more effective care.^[3] Nevertheless, the literature indicates that nurses often lack sufficient knowledge and skills in pain assessment, which may lead to inadequacies in pain management.^[5,6]

Nursing students must acquire knowledge and skills related to pain assessment and management from the early years of their education. Accordingly, these competencies are essential components of nursing education.^[7] Positive attitudes toward pain assessment among nursing students not only enhance the quality of patient care but also improve the effectiveness of pain management. However, previous studies have shown that nursing students frequently lack adequate knowledge of pain management, which can hinder effective pain control in clinical practice.^[8]

Although the importance of pain assessment and management in nursing education is well recognized, research indicates that nursing students' knowledge and attitudes in this area remain inadequate. For example, a study conducted in Türkiye reported that nursing students' knowledge of pain management was not at a desirable level, limiting their ability to manage patients' pain effectively.^[9] Similarly, another study found that students' knowledge and attitudes toward pain management were insufficient, leading to deficiencies in clinical practice.^[10] However, such studies remain limited, highlighting the need for further research on nursing students' attitudes toward pain assessment.

Therefore, this study aimed to comprehensively examine nursing students' attitudes toward pain assessment. Specifically, the study sought to evaluate students' perceptions of pain as a multidimensional phenomenon, their approaches to assessing pain in clinical settings, and their awareness of the importance of accurate pain assessment in nursing practice. In addition, the study aimed to explore whether nursing students' attitudes toward pain assessment differ according to selected sociodemographic and educational characteristics. Accordingly, the research was guided by questions addressing nursing students' overall attitudes toward pain assessment and the factors associated with these attitudes.

Materials and Methods

Study Design and Participants

This descriptive cross-sectional study was conducted among nursing students in the Department of Nursing, Faculty of Health Sciences, after obtaining ethics committee approval and institutional permission, between June 19, and June 30, 2025.

Specifically, this study sought to address the following questions:

- What is the level of nursing students' attitudes toward pain assessment?
- Is there a difference between students' demographic characteristics and their attitudes toward pain assessment?

The study population consisted of all students enrolled in the Department of Nursing at the Faculty of Health Sciences at a university ($n=320$). The sample included 2nd, 3rd, and 4th-year nursing students with clinical practice experience ($n=280$). First-year students were excluded from the study as they had not yet started clinical practice and therefore lacked experience in assessing patients' pain. Before the study, the required sample size was calculated using G*Power 3.1.9.7 with a theoretical power of 80%. The study was planned in early 2025, before data collection. At the time of planning, although a study using a similar scale had been published in 2024, there were limited studies on nursing students' attitudes toward pain assessment, and none had been conducted in the same context or population. Therefore, standard effect sizes proposed by Cohen (1988) were used as a reference.^[11] Because a t-test was planned to examine differences in pain attitude scale scores according to nursing students' demographic characteristics, the sample size calculation was based on a medium effect size (0.5), an α level of 0.05, and a power ($1-\beta$) of 0.80. Accordingly, a minimum of 210 nursing students were required. The study was completed with the participation of 234 nursing students.

Inclusion Criteria

Nursing students who met the following criteria were included in this study:

- Aged 18 years or older,
- Voluntarily agreed to participate in the study,
- Enrolled in the 2nd, 3rd, or 4th year of the nursing program,
- Completed all survey items.

Data Collection Tools

The following instruments were used for data collection.

Student Nurse Introductory Information Form

This form was developed by the researchers in line with the literature and consisted of 12 items regarding nursing students' age, gender, year of study, and pain-related experiences.^[8,10]

Nursing Students' Attitudes Scale Toward Pain Assessment (NSASPA)

This scale was developed by Bulut et al.^[12] It consists of 15 items and is structured as a five-point Likert scale. Students indicated their level of agreement with each statement as follows: "Strongly disagree (1)," "disagree (2)," "neutral (3)," "agree (4)," and "strongly agree (5)." The scale has two subdimensions: Importance and interest. The importance subdimension includes 12 negatively worded items that are reverse scored, while the interest subdimension consists of three positively worded items. The total score ranged from 15 to 75, with higher scores indicating more positive attitudes toward pain assessment. The Cronbach's alpha reliability coefficient was reported as 0.93 for the overall scale, 0.95 for the importance subdimension, and 0.70 for the interest subdimension.^[12] In the present study, the Cronbach's alpha values were 0.88 for the overall scale, 0.90 for the importance subdimension, and 0.86 for the interest subdimension.

Data Collection

Data were collected online using a measurement tool (Google Form) developed by the researchers. Before data collection, the purpose of the study, confidentiality of the data, and intended use of the findings were explained in detail to student representatives of the relevant classes. The online survey link was then shared with class groups by the student representatives. At the beginning of the data collection form, the purpose of the research and the information about confidentiality were clearly stated. In addition, the researchers' contact information was provided to enable students to ask questions about unclear items or study results. The form took approximately 3–5 min to complete.

Ethical Considerations

Ethical approval was obtained from the KTO Karatay University Faculty of Medicine Non-Drug and Non-Medical Device Research Ethics Committee (Date: 12

June 2025, Meeting no: 06). Institutional permission was obtained from the Faculty of Health Sciences, where the study was conducted. At the beginning of the online survey, students were informed about the study's aim, their right to withdraw at any time, the confidentiality of the information provided, and that the data would not be used for purposes other than research. Informed consent was obtained through the first item of the online form, in which students indicated their voluntary agreement to participate by selecting the statement: "I voluntarily agree to participate in this study." This study was conducted in accordance with the principles of the Declaration of Helsinki. Before data collection, permission to use the scales was obtained via email from the original authors.

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequency, percentage, mean, and standard deviation) were used to summarize the data. The normality of the data distribution was examined using skewness, kurtosis, histograms, Q–Q plots, and outlier tests. The Mann–Whitney U test was used to compare non-normally distributed variables with two categories, whereas the Kruskal–Wallis test was applied for comparisons involving three or more categories. Statistical significance was set at $p < 0.05$.

Results

The study was completed with 234 nursing students. The mean age of the participating students was 20.82 ± 2.04 years; 70.9% were female, and 40.6% were 2nd-year students. It was determined that 69.72% of the students had previously received training on pain management, 65.0% of whom had received this training as part of a course, and 44.4% had theoretical knowledge of pain-assessment tools. In addition, 72.6% of the students reported having experience working with patients experiencing pain during clinical practice, and 51.7% stated that they had provided individual care to a patient with pain. While 61.1% of the students indicated that they did not experience difficulties in pain assessment, 26.1% reported conducting pain assessments through behavioral observation. Moreover, 59.4% of the participants stated that they did not feel competent in pain assessment, and 68.4% reported having taken a theoretical course on pain management (Table 1).

The mean total score on the NSASPA was 61.29 ± 9.38 , with subscale means of 50.67 ± 3.18 for importance and

Table 1. Descriptive characteristics of student nurses (n=234)

Variables	Mean±SD (min-max)	
Age (years)	20.82±2.4 (19–36)	
	n	%
Gender		
Female	166	70.9
Male	68	29.1
Grade		
2 nd year	95	40.6
3 rd year	89	38.0
4 th year	50	21.4
Have you ever received training on pain assessment or pain management?		
Yes	163	69.7
No	71	30.3
If you have received training. Across which method was it delivered?		
As part of a course	152	93.3
During clinical training	5	3.1
At a symposium/conference	6	3.6
Do you have knowledge of using pain assessment tools (e.g., VAS, NRS, Wong-Baker, etc.)?		
Yes. I have theoretical knowledge	104	44.5
Yes. I have both theoretical and practical knowledge	41	17.5
No. I have no knowledge	89	38.0
Have you ever had experience observing a patient with pain in clinical practice?		
Yes	170	72.6
No	64	27.4
Have you ever provided individual care to a patient experiencing pain?		
Yes	121	51.7
No	113	48.3
Have you experienced any difficulties while performing a pain assessment on a patient you cared for during clinical practice?		
Yes	91	38.9
No	143	61.1
Which tool do you use/have you used most frequently for pain assessment?		
VAS	53	22.6
NRS	42	18.0
Wong-Baker face scale	33	14.1
Behavioural observation	61	26.1
I don't have a vehicle	45	19.2
Do you feel competent in pain assessment?		
Yes	95	40.6
No	139	59.4
Have you received any theoretical lessons on pain so far?		
Yes	160	68.4
No	74	31.6

%; Percentage; SD: Standard deviation; Min: Minimum; Max: Maximum; VAS: Visual Analogue Scale; NRS: Numerical Rating Scale.

Table 2. Distribution of total and subscale mean scores of NSASPA among student nurses (n=234)

	Mean±SD	Min-Max
Significance	50.76±8.03	13–60
Interest	10.52±3.18	3–15
NSASPA	61.29±9.38	17–75

NSASPA: Nursing students' attitude scale toward pain assessment; SD: Standard deviation.

10.52±3.18 for interest (Table 2). NSASPA scores were compared according to students' demographic and educational characteristics. No significant differences were found based on sex for the total ($U=2434.0$, $p=0.665$), importance ($U=2600.50$, $p=0.486$), or interest ($U=2880.0$, $p=0.060$) subscales. Similarly, year of study was not associated with significant differences in total ($KW=4.146$, $p=0.126$), importance ($KW=4.836$, $p=0.089$), or interest ($KW=2.222$, $p=0.329$) scores. However, students who had received pain education demonstrated significantly higher NSASPA total ($U=4166.0$, $p<0.001$), importance ($U=4520.50$, $p=0.008$), and interest ($U=4837.50$, $p=0.044$) subscale scores compared with those who had not received such education. Regarding the method of education, students who received clinical training in pain assessment showed significantly higher total NSASPA and interest subscale scores than those who attended symposiums or conferences ($KW=6.229$, $p=0.044$ and $KW=8.337$, $p=0.015$, respectively) (Table 3).

Knowledge of pain assessment tools also affected attitude scores. Students with both theoretical and practical knowledge had significantly higher NSASPA total ($KW=7.728$, $p=0.021$) and importance subscale ($KW=6.489$, $p=0.039$) scores than those without such knowledge. Students with experience observing patients in pain during clinical practice had higher NSASPA total ($U=3890.0$, $p=0.001$) and importance subscale ($U=3901.0$, $p<0.001$) scores than those without such experience. Similarly, students who had experience providing individual care to patients with pain scored significantly higher on the NSASPA total ($U=5473.50$, $p=0.008$) and interest subscale ($U=5516.50$, $p=0.010$).

Students who felt competent in pain assessment also demonstrated higher attitude scores, consistent with their self-perceived competence. Their NSASPA total ($U=5425.00$, $p=0.020$) and importance subscale ($U=5075.50$, $p=0.003$) scores were significantly higher than those who did not feel competent. Finally, comparison by theoretical course attendance revealed that students who had taken a theoretical course on pain had significantly higher NSASPA total ($U=4149.50$, $p<0.001$) and importance subscale ($U=4199.0$, $p<0.001$) scores than those who had not. These findings

indicate that theoretical education positively influenced students' attitudes toward pain assessment (Table 3).

Discussion

This study aimed to determine nursing students' attitudes toward pain assessment and included 234 nursing students. The total score on the NSASPA was above the scale mean. Similarly, Gülнар et al.^[13] reported that nursing students' attitudes toward pain assessment were above the mean score in their study examining nursing students' pain management self-efficacy and attitudes toward pain assessment. In line with this, Belli also found that nursing students' attitudes toward pediatric pain were above the scale mean.^[14] In contrast, some other studies have reported that nursing students' attitudes toward pain were below the mean score.^[9,10]

When the NSASPA subscales were examined, nursing students scored above the mean in both the "importance" and "interest" subscales. A similar finding was reported in a study investigating nursing students' attitudes toward pain assessment, where both subscales were above the mean.^[15] These results indicate that students adopt a more conscious and sensitive approach to pain assessment, suggesting that the theoretical and practical knowledge provided during their education positively influences their attitudes toward pain assessment. However, the differing findings in the literature highlight those variables, such as nursing curriculum content, the availability of clinical practice opportunities, and students' clinical experience levels may be decisive factors affecting attitudes.

In our study, students who had previously received education on pain not only had significantly higher NSASPA total scores but also scored higher on both the "importance" and "interest" subscales. Similarly, Erol Ursavaş and Karayurt^[16] found that nursing students' attitudes toward pain improved after pain management education. These findings demonstrate that theoretical and practical pain management education contributes to the development of more sensitive, conscious, and responsible approaches among students. The knowledge and awareness gained through education not only enhance students' cognitive competence but also strengthen attitudinal attributes, such as empathy and a professional approach. Therefore, incorporating pain management into nursing curricula is of great importance in supporting students' holistic approach to patient care.^[17]

In this study, nursing students who had experience observing patients with pain during clinical practice scored significantly higher on the NSASPA total scale. The literature indicates that nurses' knowledge and experience in pain assessment and management are critical determinants of their approach

Table 3. Comparison of student nurses' attitudes toward pain assessment according to their descriptive characteristics (n=234)

Variables	NSASPA significance Median (IQR) [min-max]	NSASPA interest Median (IQR) [min-max]	NSASPA total Median (IQR) [min-max]
Gender			
Female	54.0 (10.0) [20.0–60.0]	10.0 (4.0) [3.0–15.0]	63.0 (13.0) [23.0–75.0]
Male	53.0 (9.0) [13.0–60.0]	11.0 (4.0) [3.0–15.0]	63.0 (12.75) [17.0–73.0]
Test (U); p	2600.50; 0.486	2880.0; 0.060	2434.0; 0.665
Grade			
2 nd year	54.0 (10.0) [13.0–60.0]	10.0 (3.0) [3.0–15.0]	63.0 (11.0) [17.0–71.0]
3 rd year	54.0 (10.50) [35.0–60.0]	11.0 (5.50) [3.0–15.0]	64.0 (15.0) [41.0–73.0]
4 th year	55.50 (8.0) [14.0–60.0]	11.0 (4.0) [3.0–15.0]	65.50 (11.0) [29.0–75.0]
Test (KW); p	4.836; 0.089	2.222; 0.329	4.146; 0.126
Have you ever received training on pain assessment or pain management?			
Yes	55.0 (8.0) [34.0–60.0]	11.0 (4.0) [3.0–15.0]	65.0 (11.0) [38.0–73.0]
No	50.0 (14.0) [13.0–60.0]	10.0 (3.0) [3.0–15.0]	60.0 (16.0) [17.0–75.0]
Test (U); p	4520.50; 0.008**	4837.50; 0.044**	4166.0; p<0.001*
If you have received training. Across which method was it delivered?			
As part of a course ¹	55.0 (8.0) [34.0–60.0]	11.0 (4.0) [3.0–15.0]	65.0 (11.0) [38.0–73.0]
During clinical training ²	56.0 (12.0) [37.0–60.0]	15.0 (4.0) [9.0–15.0]	71.0 (14.0) [46.0–73.0]
At a symposium/conference ³	49.50 (26.75) [13.0–60.0]	6.50 (6.75) [3.0–15.0]	56.0 (27.0) [17.0–71.0]
Test (U); p	1.483; 0.476	8.337; 0.015** . 2>3	6.229; 0.044** . 2>3
Do you have knowledge of using pain assessment tools (e.g., VAS, NRS, Wong-Baker, etc.)?			
Yes, I have theoretical knowledge ¹	55.0 (8.75) [34.0–60.0]	11.0 (4.0) [3.0–15.0]	65.0 (12.0) [38.0–73.0]
Yes, I have both theoretical and practical knowledge ²	56.0 (9.0) [34.0–60.0]	10.0 (4.0) [3.0–15.0]	66.0 (11.0) [44.0–71.0]
No, I have no knowledge ³	53.0 (11.0) [13.0–60.0]	10.0 (4.0) [3.0–15.0]	63.0 (13.0) [17.0–75.0]
Test (KW); p	6.489; 0.039** . 2>3	1.894; 0.388	7.728; 0.021** . 2>3
Have you ever had experience observing a patient with pain in clinical practice?			
Yes	55.0 (8.0) [13.0–60.0]	11.0 (4.0) [3.0–15.0]	65.0 (11.0) [17.0–73.0]
No	50.0 (15.0) [20.0–60.0]	10.0 (3.75) [3.0–15.0]	58.50 (18.50) [23.0–75.0]
Test (U); p	3901.0; p<0.001*	4607.50; 0.069	3890.0; 0.001**
Have you ever provided individual care to a patient experiencing pain?			
Yes	55.0 (9.0) [13.0–60.0]	11.0 (5.0) [3.0–15.0]	66.0 (11.0) [17.0–73.0]
No	53.0 (10.0) [14.0–60.0]	10.0 (3.0) [3.0–15.0]	63.0 (13.0) [23.0–75.0]
Test (U); p	5956.0; 0.087	5516.50; 0.010**	5473.50; 0.008**
Have you experienced any difficulties while performing a pain assessment on a patient you cared for during clinical practice?			
Yes	53.0 (10.0) [34.0–60.0]	10.0 (4.0) [3.0–15.0]	63.0 (13.0) [43.0–72.0]
No	55.0 (9.0) [13.0–60.0]	10.0 (4.0) [3.0–15.0]	65.0 (12.0) [17.0–75.0]
Test (U); p	5777.0; 0.146	5936.0; 0.255	5661.50; 0.094
Do you feel competent in pain assessment?			
VAS ¹	55.0 (9.0) [13.0–60.0]	11.0 (5.0) [3.0–15.0]	66.0 (12.0) [17.0–72.0]
NRS ²	55.0 (9.0) [35.0–60.0]	11.0 (4.0) [3.0–15.0]	66.50 (11.25) [43.0–73.0]
Wong-Baker face scale ³	55.0 (8.0) [35.0–60.0]	11.0 (6.50) [3.0–15.0]	65.0 (12.0) [38.0–73.0]
Behavioural observation ⁴	54.0 (9.0) [34.0–60.0]	11.0 (4.0) [3.0–15.0]	63.0 (10.50) [43.0–73.0]
I don't have a vehicle ⁵	49.0 (18.0) [14.0–60.0]	9.0 (2.50) [3.0–15.0]	58.0 (19.50) [23.0–75.0]
Test (KW); p	11.312; 0.023** . 2>5	9.001; 0.061	17.203; 0.002** . 2>5

Table 3 (cont.). Comparison of student nurses' attitudes toward pain assessment according to their descriptive characteristics (n=234)

Variables	NSASPA significance Median (IQR) [min-max]	NSASPA interest Median (IQR) [min-max]	NSASPA total Median (IQR) [min-max]
Do you feel competent in pain assessment?			
Yes	56.0 (9.0) [34.0–60.0]	11.0 (4.0) [3.0–15.0]	65.0 (11.0) [38.0–73.0]
No	53.0 (11.0) [13.0–60.0]	10.0 (4.0) [3.0–15.0]	63.0 (14.0) [17.0–75.0]
Test (U); p	5075.50; 0.003**	6428.0;0.729	5425.00; 0.020**
Have you received any theoretical lessons on pain so far?			
Yes	55.0 (7.0) [34.0–60.0]	11.0 (4.0) [3.0–15.0]	65.0 (10.75) [38.0–73.0]
No	48.0 (14.0) [13.0–60.0]	10.0 (4.25) [3.0–15.0]	58.0 (16.75) [17.0–75.0]
Test (U); p	4199.0; p<0.001*	5158.0; 0.110	4149.50; p<0.001*

1–5: Post-hoc Bonferroni. *: p<0.001. **: p<0.05. NSASPA: Nursing students' attitude scale toward pain assessment; U: Mann–Whitney U Test; KW: Kruskal–Wallis Test; IQR: Interquartile Range; min-max: Minimum-maximum; VAS: Visual Analogue Scale; NRS: Numerical Rating Scale.

to patients in pain.^[3,18,19] This finding suggests that patient observation enables students to reinforce their knowledge and develop a more empathetic perspective on pain. Time spent with patients and observation-based learning help students understand pain not only as a clinical problem but also as a personal, physical, and emotional experience. Thus, increasing patient observation and experiential learning opportunities in nursing education can strengthen students' knowledge-based and human-sensitive approaches, thereby improving the quality of patient-centered care.

In our study, students who perceived themselves as competent in pain assessment demonstrated significantly higher attitude scores. This finding is consistent with previous studies. Gülnar et al.^[13] reported that students with high self-efficacy had higher levels of both confidence in pain management and attitude scores, while Sayın Kasar and Kütmeç Yılmaz found that students who felt confident in pain management displayed significantly more positive attitudes.^[20] These results show that when students feel confident, they perceive pain as both theoretical knowledge and a manageable clinical condition. Students with high self-efficacy can approach pain with greater empathy, awareness, and confidence in practice.

Limitations

This study was conducted only with nursing students from a single university; therefore, the findings cannot be generalized to all nursing students. As the data were collected through an online questionnaire, students' responses were based on their self-perceptions and self-reports, which may have introduced bias into the measurements. In addition, the cross-sectional design of the study limits the ability to establish causal relationships. For these reasons, future research with larger samples, across different institutions,

and using longitudinal designs is recommended to provide stronger contributions to the field.

Conclusion

This study found that nursing students had generally positive attitudes toward pain assessment. In particular, students who had received pain education, had clinical experience with patients experiencing pain, and perceived themselves as competent in pain assessment scored significantly higher on the attitude scale. These findings indicate that knowledge and clinical experience strengthen students' approaches to and attitudes toward pain. Accordingly, enhancing both theoretical and practical education on pain assessment and management within nursing curricula may not only improve students' knowledge but also foster the development of empathetic and patient-centered attitudes toward pain management.

Ethics Committee Approval: The KTO Karatay University Faculty of Medicine Non-Drug and Non-Medical Device Research Ethics Committee granted approval for this study (date: 12.06.2025, number: 06).

Informed Consent: Informed consent was obtained through the first item of the online form, where students indicated their voluntary agreement to participate by selecting the statement: "I voluntarily agree to participate in this study."

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: Artificial intelligence-supported technologies were not used in this study.

Authorship Contributions: Concept: SA; Design: SA, HDT, HY; Supervision: SA; Data Collection or Processing: SA, HDT; Analysis or Interpretation: SA; Literature Search: SA, HDT, HY; Writing: SA, HDT, HY; Critical Review: SA, HDT, HY.

Peer-review: Double blind peer-reviewed.

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ORIGINAL ARTICLE

General Antibiotic Use Behaviors among Parents of Pediatric Dental Patients: A Sociodemographic Assessment

 Zeynep Şeyda Yavşan¹,  Büşra Dinç²

¹Department of Pediatric Dentistry, Tekirdağ Namık Kemal University Faculty of Dentistry, Tekirdağ, Türkiye

²Department of Pediatric Dentistry, Selçuk University Faculty of Dentistry, Konya, Türkiye

Abstract

Introduction: Misuse of antibiotics in childhood increases antimicrobial resistance. Parents play a critical role in antibiotic use behaviors. This study assesses parents' knowledge, attitudes, and behaviors regarding antibiotic use for their children. It also examines how these factors vary by sociodemographic characteristics among parents of patients at a pediatric dentistry clinic.

Methods: A cross-sectional, questionnaire-based survey was conducted with parents of children presenting to a pediatric dentistry clinic. The interview was conducted face-to-face. The questionnaire assessed antibiotic knowledge, attitudes toward antibiotic use and misuse, and sources of information. Sociodemographic data were collected, and statistical analyses were performed to evaluate associations between variables. The collected data were analyzed statistically.

Results: The study was completed with the parents of 172 children. Most parents obtained antibiotic information from physicians (83.9%) and commonly recognized penicillin and amoxicillin-clavulanic acid. Reading package leaflets (80%) and avoiding dose alterations without medical advice (95.8%) were highly reported. Significant associations were found between parental gender and antibiotic recognition ($p<0.05$), as well as between education level and both antibiotic awareness and understanding of the consequences of irrational use ($p<0.05$). Only 12.4% of parents kept antibiotics at home, and this behavior was not associated with educational status.

Discussion and Conclusion: Parental knowledge, attitudes, and general antibiotic use behaviors are significantly influenced by sociodemographic factors, particularly education level and gender. Targeted educational interventions may enhance rational antibiotic use and support public health efforts to reduce antimicrobial resistance.

Keywords: Antibiotics; Parental knowledge; Pediatric dentistry; Rational antibiotic Use; Sociodemographic factors

Childhood is a period characterized by a high incidence of infections, which corresponds to the highest rates of antibiotic use. It is also the age group most commonly associated with unnecessary and irrational antibiotic prescriptions.^[1] Particularly in low- and middle-income countries, the high prevalence of infectious diseases,

inadequate hygiene and infrastructure, and deficiencies in healthcare systems exacerbate the issue of irrational antibiotic use among children, making it a significant public health concern.^[2] Although the sale of antibiotics without a prescription is prohibited in Türkiye, the country remains one of the highest consumers of antibiotics in the world.^[3]

Cite this article as: Yavşan ZŞ, Dinç B. General Antibiotic Use Behaviors among Parents of Pediatric Dental Patients: A Sociodemographic Assessment. Lokman Hekim Health Sci 2026;6(3):474–481.

Correspondence: Zeynep Şeyda Yavşan. Tekirdağ Namık Kemal Üniversitesi Diş Hekimliği Fakültesi, Çocuk Diş Hekimliği Anabilim Dalı, Tekirdağ, Türkiye

E-mail: ylmzynpsyda@gmail.com **Submitted:** 08.09.2025 **Revised:** 21.01.2026 **Accepted:** 23.01.2026 **Available Online:** 06.08.2026



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Various factors have been proposed to explain the inappropriate use of antibiotics in children, including overprescription by healthcare professionals,^[4] easy access to antibiotics for personal use and the limited knowledge of parents regarding antibiotics.^[5,6]

Studies show that unnecessary antibiotics in children are often prescribed for ear or dental infections.^[7,8] Physicians sometimes prescribe antibiotics without proper indications or for too long. Some parents initiate antibiotic use without consulting healthcare professionals. Many mothers and fathers lack sufficient knowledge about appropriate antibiotic use.^[9] The tendency of parents to use antibiotics for their children varies depending on factors such as their socioeconomic status, level of education, prior experience of illness, and awareness of antibiotics.^[10] The pediatric age group experiences a high incidence of febrile illnesses, making it the period with the most frequent antibiotic use. However, this is also the time when inappropriate and unnecessary antibiotic consumption is most prevalent. One contributing factor to excessive antibiotic use in children is parents' requests and their inclination to use antibiotics based on prior experiences.^[11] Similarly, a study conducted in Türkiye reported that parental demands significantly influence dentists' prescribing behaviors for children.^[8] Therefore, parental education, especially raising awareness among mothers, should be one of the main goals in ensuring rational antibiotic use in children. The literature clearly demonstrates the positive impact of education on antibiotic use behaviors.^[12] In this context, identifying existing misconceptions, knowledge gaps, and attitudes within the community is essential to developing effective educational programs that promote rational antibiotic use. This study aims to evaluate parents' knowledge, attitudes, and behaviors regarding general antibiotic use for their children and to examine how these variables are associated with sociodemographic factors among parents of pediatric dentistry patients.

Materials and Methods

Study Place and Design

This cross-sectional descriptive study was conducted at the Tekirdağ Namik Kemal University Oral and Dental Health Application and Research Center. A structured questionnaire was used to learn how parents understand and manage antibiotic use for their children. The study also identified patterns related to family demographic characteristics at the pediatric dentistry clinic.

Study Population and Data Collection

The study involved face-to-face interviews with the parents of 172 children aged 0–15 years who applied to the Pediatric Dentistry Clinic at the Tekirdağ Namik Kemal University Oral and Dental Health Application and Research Centre for various dental issues between February 2023 and February 2024. The study included parents (mother or father) of children aged 0–15 years who attended our center for the management of dental complaints. Parents of children with chronic illnesses that could lead to frequent antibiotic use, as well as those requiring antibiotic prophylaxis due to the risk of infective endocarditis, were excluded from the study.

Questionnaire Design

A structured questionnaire comprising 20 items was developed by the researchers for this study. The questionnaire included multiple-choice, yes/no, and Likert-type response formats. The questionnaire consisted of five sections: (1) The sociodemographic characteristics of parents and children, (2) Parental awareness of antibiotics and sources of information, (3) Antibiotic use and storage practices, (4) Purpose and method of antibiotic use, and (5) Previous dental-related antibiotic experiences.

The content and structure of the questionnaire were informed by previous studies that evaluated parents' knowledge, attitudes, and practices regarding antibiotic use in children, including those conducted in pediatric and dental settings.^[13,14]

To ensure content validity, two pediatric dentistry experts and one public health specialist reviewed a preliminary version of the questionnaire. Researchers made minor clarity improvements based on their feedback. Parents then self-administered the final questionnaire while waiting in the clinic.

While waiting for their children's examinations, parents were informed about the study and asked to complete a questionnaire designed to assess their knowledge of antibiotic use on a voluntary basis. Informed consent forms were obtained from all parents. Only mothers and fathers were considered parents in this study. After completing the questionnaire, the parents and their children were admitted to the clinic for examination, during which relevant clinical data were recorded.

Ethical Considerations

Ethical approval for the study was obtained from the Non-Interventional Ethics Committee of Tekirdağ

Namik Kemal University (Date: 31.01.2023, Decision no: 2023.13.01.13) prior to its initiation. The study complied with the Helsinki rules.

Statistical Analysis

The research was designed as a cross-sectional study consisting of survey questions aimed at measuring the level of knowledge of parents about antibiotics. A convenience sampling strategy was applied, which might limit the extent to which the findings can be generalized to the wider population. Therefore, the results should be interpreted with mindful consideration of the potential selection bias associated with convenience sampling. The collected data were analyzed using frequency distributions and descriptive statistics. Categorical variables were summarized using frequencies and ages. Missing data were handled using an available-case (pairwise deletion) approach. Although the total sample consisted of 172 participants, the number of cases included in each analysis varied slightly depending on item-level missing responses. For each statistical analysis, only participants with complete data for the relevant variables were included. Normality was assessed for the numerical variables using skewness-kurtosis values and Q-Q plots, and since they demonstrated a normal distribution, they were presented as mean, standard deviation, minimum, and maximum values. Data obtained from parents were evaluated under five main categories: demographic characteristics; reason for clinic visit and affected dental region; sources of information about antibiotics and known antibiotic names; purpose and method of antibiotic use; and questions related to antibiotic use and awareness. Specifically, parental gender, educational level, and other sociodemographic characteristics were compared with outcomes such as knowledge of antibiotic names, awareness of inappropriate antibiotic use, frequency of antibiotic use, and home storage of antibiotics. Chi-square tests were applied when expected cell counts met the required assumptions, whereas Fisher's exact test was preferred in comparisons with small subgroup sizes. These tests were selected because they are appropriate for assessing relationships between categorical variables and allow for a reliable evaluation of the differences across parent groups. A significance level of $\alpha = 0.05$ was adopted for all main and sub-analyses, and the results were reported at $p < 0.05$, $p < 0.01$ and $p < 0.001$. The statistical analyses were conducted using IBM Statistical Package for the Social Sciences Statistics version 24.0, developed by IBM Corporation (Armonk, New York, USA).

Table 1. Demographic findings

	n=172	%
Childs' gender		
Male	70	40.7
Female	102	59.3
Parents' gender		
Mother	109	63.4
Father	63	36.6
Children's age group		
1–9 years old	97	56.4
10–15 years old	75	43.6
Average age (standard deviation)	9.3 (3.0)	
Minimum–maximum	1–15	
Parents' age group		
27–39 years old	90	52.3
40–56 years old	82	47.7
Average age (standard deviation)	39.3 (5.3)	
Minimum–maximum	27–56	
Parents' education level		
Primary school	35	20.3
Secondary school	30	17.4
High school	50	29.2
University	46	26.7
Postgraduate	11	6.4

Results

A total of 200 parents participated in the study. However, those who did not respond to at least 50% of the survey questions were excluded. Therefore, 172 parents who responded to the survey were included in the study. 63.4% (n=109) of the parents were mothers and 36.6% (n=63) were fathers. 40.7% (n=70) of the parents' children were boys, and 59.3% (n=102) were girls. The average age of the children was 9.3 years. The youngest child was, and the oldest child was 15. The average age of the parents was 39.3 years. The youngest parent was 27, and the oldest parent was 56.

20.3% (n=35) of the parents had a primary school education, 17.4% (n=30) had a secondary school education, 29.2% (n=50) had a high school education, 26.7% (n=46) had a university education, and 6.4% (n=11) had a postgraduate education (Table 1).

Of the individuals surveyed, 83.9% (n=162) obtained information about antibiotics from a doctor, 9.8% (n=19) from the package leaflet, 5.3% (n=10) from the internet, and 1.0% (n=2) from other means. The most commonly

Table 2. The relationship between the gender of the parent who completed the questionnaire and known antibiotic names

Antibiotic names known to parents	Parent		Total n (%)
	Mother	Father	
	n (%)	n (%)	
Amoxicillin+clavulanic acid	62 (32.0)	16 (18.0)	78 (27.6)
Cephalexin	13 (6.7)	5 (5.6)	18 (6.4)
Penicillin	46 (23.6)	34 (38.2)	80 (28.3)
Amoxicillin	30 (15.5)	13 (14.6)	43 (15.2)
Ampicillin	14 (7.2)	3 (3.4)	17 (6.0)
Ciprofloxacin	10 (5.2)	3 (3.4)	13 (4.6)
Other	4 (2.1)	2 (2.2)	6 (2.1)
Don't know	15 (7.7)	13 (14.6)	28 (9.8)
Total	194 (100.0)	89 (100.0)	283 (100.0)

Fisher's exact test ($p=0.047$), participants were allowed to select more than one response option.

recognized antibiotics were penicillin (28.3%, $n=80$), amoxicillin and clavulanic acid (27.6%, $n=78$), amoxicillin (15.2%, $n=43$), cefalexin (6.4%, $n=18$), ampicillin (6.0%, $n=17$), and ciprofloxacin (4.6%, $n=13$).

47.9% ($n=80$) of parents reported using antibiotics once a year, 34.7% ($n=58$) once every 4–6 months, 10.8% ($n=18$) once every 2–3 months, and 6.6% ($n=16$) once a month. 80% ($n=136$) of parents reported reading the antibiotic package leaflet, 3.5% ($n=6$) reported not reading it, and 16.5% ($n=28$) reported sometimes reading it. 95.8% ($n=163$) of parents reported not making any changes to antibiotic doses or frequency without a doctor's recommendation,

1.8% ($n=3$) reported sometimes making changes, and 2.4% ($n=4$) reported making changes. Descriptive evaluation of the items related to the purpose and method of antibiotic use indicated that these questions provided information on parents' reasons for administering antibiotics, the duration and frequency of use, and dose-adjustment practices.

65.7% ($n=113$) of parents reported that their children had not been administered prophylactic antibiotics before tooth extraction or any other dental treatment; 19.8% ($n=34$) reported that they had been administered antibiotics; and 14.5% ($n=25$) were unaware of whether they had been administered antibiotics.

The distribution of recognized antibiotic names exhibited disparities between mothers and fathers ($p<0.05$). The most frequently known antibiotic among mothers was amoxicillin + clavulanic acid (32.0%, $n=62$), while the most frequently known antibiotic among fathers was penicillin (38.2%, $n=34$) (Table 2).

A statistically significant relationship was found between parents' educational status and the antibiotic names they knew ($p<0.001$) (Table 3). Examining the antibiotic names known by parents according to their educational status revealed that both cephalexin and ciprofloxacin were recognized by 2.4% ($n=1$) of primary school graduates and 14.3% ($n=7$) of postgraduates. The proportion of people who knew these antibiotics increased with higher levels of education. Penicillin emerged as the most common response among primary school graduates (31.0%, $n=13$), whereas amoxicillin + clavulanic acid was most frequently recognized by secondary school graduates (32.4%, $n=11$). The "do not know" response was

Table 3. The relationship between the parents' educational status and the names of antibiotics they know

Antibiotic names known to parents	Parents' educational status					Total n (%)
	Primary school	Secondary school	High school	Undergraduate	Postgraduate	
	n (%)	n (%)	n (%)	n (%)	n (%)	
Amoxicillin+clavulanic acid	9 (21.4)	11 (32.4)	23 (33.3)	26 (29.2)	9 (18.4)	78 (27.6)
Cephalexin	1 (2.4)	0 (0)	5 (7.2)	5 (5.6)	7 (14.3)	18 (6.4)
Penicillin	13 (31.0)	9 (26.5)	19 (27.6)	29 (32.6)	10 (20.4)	80 (28.3)
Amoxicillin	6 (14.3)	3 (8.8)	10 (14.5)	15 (16.9)	9 (18.4)	43 (15.2)
Ampicillin	2 (4.8)	2 (5.9)	0 (0)	6 (6.7)	7 (14.3)	17 (6.0)
Ciprofloxacin	1 (2.4)	1 (2.9)	0 (0)	4 (4.5)	7 (14.3)	13 (4.6)
Other	3 (7.1)	0 (0)	3 (4.3)	0 (0)	0 (0)	6 (2.1)
Don't know	7 (16.6)	8 (23.5)	9 (13.1)	4 (4.5)	0 (0)	28 (9.8)
Total	42 (100.0)	34 (100.0)	69 (100.0)	89 (100.0)	49 (100.0)	283 (100.0)

Fisher's exact test ($p<0.001$), participants were allowed to select more than one response option.

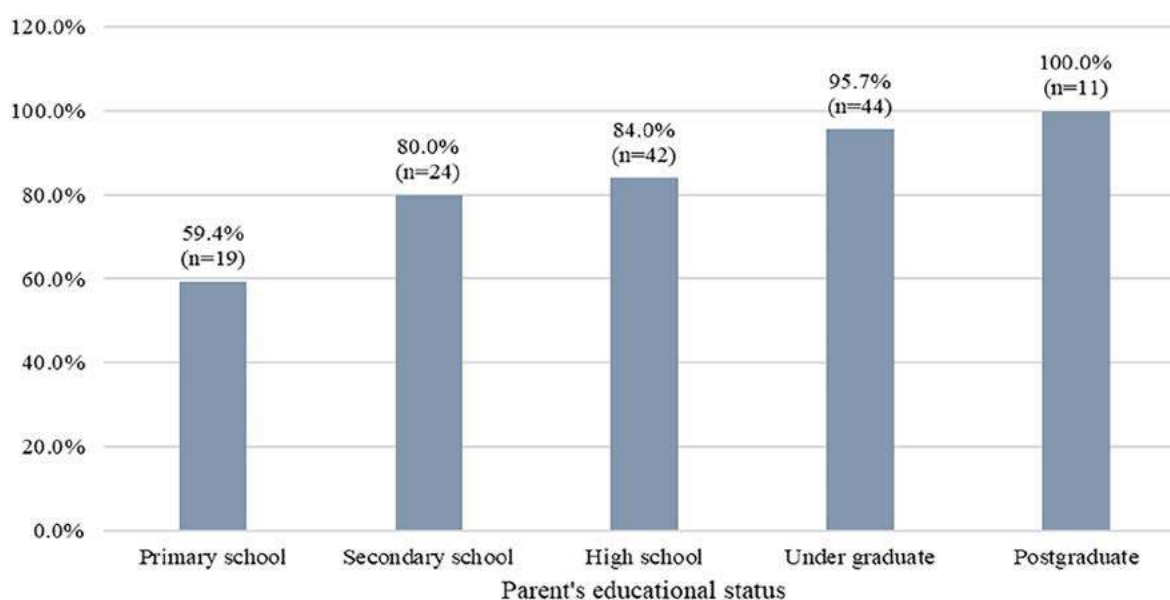


Figure 1. Participants' awareness that inappropriate antibiotic use may result in treatment ineffectiveness (χ^2 [df=4, n=169 (3 missing)]=20.203, $p<0.001$, Cramer's V=0.346).

reported by 16.6% (n=7) of primary school graduates, 4.5% (n=4) of bachelor's degree holders, and none of the postgraduate degree holders.

Awareness that irrational antibiotic use may reduce effectiveness when antibiotics are truly needed increased with education level ($p<0.05$). Higher education level was associated with greater awareness of the possible consequences of irrational antibiotic use (Fig. 1).

A total of 21 parents (12.4%) reported keeping a supply of antibiotics at home for their children, whereas 149 parents (87.6%) did not. No statistically significant relationship was found between parents' educational status and the proportion of antibiotics kept at home ($p>0.05$).

Discussion

The most important finding of this study is that parents' knowledge and awareness regarding antibiotic use vary substantially across sociodemographic groups, with gender and educational level emerging as key factors influencing familiarity with commonly used antibiotics. These results highlight the importance of sociodemographic factors in shaping parents' antibiotic-related awareness and decision-making. This study contributes to the relatively limited research on parents of pediatric dentistry patients and provides insight into which parent groups may benefit most from targeted educational interventions. Moreover, by examining unnecessary or inappropriate antibiotic use prior to dental treatment, the study takes a broader perspective on antibiotic use.

The unnecessary and incorrect use of antibiotics poses a serious threat to global health. Ensuring the rational use of antibiotics requires the cooperation of doctors and families alike.^[15] Socioeconomic conditions, education levels, and past disease experiences may all have an impact on how parents use antibiotics.^[16]

Studies have shown that effective communication between parents and doctors is crucial for the proper use of antibiotics.^[17,18] In our study, 83.9% of parents obtained information about antibiotics from their doctor. This result indicates that doctor–parent communication plays a critical role in promoting the correct and rational use of antibiotics, given that the vast majority of parents obtain their knowledge about antibiotics from doctors.

A higher level of education among parents is associated with a greater tendency to correctly identify antibiotics. This situation is consistent with the significantly higher recognition rate of common antibiotics, such as amoxicillin and clavulanic acid, among parents with higher education levels (81.8% among postgraduates, compared to 28.1% among primary school graduates). Similarly, the proportion of "I don't know" responses decreases with increasing education (e.g., 0% among postgraduates), and this relationship is statistically significant ($p<0.05$). These findings are similarly consistent with those of Mijovic et al.^[1] In their study, Mijovic et al.^[1] also found that parents with higher levels of education had significantly better knowledge of antibiotics.

A statistically significant relationship was found between the educational status of the parents and the knowledge

that irrational antibiotic use could lead to antibiotic resistance. These findings are consistent with those of Keskin Tunç et al.^[19] In our study, the finding of a significant relationship between the education level of the parents and the knowledge that irrational antibiotic use can lead to antibiotic resistance shows that the level of education is an important determinant in increasing health literacy and antimicrobial resistance awareness.

In our study, 65.7% of parents reported that their children were not given preventive antibiotics before tooth extraction or dental treatment, and 14.5% reported not being informed about this. This situation shows that prophylactic antibiotic use is not preferred for routine pediatric dental treatment and is consistent with current guidelines. According to the guidelines of the American Heart Association and the American Academy of Pediatric Dentistry, antibiotic prophylaxis is only indicated for patients at high risk of infective endocarditis, such as immunocompromised individuals, those with certain congenital heart diseases, and those with severe immunodeficiency. It is not recommended for routine dental extractions or treatments in healthy children.^[20,21] While the results are positive in terms of preventing unnecessary antibiotic use, the fact that 14.5% of the group lacked knowledge on this subject highlights the importance of informing parents about pre-treatment procedures and the necessity of antibiotics.

According to the findings of our study, 80% of parents reported that they read the antibiotic package insert, and 95.8% stated that they did not make any changes to the dosage or frequency other than those recommended by their physician. These results indicate a high level of awareness regarding antibiotic use and adherence to medical instructions in the community, which may contribute to preventing inappropriate antibiotic use and the development of resistance.

A statistically significant correlation was found between parental gender and known antibiotic names. The most frequently known antibiotic among mothers was amoxicillin + clavulanic acid (60.2%), whereas the most frequently known antibiotic among fathers was penicillin (31.0%). The gender-based difference in antibiotic knowledge may be explained by variations in exposure to commonly prescribed medications. Mothers' greater awareness of amoxicillin and clavulanic acid is probably due to its widespread use in pediatric practice, as mothers tend to accompany children to healthcare appointments more often than fathers. In contrast, fathers' greater familiarity with penicillin may stem from its long-standing and well-known presence as a classic antibiotic, suggesting a broader historical awareness

rather than recent exposure through prescriptions. These differences suggest that current prescribing trends and gender-related caregiving roles may both influence parental antibiotic knowledge. In this study, parents' familiarity with commonly used antibiotics was evaluated as an indicator of general awareness and exposure to antibiotic use, consistent with previous research that has used the ability to correctly name antibiotics as a marker of antibiotic-related knowledge and experience.^[22]

Some families may keep a supply of antibiotics at home so that they can begin treatment immediately if their children fall ill or experience a toothache. Research carried out in our country has revealed that the rates of keeping spare antibiotics at home vary. In a study conducted in Giresun, 15.4% of parents kept spare antibiotics at home,^[23] whereas in a study conducted in Izmir, this rate was 21.5%.^[24] In a study conducted among patients applying to primary healthcare institutions in Mersin province, this rate was 6.9%.^[25] In another study, this rate was determined to be 4.5%.^[10] In our study, we found that 12.4% of parents kept spare antibiotics at home. The rate reported here was lower than that reported in some studies, but higher than that reported in others. However, no statistical difference was found between the educational status of parents who kept spare antibiotics at home and those who did not. Therefore, this difference may stem from factors such as ease of access to regional health services, community awareness levels, socioeconomic conditions and previous experience of illness.

This study has several limitations. First, the results are not generalizable due to the study's single-center nature and relatively small sample size. Furthermore, data collected through parental self-reports via a questionnaire may not accurately reflect actual knowledge and behavior, due to factors such as social desirability bias and recall bias.

In addition, incomplete survey responses and missing data may limit the interpretation of the results. Another limitation of this study is that the findings reflect the sociodemographic characteristics of families attending a single pediatric dentistry center. The clinic primarily serves an urban population with relatively similar educational and socioeconomic backgrounds, which may have influenced parents' levels of antibiotic knowledge, attitudes, and healthcare-seeking behaviors. As these characteristics may differ across rural areas, regions with varying access to health care, or populations with different cultural practices, the results may not be fully generalizable to all parents. Therefore, future studies including more diverse and multi-center samples are needed to enhance external validity.

Another limitation of the study is that the questionnaire used to assess parental knowledge, attitudes, and behaviors regarding antibiotic use was developed specifically for this research. Although content validity was reviewed by experts, the instrument did not undergo statistical validation or reliability testing, which may limit the generalizability of the findings.

Conclusion

This study reveals that parents' knowledge, attitudes, and behaviors regarding antibiotic use are strongly influenced by sociodemographic factors, particularly education level and parental role. While most parents demonstrated appropriate awareness and reported responsible antibiotic practices, gaps in knowledge were observed in specific areas, such as the rationale for prophylactic use and the storage of antibiotics at home. The findings also highlight the critical contribution of physician–parent communication in promoting rational antibiotic use, as healthcare professionals remain the primary source of information. Although routine dental procedures rarely require prophylactic antibiotics in healthy children, a lack of awareness among some parents underscores the need for improved education on indications for use. Taken together, the results indicate that further targeted interventions and health education strategies are necessary to enhance antimicrobial awareness and prevent inappropriate antibiotic use. Future research should include larger, more diverse populations to improve generalizability and ensure a comprehensive understanding of parental knowledge and practices regarding antibiotic use.

Ethics Committee Approval: The Tekirdağ Namik Kemal University Ethics Committee granted approval for this study (date: 31.01.2023, number: 2023.13.01.13).

Informed Consent: Informed consent forms were obtained from all parents.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: The author declared that artificial intelligence (AI) supported technologies were not used in the study.

Authorship Contributions: Concept: ZŞY; Design: ZŞY; Supervision: ZŞY; Resource: ZŞY; Materials: ZŞY; Data Collection or Processing: ZŞY; Analysis or Interpretation: ZŞY, BD; Literature Search: ZŞY, BD; Writing: ZŞY, BD; Critical Reviews: ZŞY, BD.

Acknowledgments: We would like to thank Associate Professor Dr. Volkan Kaplan for his efforts in entering the data after collection.

Peer-review: Double blind peer-reviewed.

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An Assessment of Final-Year Medical Students' Knowledge on Climate Change and Infectious Diseases at a Medical School

 Burak Kurt¹,  Firdevs Şahin Acar¹,  Yavuzalp Solak²,  Musa Şahin³

¹Department of Public Health, Ankara University Faculty of Medicine, Ankara, Türkiye

²Department of Public Health, Çubuk District Health Directorate, Ankara, Türkiye

³Department of Public Health, Adana Provincial Health Directorate, Adana, Türkiye

Abstract

Introduction: Although awareness of climate change has increased in recent years, there is still a knowledge gap regarding the impact of climate change on infectious diseases. This study aims to determine the knowledge level of final-year medical students regarding climate change and infectious diseases, to identify related factors, and to contribute to medical education on this topic.

Methods: The population of this cross-sectional study consisted of 279 final-year students at Ankara University Faculty of Medicine. Data analysis was performed using Microsoft Excel and IBM Statistical Package for the Social Sciences 30. Descriptive statistics were expressed as frequency, percentage, mean, and standard deviation. Appropriate analysis methods were used for comparisons between groups, and a $p < 0.05$ was considered statistically significant.

Results: Of the participants, only 17.9% had received education about climate change, and 10.4% had received education about its health effects. 80% expressed concerns about climate change and infectious diseases. The participants' levels of knowledge and perception were moderate overall; however, perception scores were significantly higher among those who had previously received education, thought about, or discussed these topics. In addition, climate-infectious impact scores were significantly higher among those who had previously received education, were willing to receive education, or thought about these topics. While 71.3% of the participants stated that they obtained their information from social media, 59.9% indicated that they would like to receive further education.

Discussion and Conclusion: The current medical school curriculum should be reviewed, and topics related to climate change should be addressed in more detail.

Keywords: Climate change; Infectious diseases; Knowledge level; Medical student

The impact of the climate crisis has been intensifying, especially over the last two centuries, and the effects of it are deepening continuously. The temperature of the Earth's surface has risen to a serious level, with every year since 1992 being recorded as the hottest year in history.^[1,2]

Human activities, mostly based on greenhouse gas emissions, have led to global warming, and between 2011 and 2020, the global surface temperature increased by 1.1°C compared to the average temperature of the 1850–1900 period.^[3]

Cite this article as: Kurt B, Şahin Acar F, Solak Y, Şahin M. An Assessment of Final-Year Medical Students' Knowledge on Climate Change and Infectious Diseases at a Medical School. Lokman Hekim Health Sci 2026;6(3):482–488.

Correspondence: Firdevs Şahin Acar. Ankara Üniversitesi Tıp Fakültesi, Halk Sağlığı Anabilim Dalı, Ankara, Türkiye

E-mail: sahinnfirdevs@gmail.com **Submitted:** 16.09.2025 **Revised:** 14.01.2026 **Accepted:** 25.01.2026 **Available Online:** 06.08.2026



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The health effects resulting from climate change can occur directly or indirectly. Direct impacts include increased heat stress due to heat waves, disasters, and extreme weather events; changes in the distribution of infectious diseases; and declining air quality.^[4,5]

Health professionals can play important roles in responding to climate change and the growing threat of infectious diseases resulting from this crisis. These roles may include participating in policymaking, leading necessary campaigns or media broadcasts to mobilize the public, producing written materials such as guidelines and educational resources, and making valuable contributions at scientific meetings to shift attention to health effects arising from climate change, both as participants and organizers.^[6]

The studies conducted in Türkiye and abroad show that climate change is generally not included in medical school curricula, and very few faculties use this topic as course content. According to data from a study conducted in Türkiye, only 5% of universities offering medical education in Turkish include "climate change" in their curriculum.^[7,8] When considering the relationship between climate change and infectious diseases, it is evident that current and future societies will continue to be affected by ongoing and future climate changes. Therefore, education on how to cope with climate change should be included in the curriculum of future doctors.^[9,10]

By including climate change in their curricula, medical schools will not only prepare their students for the reality of infectious diseases and living conditions affected by climate change but also develop the important skills modern physicians need to address the increasing health burdens of non-communicable diseases, aging populations, systemic socioeconomic disadvantages, and structural changes in the fundamental determinants of health.^[11,12]

Although recent studies on climate change awareness have increased, there are still gaps in the literature regarding the impact of climate change on infectious diseases. In this study, we aim to assess the level of awareness and the influencing factors regarding the climate crisis and infectious diseases among final-year medical students – who are naturally expected to take on significant roles in the fight against infectious diseases that may emerge with the climate crisis – and to support curriculum development in this field.

Materials and Methods

Study Type, Place, and Design

This cross-sectional study was conducted at Ankara University Faculty of Medicine in July 2023.

Population Research

The study population consisted of 336 final-year students at Ankara University Faculty of Medicine. The goal was to reach all students. Those who declined to participate in the survey and those who did not give consent were excluded from the study, resulting in a total of 279 students being reached.

Data Collection Tools (Questionnaire)

Data were collected through a questionnaire comprising 19 main and subquestions, created on Google Forms. The first seven questions included items on demographic information and educational status. Question 8 measured "perception score of participants regarding climate change and infectious diseases" using a five-point Likert scale consisting of eight questions, and the maximum possible score was 40. Questions 10 and 11 measured "level of knowledge about infectious diseases," and Question 12 measured "level of knowledge about the impact of climate change on infectious diseases." Each correct answer was awarded 1 point in these sections, and the maximum possible score was 17 and 12, respectively. Questions 9 and 13–19 concerned whether respondents had previously thought about or discussed climate change and whether they wished to receive education on the subject in the future.

The questionnaire used in our study was developed by the authors based on a comprehensive literature review. Subsequently, a pilot test was conducted on 10 participants who were not included in the main study, and necessary adjustments were made based on the feedback received. The detailed questionnaire form is included in Appendix 1.

Statistical Analysis

Data analysis was performed using Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) Statistics for Windows, version 30.0 (SPSS Inc., Chicago, Ill., USA) software. Descriptive statistics were expressed as frequency, percentage, mean, and standard deviation (SD).

The normality of the data distribution was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests.

The relationship between normally distributed scores and binary variables was analyzed using the t-test, with the test statistic expressed as t. The relationship between normally distributed scores and variables with more than two categories was evaluated using one-way analysis of variance, with post hoc comparisons performed with the Bonferroni test; the test statistic was expressed as F. Normally

distributed group data are presented as mean $\pm$ SD. The relationship between non-normally distributed scores and binary variables was analyzed using the Mann–Whitney U test, with the test statistic expressed as Z, and the data are presented as median (min–max). The relationship between non-normally distributed scores and variables with more than two categories was evaluated using the Kruskal–Wallis test, with the test statistic expressed as X^2 , and post hoc comparisons were performed with Tamhane's T2 test. Effect sizes were calculated to assess the magnitude of the differences examined. Cohen's d was calculated for parametric values, and r values were calculated for non-parametric tests (Mann–Whitney U and Kruskal–Wallis). Effect sizes were interpreted as small (0.1–0.29), medium (0.3–0.49), and large (≥ 0.5).

A value of $p < 0.05$ was considered statistically significant. Statistically significant differences among groups are indicated by different superscript letters.

Ethical Approval

Approval for the study was obtained from the Ethics Committee of Ankara University Faculty of Medicine and the Dean's Office of the Faculty of Medicine. No financial support was received for this research. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Results

Descriptive Properties of Participants

The mean age of the participating students was 23.4 ± 2.7 years. Among the participants, 52.7% ($n=147$) identified as female, 45.9% ($n=128$) were male, 1.1% ($n=3$) preferred not to disclose their gender, and 0.4% ($n=1$) were other. The language of instruction for 94.3% ($n=263$) of the participants was Turkish, whereas 5.7% ($n=16$) received their education in English.

The proportion of participants who stated that they had previously received education, courses, or school lessons related to climate change was 17.9% ($n=50$), whereas the proportion who had received education specifically on the health effects of climate change was 10.4% ($n=29$).

When asked about the factors contributing most to the spread of infectious diseases, 38.4% ($n=107$) of the participants cited social and behavioral factors, followed by pathogen factors at 24.7% ($n=69$), environmental factors at 22.6% ($n=63$), health system factors at 10.0% ($n=28$), and host factors at 4.3% ($n=12$).

When questioned about how often they thought about the impact of climate change on infectious diseases in their daily lives before participating in the survey, 33.3% ($n=93$) responded "never," 41.9% ($n=117$) "rarely," 18.3% ($n=51$) "occasionally," 4.3% ($n=12$) "frequently," and 2.2% ($n=6$) "always."

A total of 52.3% ($n=146$) of the students reported that they had never discussed the impact of climate change on infectious diseases with their peers or instructors. The proportion who stated they rarely discussed it was 33.3% ($n=93$); those who discussed it occasionally were 10.0% ($n=28$), frequently 3.6% ($n=10$), and always 0.7% ($n=2$). After taking the survey, 80.3% ($n=224$) of the participants stated that their views about the impact of climate change on infectious diseases changed toward a more concerned perspective, whereas 19.7% ($n=55$) reported that their opinions did not change.

The most common source of information for participants was social media at 71.3% ($n=199$), followed by official institutional websites at 16.1% ($n=45$), TV programs and documentaries at 9.7% ($n=27$), books and newspapers at 5.4% ($n=15$), radio and podcasts at 3.2% ($n=9$), family and friends at 2.9% ($n=8$), and educational programs and conferences at 2.5% ($n=7$).

A total of 59.9% ($n=167$) of participants stated that they would like to receive education on the impact of climate change on infectious diseases. However, 15.4% ($n=43$) did not wish to receive such education, and 24.7% ($n=69$) had no opinion.

The majority of participants indicated that they would prefer to receive such education online (65.2%, $n=182$). The proportion of those who preferred face-to-face education was 26.9% ($n=75$), those preferring interactive workshops was 21.9% ($n=61$), and those preferring virtual reality simulations was 39.4% ($n=110$).

Analysis of Perception Scores

The mean perception score of participants regarding climate change and infectious diseases was 30.2 ± 4.7 . The knowledge score on infectious diseases ranged from 1 to 17, with a median of 13 (mean $\pm$ SD= 12.6 ± 3.2) (Fig. 1).

The perception scores regarding climate change and infectious diseases were profoundly higher among those who had previously received education on climate change (31.6 ± 6.8) compared to those who had not (29.9 ± 4.0) ($t=-2.318$, $p=0.021$). Participants who reported thinking about climate change at any frequency prior to the survey had significantly higher perception scores (31.0 ± 4.2).

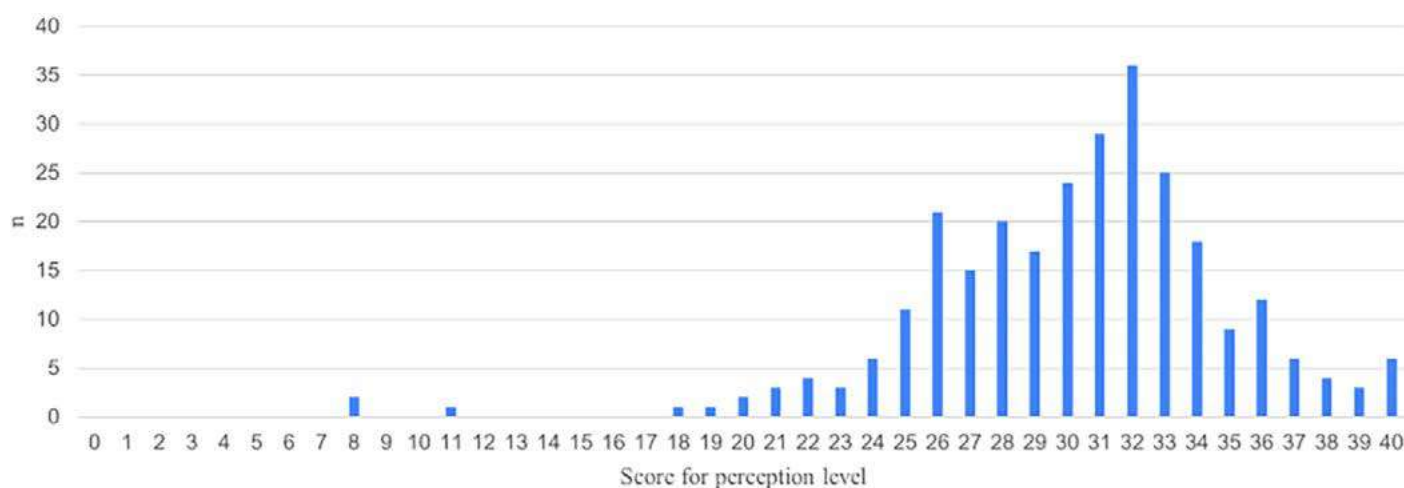


Figure 1. Frequency distribution of participants' perception scores regarding climate change and infectious diseases.

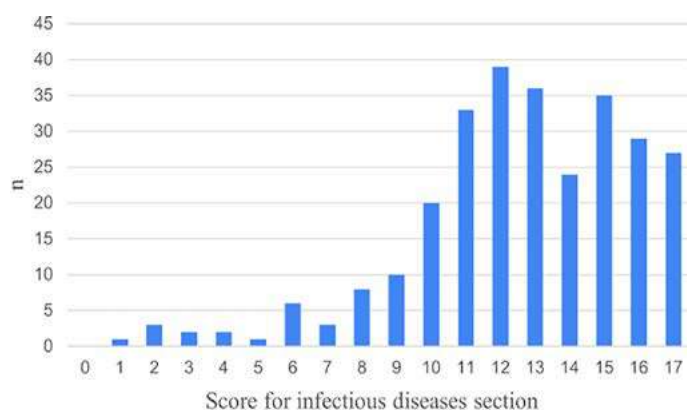


Figure 2. Frequency distribution of participants' knowledge scores on infectious diseases.

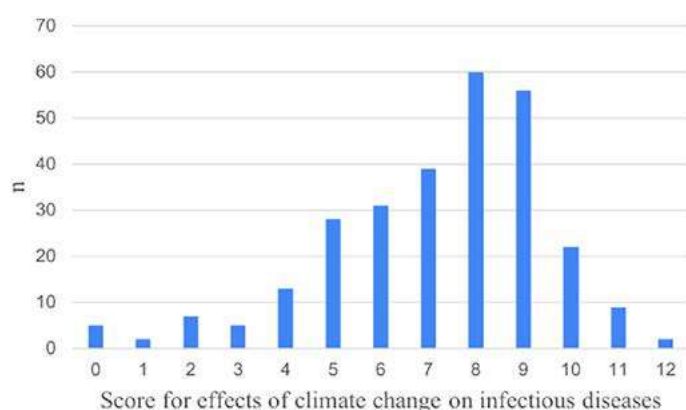


Figure 3. Frequency distribution of participants' scores on the perceived effects of climate change on infectious diseases.

compared to those who reported never thinking about it (28.5 ± 5.1) ($t = -4.186$, $p < 0.001$). Those who had previously discussed or exchanged ideas about climate change with peers or instructors also had significantly higher perception scores (31.4 ± 4.4) than those who had not (29.1 ± 4.7) ($t = -4.098$, $p < 0.001$) (Table 1).

Analysis of Level of Knowledge about Infectious Diseases

The median score for risk factors for contracting infectious diseases was 7, ranging from 1 to 8 ($\text{mean} \pm \text{SD} = 6.4 \pm 1.6$). The median score for awareness of disease vectors was 6, with scores ranging from 0 to 9 ($\text{mean} \pm \text{SD} = 6.1 \pm 2.0$). Total score for knowledge about infectious diseases ranged from 1 to 17, with a median of 13 ($\text{mean} \pm \text{SD} = 12.6 \pm 3.2$) (Fig. 2). No significant association was found between participants' various characteristics and their knowledge scores regarding infectious diseases (Table 1).

Analysis of the Impact of Climate Change on Infectious Diseases' Scores

The score for the impact of climate change on infectious diseases ranged from 0 to 12, with a median of 8 ($\text{mean} \pm \text{SD} = 7.2 \pm 2.3$) (Fig. 3).

The scores for the impact of climate change on infectious diseases were significantly higher among those who had received education on climate change (9 [4–11]) compared to those who had not ($Z = -3.315$, $p = 0.001$). Participants who had received education on the health effects of climate change also had significantly higher scores for the impact of climate change on infectious diseases (9 [4–12]) than those who had not ($Z = -3.377$, $p = 0.001$). Those who expressed a desire to receive education on the impact of climate change on infectious diseases had significantly higher scores in this area (8 [0–12]) compared to those who did not (7 [0–10]), whereas there was no significant difference between those who had no opinion and the other groups ($\chi^2 = 9.623$,

Table 1. Comparison of participants' perception and knowledge levels according to sociodemographic characteristics

Variable	n	Score 1 perception level	Test p	Score 2 knowledge level	Test p	Score 3 climate-infectious impact	Test p
Previous climate change education							
Yes	50	31.6±6.8	t=-2.318	13 (2-17)	Z=-0.988	9 (4-11)	Z=3.315
No	229	29.9±4.0	0.021*	13 (1-17)	0.323***	7 (0-12)	0.001***
Previous climate and health education							
Yes	29	31.2±8.5	t=-1.264	14 (2-17)	Z=-1.421	9 (4-12)	Z=-3.377
No	250	30.1±4.0	0.207*	13 (1-17)	0.155***	8 (0-12)	0.001***
Did the survey change your opinion?							
Yes, more concerned	224	30.3±4.3	t=0.522	13 (2-17)	Z=-0.988	8 (0-12)	Z=-1.485
No, not changed	55	29.9±5.9	0.602*	13 (1-17)	0.323***	8 (0-12)	0.138***
Willingness to receive education							
Yes	167	30.4±4.8	F=0.675	13 (2-17)	X ² =1.567	8 (0-12) ^a	X²=9.623
No	43	29.5±4.9	0.510**	13 (1-17)	0.457****	7 (0-10) ^b	0.008****
No opinion	69	30.1±4.3		13 (2-17)		7 (0-12)	
Thinking before survey							
Never	93	28.5±5.1	t=-4.186	12 (2-17)	Z=-1.380	7 (0-11)	Z=-2.688
Yes	186	31.0±4.2	p<0.001*	13 (1-17)	0.168***	8 (0-12)	0.007***
Discussion with peers							
No	146	29.1±4.7	t=-4.098	12 (2-17)	Z=-1.155	7 (0-11)	Z=-1.946
Yes	133	31.4±4.4	p<0.001*	13 (1-17)	0.248***	8 (0-12)	0.052***

*: T-test; **: One-way analysis of variance; ***: Mann-Whitney U; ****: Chi-square test. a, b: Values with different superscript letters within the same column are statistically significantly different based on post-hoc pairwise comparison (p<0.05).

p=0.008). Participants who reported thinking about climate change at any frequency prior to the survey had significantly higher scores for the impact of climate change on infectious diseases (7 [0-11]) compared to those who reported never thinking about it (8 [0-12]) (Z=-2.688, p=0.007) (Table 1).

Discussion

Our study is one of the first conducted in Türkiye to assess medical students' knowledge regarding climate change and infectious diseases. While existing studies in the literature focus on the relationship between climate change and infectious diseases, our study differs from previous work in that it demonstrates medical students' knowledge levels. In all these respects, our study contributes to the literature and lays the foundation for future studies.

This study evaluated the knowledge and perception levels of final-year medical students at a medical school regarding climate change and infectious diseases. The fact that only 17.9% of participants reported having received education about climate change, and only 10.4% about the health effects of climate change, confirms the point emphasized in

the literature regarding the integration of climate change into medical education. Two separate studies conducted at different medical faculties in the Indian cities of Karimnagar and Bangalore have shown that both healthcare workers and medical students, who are future healthcare professionals, need more knowledge about the impact of climate change on health.^[13,14] With the increase in global temperatures and the frequency of extreme weather events, climate-related illnesses such as heat-related diseases, vector-borne diseases, and infectious diseases have become a significant public health problem.^[15]

In our study, the perception scores regarding climate change and infectious diseases were found to be significantly higher among those who had previously received education on climate change compared to those who had not. This shows that education-based approaches are highly effective in increasing individuals' awareness. Indeed, as stated in a study conducted at Stanford University in California, USA, involving faculty members, clinicians, and medical students, with the aim of creating a comprehensive model for climate and medical education,

as climate change is forcing the world to rethink the concept of a “new normal,” it is of great importance for clinicians to be prepared for the new health effects that climate change may bring to the communities they serve. Another study conducted at Erasmus MC in Rotterdam, the Netherlands, among medical students emphasized that climate change should be better integrated into the medical curriculum from the 1st year onward.^[16,17]

The majority of participants stated that they were open to receiving education about climate change and infectious diseases and that they preferred simulation-based or online approaches. Most participants also indicated their willingness to receive education on the impact of climate change on infectious diseases. If such training were offered, they would prefer to receive it online. This finding is consistent with several studies in the literature. For example, in a study conducted in China, role-play and simulations that mimic reality were used to help students understand different perspectives, predict events that could occur in the future, and increase their interest and enjoyment in learning. It was shown that these simulations increased students' willingness to contribute to the real world in the same way.^[18]

Regarding the impact of climate change on infectious diseases, the most frequently cited source of information by participants was social media. This shows that digital platforms have become the primary source of information for young healthcare professionals. A scoping review conducted by performing systematic searches in PubMed, Scopus, Web of Science, ProQuest, and EBSCO databases on climate change with medical and nursing students also identified the internet as the most popular source.^[19]

The health effects of climate change are not limited to heat waves and extreme events; they also affect the geographic distribution of infectious diseases by changing the habitats of vectors. In this context, the low frequency of participants discussing the impact of climate change on infectious diseases with their peers or instructors suggests that this topic does not receive sufficient attention in academic settings. Indeed, a study conducted with medical and nursing students at Yale University revealed that medical curricula lack sufficient education on climate change.^[20]

After the survey, 80% of participants reported that their views shifted in a more “concerned” direction, indicating that informative and awareness-raising initiatives can be effective. This also suggests that even a survey can raise awareness in the short term. Similarly, a study published in 2021 described the design and implementation of a

new elective course titled “The Impact of Climate Change on Human Health” for Stanford medical students, and the findings revealed that courses on climate science and health in medical schools led to changes in students' opinions and behaviors.^[21]

Our study had certain limitations. First, as the present study was cross-sectional, it was not suitable for establishing causal relationships. Second, as the data were collected through self-reporting, recall bias or social desirability bias may have occurred. Third, as the participants were selected from a single medical school, the results may not be generalizable to all medical students. Furthermore, as the study was conducted during a specific period, it may not reflect awareness levels that may change over time. However, one of the strengths of the study was the examination of many independent variables from different perspectives.

Conclusion

This study has demonstrated that awareness among medical students regarding the impact of climate change on infectious diseases needs to be increased. Including this topic in educational curricula will not only raise students' individual knowledge levels but also enable a more robust response to these issues within the health system in the future.

Although the majority of medical students recognize the importance of issues caused by climate change, most have not received any education on this topic and experience a lack of knowledge. The small group who had taken a course or class on the subject had a significantly higher level of knowledge. The current medical school curriculum should be reviewed, and topics related to climate change should be addressed in more detail.

Ethics Committee Approval: The Ankara University Faculty of Medicine and the Dean's Office of the Faculty of Medicine Ethics Committee granted approval for this study (date: 17.05.2023, number: İOS-312-23).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: Not declared.

Authorship Contributions: Concept: BK, FŞA, YS, MŞ; Design: BK, FŞA, YS, MŞ; Supervision: BK, FŞA, YS, MŞ; Resource: BK, FŞA; Materials: BK; Data Collection or Processing: BK, FŞA; Analysis or Interpretation: BK, FŞA, YS, MŞ; Literature Search: BK, FŞA, YS, MŞ; Writing: BK, FŞA, YS, MŞ; Critical Review: BK, FŞA, YS, MŞ.

Peer-review: Double blind peer-reviewed.

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Examination of Adolescents' Digital Addiction Levels in Terms of Various Variables: The Case of Kırşehir

Edanur Tar Bolacalı,¹ Rabia Bayrak,² Betül Işıtan³

¹Department of Pediatric Nursing, Kırşehir Ahi Evran University Faculty of Health Sciences, Kırşehir, Türkiye

²Department of Elderly Care, Kırşehir Ahi Evran University, Vocational School of Health Services, Kırşehir, Türkiye

³Kırşehir Ahi Evran University Faculty of Medicine, Kırşehir, Türkiye

Abstract

Introduction: This study aims to determine the levels of digital addiction among adolescents living in Kırşehir province and to examine whether these levels differ in terms of various variables.

Methods: The population of this descriptive, cross-sectional, and exploratory study conducted in multiple centers consisted of secondary school students attending a school in a province located in the Central Anatolia Region of Turkey. Data were collected using a Personal Information Form and the Digital Addiction Scale. Data analysis involved the use of the Independent Sample t-test, One-way analysis of variance, and multiple linear regression analysis, and ethical principles were adhered to throughout the study.

Results: It was determined that 55% of adolescents with an average age of 12.88 ± 0.51 were female. It was concluded that the mean total score on the Digital Addiction Scale for adolescents was 61.82 ± 26.86 , the mean total score on the Interpersonal Relationships subscale was 29.63 ± 14.02 , and the mean total score on the Introverted Factors subscale was 32.19 ± 13.46 . It was determined that "gender, family status, mother's employment status, family income status, ownership of a game console, academic achievement, and activity status" had an effect on the Digital Addiction Scale for Children and sub-dimension total mean scores and that the difference was statistically significant ($p < 0.05$).

Discussion and Conclusion: It was concluded that adolescents' levels of digital addiction are moderate and are influenced by factors such as "gender, family status, mother's employment status, family income, ownership of a game console, academic achievement, and participation in activities." Special support programs should be developed to improve adolescents' levels of digital addiction.

Keywords: Adolescent; Behavioral addiction; Internet addiction; Smartphone addiction; Technology use

The use of digital technologies has continued to grow rapidly over the past century. As a result, tools such as the internet, computers, smartphones, and tablets have become an integral part of daily life.^[1] In our country, the

use of the internet and technological devices has also increased over the years. According to data from the Turkish Statistical Institute^[2] Survey on the Use of Information Technologies by Children, "Internet usage among children

Cite this article as: Tar Bolacalı E, Bayrak R, Işıtan B. Examination of Adolescents' Digital Addiction Levels in Terms of Various Variables: The Case of Kırşehir. Lokman Hekim Health Sci 2026;6(3):489–497.

Correspondence: Edanur Tar Bolacalı. Kırşehir Ahi Evran Üniversitesi Sağlık Bilimleri Fakültesi, Çocuk Sağlığı ve Hastalıkları Hemşireliği

Anabilim Dalı, Kırşehir, Türkiye

E-mail: edanurtar.1107@gmail.com **Submitted:** 07.10.2025 **Revised:** 17.01.2026 **Accepted:** 29.01.2026 **Available Online:** 06.08.2026



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aged 6–15 was 82.7% in 2021 and 91.3% in 2024,” and it was determined that 92.2% of boys and 90.3% of girls use the internet. About 97.4% of children stated that they use the internet regularly and reported that they use the internet “to watch videos (83.9%), for homework, learning, or participating in online classes (75.0%), and to play games (72.7%).”^[2] This increase in the use of digital technologies brings with it many benefits, such as quick access, easy sharing of information, problem solving, individual learning, efficient use of time, and ease of communication. However, alongside these benefits, unhealthy and excessive use of technology also brings certain harms.^[3] Some of these include obesity, sleep problems, eye and posture disorders, violent tendencies, anger and anxiety disorders, stress, fear and loneliness, decreased communication skills, decline in academic achievement, and alienation. Some of these harms stem from the fact that its use can reach addictive levels. This condition, known as technology addiction or digital addiction, affects many people.^[1,3]

Addiction is defined as the continued use of a substance or behavior despite its harmful effects on the individual and the loss of control over that substance or behavior. “Digital addiction” falls under the subheadings of behavioral addiction. Digital addiction encompasses diagnostic criteria such as the behavior becoming central to the person’s life and directing their thoughts and feelings (salience), changing their mood through this behavior (mood modification), increasing the duration of use to achieve the same effect (tolerance), experiencing negative emotional or physical symptoms when use is discontinued (withdrawal), conflicts with the individual or their environment (conflict), and a high level of relapse even after a long period of abstinence (relapse).

^[1,3] Although digital addiction is not formally recognized as a distinct diagnostic category in the Diagnostic and Statistical Manual of Mental Disorders, it is conceptually discussed within the framework of behavioral addictions, particularly in relation to excessive internet and gaming use. Similarly, the International Classification of Diseases, 11th Revision, includes Gaming Disorder under disorders due to addictive behaviors, which is considered conceptually related to digital addiction. These classifications contribute to understanding digital addiction as a behavioral pattern with addictive characteristics.^[4,5] Digital addiction was first referred to as internet addiction, but with the advancement of technology, it has been subdivided into categories such as “internet addiction, smartphone addiction, digital gaming addiction, and social media addiction.”^[1]

The internet supports human life and provides benefits such as access to social media, playing digital games, enabling interaction between two strangers in distant parts of the world, and quickly accessing desired information. According to We Are Social^[6] data, 66.2% of the world’s population is internet users, while in Turkey this rate is 74.41%. Globally, people spend more than 6.5 h a day on online activities, which means that almost a third of human life is spent on the internet. Today, most adolescents start using the internet from early childhood (under the age of 5). Increased access to the internet from an early age and excessive internet use lead to addictive behaviors, paving the way for “internet addiction.”^[1–6] According to a report by We Are Social, there are 5.61 billion mobile device users worldwide.^[6] Smartphones, which have many functions such as accessing social media, conducting research, communicating, and playing games, have become an important part of our lives, and with the intensive use of smartphones, “smartphone addiction” is becoming widespread.^[7,8]

Access to digital games, which can be played individually or in groups in a virtual environment, is facilitated by numerous tools, ensuring continuous access to these games. The inability to quit digital games despite their negative effects on individuals is referred to as digital game addiction. Digital games, which are beginning to replace traditional games for children, can cause addiction and harm the physical and mental development of children and adolescents.^[1,9] The concept of “social media,” which encompasses online environments where people use to share messages, images, and communicate with each other, can have positive outcomes such as easily sharing ideas and meeting individuals who enjoy similar things, but it can also harm its users.^[9] Easy access to personal information, information overload, exposure to bullying and sexual content, and decreased exercise and academic achievement as a result of excessive use are among the harms that social media can cause. These negative situations that can occur during a sensitive period, such as adolescence, can adversely affect their development.^[7,8]

According to the World Health Organization (WHO), individuals aged 10–19 are considered adolescents (WHO, 2025),^[10] and it is known that “digital addiction” is more prevalent among adolescents than other age groups.^[11] Adolescence is a period in which individuals experience physical, psychological, and cognitive development; these changes and developments affect their relationships with the world and themselves. During this period, when socialization and relationships with the environment are

important, adolescents' conflicts with themselves and their environment can lead them to engage with technological devices. Excessive technology use that begins with this orientation can lead to negativity in an individual's life. Furthermore, the widespread use of technological devices by adolescents, whose use has increased over the years among children and young people, is one of the factors that makes them more vulnerable to addiction.^[11,12]

Increased digital addiction among adolescents can cause many physical and mental problems. Parallel to digital addiction, there may be an increase in aggression, a decline in academic achievement, difficulty socializing, a decrease in sleep quality, failure to fulfill responsibilities, a decrease in movement and exercise, dissatisfaction with life, fatigue, pain, reduced time spent with friends, conflicts with family and peers, decreased interest in hobbies, anxiety, excessive food consumption, inability to concentrate, weight gain, decreased cognitive development, depression, and a tendency toward mental illness.^[3,8,11,12] The fact that digital addiction leads to many negative situations in adolescents highlights the need to address it with sensitivity and conduct research on it. Pediatric nurses, who are in direct contact with children and adolescents, as well as all healthcare professionals, bear significant responsibility in this regard. Although a limited number of studies have been conducted on this subject in the literature, no study examining the levels of digital addiction among adolescents in Kırşehir has been found.^[11,12] Based on this, this study aims to determine the levels of digital addiction among adolescents living in Kırşehir and to examine whether these levels differ in terms of various variables.

Materials and Methods

Design

This study was designed as a descriptive, cross-sectional, correlational, and multicenter research study.

Research Population and Sample

The research population consists of adolescents attending five middle schools in a province in the Central Anatolia region of Turkey. The choice of province was influenced more by the feasibility of the research, the availability of institutional permissions, and opportunities for cooperation with schools than by the level of digital technology use. The research sample consists of adolescents enrolled in these schools who met the inclusion criteria and whose families and themselves agreed to participate in the research. The inclusion criteria for the study were adolescents aged

10–13 years attending the selected schools who provided informed consent. The sample size of the study was calculated by referring to the average digital addiction level score (56.74+19.02) of adolescents in a similar study.^[13] Calculations made using the G*Power 3.1 program determined that a total of 515 adolescents needed to be included in the study with 0.95 power, 0.05 error margin, and 0.145 effect size; to account for potential missing data, the sample size was increased by approximately 10%.^[14] The study sample was selected from adolescents who met the inclusion criteria using simple random sampling, one of the probability sampling methods.

Data Collection Tools

Data were collected using the "Personal Information Form" and the "Digital Addiction Scale."

Personal Information Form

The "Personal Information Form," prepared by researchers in line with the literature,^[9,13,15] consists of a total of 13 questions. The first seven questions aim to determine adolescents' age, gender, family status, parents' employment status, and perceived economic status. The remaining six questions are aimed at determining digital device usage characteristics (ownership of a game console, computer, tablet, or smartphone), academic achievement, and activity levels.

Digital Addiction Scale for Children (DASC)

The scale was designed by Hawi et al.^[16] to measure the level of digital addiction among children aged 10–14. It consists of 25 items on a 5-point Likert scale ranging from 1=Never to 5=Always. Kaçmaz et al.^[17] adapted the scale into Turkish. The scale consists of two subscales: Interpersonal factors (4, 6, 9, 10, 13, 16, 17, 18, 19, 20, 22, 23 and 25. item) and intrapersonal (1, 2, 3, 5, 7, 8, 11, 12, 14, 15, 21 and 24. item). The lowest possible score on the scale is 25, and the highest possible score is 125, with higher scores indicating a higher risk of digital addiction.^[17] In the Turkish validity and reliability study of the scale, Cronbach's Alpha internal consistency reliability coefficient was found to be $\alpha=0.90$,^[17] and in this study, Cronbach's Alpha value was found to be 0.96.

Data Collection

Permission to conduct the study was obtained from the Provincial Directorate of National Education, allowing access to the selected schools without requiring individual school-level approvals. Before data collection, the school

administration and teachers were consulted, and the necessary explanations about the study were provided to the adolescents. Informed consent forms were sent to the students' families. The data collection schedule was determined in consultation with the school principal and guidance counselors. Adolescents who agreed to participate in the study were also given an informed consent form, and the students' informed consent was obtained. The research data were collected by the researchers between January and May 2025 in the classroom environment under the supervision of the researchers in a manner that did not disrupt the flow of lessons. All adolescents present on the day of data collection and meeting the inclusion criteria were invited to participate. The researchers answered the adolescents' questions, and the data collection process took approximately 15–20 min.

Statistical Analysis

The data obtained were analyzed using IBM Statistical Package for the Social Sciences Statistics 29 (IBM Corporation, Armonk, New York, USA) software. Descriptive statistical methods (mean, standard deviation) and tests appropriate for data distribution were used to compare quantitative data when evaluating the findings obtained in the study. The normality of the variables used in the study was determined by examining "skewness and kurtosis values, histograms, and Q-Q plot graphs," and the data were found to be normally distributed. The "Independent Sample t Test" and "One-Way ANOVA" tests were used to compare categorical and continuous data. Multiple linear regression analysis was conducted as an exploratory analysis, with DASC Total as the dependent variable and selected variables related to adolescents' digital addiction levels (gender, family income, academic achievement, and activity status) as independent variables, to examine the extent to which these variables explain digital addiction levels. For the multiple linear regression analysis, the normality of residuals was evaluated using histogram and normal P–P plots. Visual inspection indicated that the residuals were normally distributed, and the assumptions of linearity and homoscedasticity were met. The significance level was accepted as $p < 0.05$ in all statistical analyses.

Ethical Principles

Before starting the study, ethical approval was obtained from the Scientific Research and Publication Ethics Committee of Kırşehir Ahi Evran University Faculty of Social and Human Sciences, dated 21.03.2024, and

numbered 2024/03/23. In addition, permission to collect data was obtained from the Provincial Directorate of National Education, and permission to use the Digital Addiction Scale was obtained by contacting the authors who adapted the scale into Turkish. Before the data collection process, informed consent was obtained from adolescents and their parents through an Informed Consent Form. The study was conducted in accordance with the principles outlined in the Helsinki Declaration on Human Rights.

Results

The study was completed with 575 adolescents. The average age of adolescents was 12.88 ± 0.51 . It was determined that 55% of them were female, 72.5% lived in a nuclear family, 39.7% had two siblings, 69.0% had a mother who did not work, 90.8% had a father who worked, and 51.5% had a family income that equals expenses. Of the adolescents, 48.5% reported owning a game console, 53% a computer, 46.3% a tablet, and 79.7% a smartphone. Of the adolescents, 74.4% stated that they had received commendation in the previous term, 59.1% stated that they exercised regularly, and 23.8% stated that they preferred soccer as a physical activity (Table 1).

Group comparisons were conducted for both the total DASC score and its two subscales (interpersonal and intrapersonal factors), as defined in the original scale structure. It was determined that characteristics such as "number of siblings, father's employment status, and ownership of a computer, tablet, or smartphone" had no effect on the mean total scores for DASC and its subscales ($p > 0.05$). "Gender, family status, mother's employment status, family income status, game console ownership, academic achievement, and activity participation" were found to have an effect on the mean total scores of the DASC and its subscales, and the difference between them was statistically significant ($p < 0.05$). The analyses revealed that male participants had statistically significantly higher ($p < 0.05$) DASC and subscale total scores than female participants, participants whose mothers worked had statistically significantly higher ($p < 0.05$) DASC and subscale total scores than those whose mothers did not work, participants whose family income exceeded expenses had statistically significantly higher ($p < 0.05$) DASC and subscale total scores than those whose income equaled expenses, and participants who owned a game console had statistically significantly higher ($p < 0.05$) DASC and subscale total scores than those who did not own a game console (Table 1).

Table 1. Comparison of the digital addiction scale and subscale total mean scores according to the descriptive characteristics of adolescents (n=575)

Characteristics	n (%)	Mean±SD		
		Interpersonal factors	Intrapersonal factors	Total digital addiction
Gender				
Female	316 (55.0)	28.04±12.97	30.97±12.88	59.019±25.185
Male	259 (45.0)	31.57±15.01	33.69±14.03	65.255±28.452
Test value, p-value		t=-2.98; p=0.003	t=-2.39; p=0.017	t=-2.752; p=0.006
Family status				
Nuclear	417 (72.5)	28.41±13.52 ^a	31.26±13.09 ^a	59.66±25.93 ^a
Extended	118 (20.5)	32.15±14.74 ^{ab}	34.03±14.01 ^{ab}	66.18±28.26 ^{ab}
Non-intact	40 (7.0)	34.95±15.11 ^b	36.60±14.62 ^b	71.55±28.26 ^b
Test value, p-value		F=6.49; p= 0.002	F=4.29; p= 0.014	F=5.61; p=0.004
Number of siblings				
1	150 (26.1)	29.09±14.51	31.99±13.60	61.09±27.60
2	228 (39.7)	29.69±14.18	32.46±13.55	62.16±27.15
3	134 (23.3)	28.95±13.20	31.54±12.90	60.49±25.23
4 or above	63 (11.0)	32.14±14.00	33.11±14.25	65.25±27.71
Test value, p-value		F=0.85; p=0.465	F=0.24; p= 0.865	F=0.50; p= 0.681
Mother's employment status				
Working	279 (31.0)	33.91±15.72	35.75±14.50	64.58±29.18
Not working	296 (69.0)	27.71±12.75	30.60±12.68	59.24±24.25
Test value, p-value		t=4.62; p<0.001	t=4.09; p<0.001	t=2.38; p=0.018
Father's employment status				
Working	522 (90.8)	29.60±14.14	32.18±13.49	61.78±27.02
Not working	53 (9.2)	29.94±12.92	32.40±13.34	62.34±25.48
Test value, p-value		t=-0.17; p= 0.865	t=-0.11; p=0.910	t=-0.15; p=0.884
Family income status				
Income exceeds expenses	83 (48.5)	30.86±15.22	33.71±14.48	64.58±29.18
Income equals expenses	492 (51.5)	28.47±12.70	30.77±12.29	59.24±24.25
Test value, p-value		t=2.04; p= 0.042	t=2.62; p=0.009	t=2.38; p=0.018
Own a game console				
Yes	83 (14.4)	32.63±14.74	35.59±13.23	68.22±27.42
No	492 (85.6)	29.13±13.85	31.62±13.43	60.75±26.64
Test value, p-value		t=2.11; p=0.035	t=2.49; p=0.013	t=2.35; p=0.019
Own a computer				
Yes	305 (53.0)	29.76±13.95	32.62±13.03	62.38±26.30
No	270 (47.0)	29.49±14.13	31.72±13.95	61.21±27.52
Test value, p-value		t=0.23; p=0.814	t=0.79; p=0.427	t=0.52; p=0.603
Own a tablet				
Yes	266 (46.3)	29.69±14.20	32.50±13.54	62.20±27.12
No	309 (53.7)	29.58±13.89	31.93±13.42	61.51±26.68
Test value, p-value		t=0.10; p=0.924	t=0.51; p=0.612	t=0.30; p=0.761
Own a smartphone				
Yes	458 (79.7)	29.59±13.92	32.42±13.34	62.01±26.62
No	117 (20.3)	29.79±14.46	31.32±13.98	61.12±27.89

Table 1 (cont.). Comparison of the digital addiction scale and subscale total mean scores according to the descriptive characteristics of adolescents (n=575)

Characteristics	n (%)	Mean±SD		
		Interpersonal factors	Intrapersonal factors	Total digital addiction
Test value, p-value		t=-0.14; p=0.888	t=0.78; p=0.433	t=0.32; p=0.750
Academic achievement				
Certificate of achievement	428 (74.4)	28.99±13.90 ^a	31.58±13.06 ^a	60.57±26.37 ^a
Certificate of recognition	112 (19.5)	29.38±13.29 ^a	32.18±13.85 ^a	61.55±26.28 ^a
None	35 (6.1)	38.26±15.35 ^b	39.77±15.12 ^b	78.03±30.10 ^b
Test value, p-value		F=7.24; p<0.001	F=6.09; p=0.002	F=6.98; p<0.001
Activity status				
None	235 (40.9)	30.80 ±13.88 ^a	33.48±13.44 ^a	64.28±26.60 ^a
Soccer	137 (23.8)	29.85±15.6a ^b	32.01±14.42 ^{ab}	61.86±29.67 ^{ab}
Volleyball-Basketball	111 (19.3)	25.77±11.92 ^b	28.59±12.14 ^b	54.36±23.45 ^b
Other	92 (16.0)	30.75±13.41 ^b	33.38±12.96 ^b	64.13±25.56 ^b
Test value, p-value		F=3.42; p=0.009	F=3.09; p=0.016	F=3.39; p=0.009

Mean±SD: Mean±Standard deviation; t: Student t-test; F: One-way analysis of variance (ANOVA); p<0.05; a<b<c.

Table 2. Digital addiction scale and subscale total mean scores

Scale	Mean±SD	Min-max	Cronbach's Alfa
Interpersonal factors	29.63±14.02	13–65	0.934
Intrapersonal factors	32.19±13.46	12–60	0.940
Total digital addiction scale	61.82±26.86	25–125	0.966

Mean±SD: Mean±standard deviation; Min-Max: Minimum-maximum.

Following statistically significant one-way ANOVA results, post hoc Tukey analyses were performed to identify the groups responsible for the observed differences in the total scores of the DASC and its subscales according to family status, academic achievement, and activity participation status. For family status, adolescents from non-intact families had significantly higher mean total scores on the DASC and its subscales compared to those from nuclear families ($p<0.05$). Regarding academic achievement, adolescents who did not receive any achievement certificates had significantly higher DASC total and subscale scores than those who received Certificates of Appreciation or Thanks ($p<0.05$). With respect to activity participation, adolescents who did not participate in any activities had significantly higher DASC total and subscale scores than those who participated in volleyball or basketball activities ($p<0.05$) (Table 1).

The total DASC scores range from 25 to 125, with an average of 61.82 ± 26.86 , while the average total score for the Interpersonal Relationships Subscale is 29.63 ± 14.02 and the average total score for the Introversion Factors Subscale is 32.19 ± 13.46 . The Cronbach's Alpha for the

Table 3. Relationship between digital addiction scale score and some variables

Variables	Family income		Academic achievement		Activity status	
	r	p	r	p	r	p
Gender	0.028	0.505	0.042	0.312	-0.020	0.639
Family income			0.195	<0.001	-0.004	0.932
Academic achievement					0.009	0.827

r: Pearson's correlation coefficient.

DASC is 0.966, the Cronbach's Alpha for the Interpersonal Relationships Subscale is 0.934, and the Cronbach's Alpha for the Introversion Subscale is 0.940 (Table 2).

Before the regression analysis, correlations among the independent variables were examined (Table 3). The correlation coefficients ranged from -0.020 to 0.195, indicating weak relationships and no evidence of multicollinearity among the independent variables. These findings are consistent with the VIF values reported in Table 4.

In the study, a multiple linear regression model was used to examine the relationship between adolescents' level of digital addiction and factors such as gender, family income status, academic achievement, participation in activities, and DASC, yielding an AdjR² value of 0.050. This result indicates that all factors in the model together explain 5% of the variation in the DASC total score (R^2 : 0.061, AdjR²: 0.050, $p<0.001$) (Table 4).

Table 4. Relationship between digital addiction scale score and some variables

Factors associated with DASC	DASC total					
	β^1 (95% CI)	SE	β^2	t	p	VIF
Constant	58.025 (50.056–65.994)	4.051		14.323	<0.001	
Gender	6.199 (-0.836–13.234)	3.576	0.115	1.733	0.084	1.580
Family income status	-7.046 (-12.696--1.396)	2.872	-0.130	-2.453	0.015	1.006
Academic achievement	23.128 (10.246–36.010)	6.549	0.188	3.532	<0.001	1.008
Activity status	1.186 (-5.970–8.342)	3.638	0.022	0.326	0.745	1.575

F: 5.458 R: 0.247 R²: 0.061 Adj. R²: 0.050 p<0.001. CI: Confidence interval; SE: Standard error; VIF: Variance inflation factor; DASC: Digital addiction scale for children.

Discussion

With the widespread use of digital technologies today, digital addiction among adolescents is on the rise. Digital addiction causes many physical and mental problems in adolescents. Therefore, digital addiction among adolescents must be addressed and studied with sensitivity. This study determined the levels of digital addiction among adolescents living in the province of Kırşehir and examined whether these levels differed in terms of various variables, presenting an evidence-based perspective on digital addiction among adolescents. The results obtained from the research findings indicate that the levels of digital addiction among the adolescents included in the study were moderate. When studies on the subject are examined,^[15,18–20] it is seen that, similar to our findings, the literature also indicates that adolescents' digital addiction is at a moderate level.

According to research findings, it has been determined that the level of digital addiction is higher in men than in women. In a study by Gürarslan Baş and Karatay^[12] examining technology use and addictive behaviors in adolescents, it was found that men had higher levels of digital addiction. Similarly, a study conducted by Lin^[11] with adolescents in Taiwan found that males had higher levels of internet addiction. Similar studies in the literature have also determined that males have higher levels of digital addiction,^[19,21,22] these results are consistent with our findings. On the other hand, studies by Ünal and Korkmaz^[23] and Fişekçioğlu and Denктаş^[24] found that digital addiction does not differ by gender. In this study, it is thought that the lower level of digital addiction among women may be due to girls being raised in a more controlling manner, interacting more in social environments, more restrictions being placed on girls, and girls being able to devote less time to themselves.^[1,25,26]

This study found that adolescents from non-intact families have higher levels of digital addiction than those from intact families, which is consistent with the literature.^[3,25] A study by

Taylan et al.^[25] determined that adolescents whose parents were separated spent more time on digital games than those whose parents were deceased or alive and together. A study by Deniz et al.^[3] also found that adolescents whose parents were divorced had higher levels of digital game addiction than other groups. This study found that adolescents whose mothers worked had higher levels of digital addiction than those whose mothers did not work. A study conducted by Altınok^[15] with high school students also found that adolescents whose mothers worked had higher levels of digital addiction than those whose mothers did not work, which is similar to the findings of this study. This situation is thought to be an indication of the positive effect of the time allocated to the child by the family on addiction. Arslan et al.^[26] concluded in their study that family income does not affect the level of digital addiction. In Altınok's^[15] study, it was found that family income is related to digital addiction, and that adolescents with good and very good family income have higher levels of digital addiction than adolescents with medium family income. This study also found that those with family income exceeding their expenses had higher levels of digital addiction than those with family income equal to their expenses. This situation may be due to adolescents with good family income having greater access to technological tools, owning their own technological devices, and thus being able to spend more time on them.^[18]

Research findings indicate that adolescents who own a game console have significantly higher levels of digital addiction compared to those who do not own one. The high visual quality, level of interaction, and social connectivity offered by console games can lead users to spend more time playing, which in turn can pave the way for the emergence of addiction components. Ownership of a game console can increase the risk of addiction, particularly by increasing the opportunity for online or prolonged gaming. Similarly, the literature emphasizes that easy access to digital gaming platforms reinforces addictive behaviors.^[20,27]

Dikmen et al.^[28] found a negative relationship between academic achievement and digital game addiction in a study conducted with adolescents. A study by Delebe and Hazar^[20] found that digital game addiction leads to a decline in academic achievement. The findings of this study, in line with the literature, concluded that adolescents with low academic achievement had higher levels of digital addiction than those with high academic achievement. A study conducted by Fişekçioğlu and Denктаş^[24] with adolescents concluded that adolescents who play sports have lower levels of digital addiction than adolescents who do not play sports. In a study by Hazar et al.,^[27] it was also found that adolescents who did not exercise regularly had higher levels of digital game addiction than adolescents who exercised regularly. In this study, similar to the literature, it was determined that adolescents who did not engage in any activities had higher levels of digital addiction than adolescents who regularly played volleyball or basketball. It is thought that this situation may stem from students who devote their time to sports, spending less time with technology. Therefore, the findings obtained as a result of this study, which show the significant relationships between adolescents' levels of digital addiction and certain variables, highlight the importance of studies on the conscious and balanced use of technology. One important outcome of this study is that some variables related to adolescents' level of digital addiction were found to be statistically associated with the DASC total score; however, their overall contribution to explaining variation in digital addiction was limited. The regression model accounted for approximately 5% of the variance, indicating that these variables provide a partial perspective on adolescents' digital addiction. Accordingly, the regression findings should be interpreted within an exploratory framework. This result underscores the multifactorial nature of digital addiction and suggests that adolescents' digital behaviors are influenced by a broader set of psychological, social, and contextual factors beyond those included in the present model. On the other hand, it is thought that there is a significant gap in the literature regarding adolescents' level of digital addiction and the factors that influence it, and that new studies are needed to define this gap.

Limitations

This study has some limitations. First, the use of self-report instruments may have introduced response biases, such as social desirability or inaccurate recall. Second, the cross-sectional design limits the ability to infer causal relationships between digital addiction and associated

factors. Finally, although the study sample was carefully selected, it only included adolescents from the schools where the study was conducted, which may limit the generalizability of the results to the wider adolescent population.

Conclusion

It was concluded that adolescents' levels of digital addiction are moderate and are influenced by factors such as "gender, family status, mother's employment status, family income, ownership of a game console, academic achievement, and participation in activities." Based on the study results, it is recommended that educational programs be organized to reduce adolescents' risk of digital addiction, parental awareness be increased, adolescents be directed toward different activities, psychosocial support be provided, intervention studies be conducted, and guidelines and policies be developed. It is recommended that studies be conducted across different age groups, socioeconomic levels, and cultural contexts to increase the generalizability of the results. Furthermore, it is recommended that nurses and other health professionals play an active role in preventing digital addiction and mitigating its negative effects by engaging in school-based health education, family counseling, early identification of at-risk groups, and promoting healthy lifestyle habits.

Ethics Committee Approval: The Kırşehir Ahi Evran University Faculty of Social and Human Sciences Research and Publication Ethics Committee granted approval for this study (date: 21.03.2024, number: 2024/03/23).

Informed Consent: Written informed consent was obtained.

Conflict of Interest: None declared.

Financial Disclosure: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Use of AI for Writing Assistance: During the preparation of this work, the authors used Grammarly and DeepL programs in order to language editing. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Authorship Contributions: Concept: ETB, RB, BI; Design: ETB, RB, BI; Supervision: ETB, RB, BI; Resource: ETB, RB, BI; Materials: ETB, RB, BI; Data Collection or Processing: ETB, RB, BI; Analysis or Interpretation: ETB, RB, BI; Literature Search: ETB, RB, BI; Writing: ETB, RB, BI; Critical Review: ETB, RB, BI.

Acknowledgments: The authors would like to express their sincere gratitude to the adolescents and their families who voluntarily participated in this study, as well as to the school administrators and teachers for their support during the data collection process.

Peer-review: Double blind peer-reviewed.

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ORIGINAL ARTICLE

Extra-Intestinal Manifestations in Patients with Inflammatory Bowel Disease

 Nazmiye Serap Biçer¹,  Gülten Can Sezgin²,  Abdurrahman Soner Şenel³,  Osman Elçin³,
 Yasemin Özden Eldemir³,  Eda Öksüm Solak⁴,  Duygu Gülmez Sevim⁵

¹Department of Internal Medicine, Kayseri City Training and Research Hospital, Kayseri, Türkiye

²Division of Gastroenterology, Department of Internal Medicine, Erciyes University Faculty of Medicine, Kayseri, Türkiye

³Division of Rheumatology, Department of Internal Medicine, Erciyes University Faculty of Medicine, Kayseri, Türkiye

⁴Department of Dermatology, Erciyes University Faculty of Medicine, Kayseri, Türkiye

⁵Department of Ophthalmology, Erciyes University Faculty of Medicine, Kayseri, Türkiye

Abstract

Introduction: Extra-intestinal manifestations (EIMs) significantly contribute to morbidity in patients with inflammatory bowel diseases (IBDs). This study aimed to determine the prevalence and distribution of EIMs in patients with ulcerative colitis (UC) and Crohn's disease (CD) and to evaluate associations between EIMs, disease activity, and demographic factors.

Methods: This single-center, descriptive observational study included 121 adult IBD patients (65 UC, 56 CD). EIMs were systematically assessed through specialist consultations (rheumatology, dermatology, ophthalmology) and review of laboratory, imaging, and clinical data. Disease activity was classified using standardized indices (CD Activity Index for CD; Truelove and Witts/Mayo Score for UC). Statistical analyses were performed to identify associations between variables.

Results: At least one EIM was identified in 57.0% (n=69) of patients. The most frequent EIMs were hepatobiliary (33.9%), bone-joint (28.9%), and skin-mucosal (24.8%). EIM prevalence was not associated with age or gender. However, differences were observed between disease types: Urinary involvement (29.2% in UC vs. 8.9% in CD; p=0.005) and cardiovascular involvement (16.9% in UC vs. 1.8% in CD; p=0.005) were both more common in UC. Oral cavity (p=0.018), cardiovascular (p=0.032), and urinary (p=0.046) manifestations were significantly associated with active disease. In contrast, hepatobiliary manifestations were more frequently observed in patients in remission.

Discussion and Conclusion: EIMs are highly prevalent in IBD, affecting over half of this patient cohort. The findings reveal that specific EIMs are associated with distinct disease phenotypes (e.g., urinary/cardiovascular in UC) and disease activity status (e.g., oral/cardiovascular in active disease vs. hepatobiliary in remission). This underscores the necessity of routine, multidisciplinary screening for EIMs, even in patients with asymptomatic or inactive intestinal disease, to ensure comprehensive management.

Keywords: Crohn's disease; Disease activity; Extraintestinal manifestations; Inflammatory bowel disease; Ulcerative colitis

Cite this article as: Biçer NS, Sezgin GC, Şenel AS, Elçin O, Eldemir YÖ, Öksüm Solak E, Gülmez Sevim D. Extra-Intestinal Manifestations in Patients with Inflammatory Bowel Disease. Lokman Hekim Health Sci 2026;6(3):498–505.

Correspondence: Nazmiye Serap Biçer. Kayseri Şehir Eğitim ve Araştırma Hastanesi, İç Hastalıkları Kliniği, Kayseri, Türkiye

E-mail: serapbicir@gmail.com **Submitted:** 12.10.2025 **Revised:** 21.01.2026 **Accepted:** 05.02.2026 **Available Online:** 06.08.2026



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Inflammatory bowel diseases (IBD), including ulcerative colitis (UC), Crohn's disease (CD), and indeterminate colitis, are chronic inflammatory disorders characterized by relapsing diarrhea, abdominal pain, gastrointestinal bleeding, and malabsorption.^[1] UC primarily involves the mucosa and submucosa of the colon, and clinical severity correlates with the extent of inflammation.^[2] CD is characterized by transmural inflammation that may affect any part of the gastrointestinal tract, most commonly the terminal ileum, resulting in a wide spectrum of symptoms ranging from abdominal pain and diarrhea to perianal complications and dyspeptic complaints.^[3]

In addition to intestinal involvement, extra-intestinal manifestations (EIMs) frequently occur in IBD and may affect several organ systems, manifesting with varying degrees of severity.^[4] EIMs commonly involve the musculoskeletal, dermatological, ocular, hepatobiliary, hematological, and genitourinary systems.^[5] The underlying mechanisms remain incompletely understood; however, immune dysregulation, altered leukocyte, gut microbiota alterations, and genetic predisposition have been suggested.^[5]

Since EIMs contribute substantially to morbidity and may adversely influence treatment outcomes, early recognition and appropriate management are essential for improving overall disease prognosis.^[6] Standardized indices, including the CD Activity Index (CDAI) for CD and the Mayo Score for UC, are commonly used to assess disease activity and guide clinical decisions.^[7,8] Considering the clinical significance of EIMs, the aim of this study was to determine the prevalence and systemic distribution of EIMs in patients with IBD and to evaluate their associations with disease activity and demographic factors such as age and gender.

Materials and Methods

Study Design, Setting, and Ethical Considerations

This descriptive observational study was conducted at a 1300-bed tertiary university hospital. The study protocol was designed in accordance with the Declaration of Helsinki and was approved by the Erciyes University Faculty of Medicine Clinical Research Ethics Committee (Approval No: 2020/476; Date: September 23, 2020). All participants provided written informed consent before enrollment.

Study Population and Enrollment

The study included 121 adult patients with clinically, endoscopically, and/or histopathologically confirmed IBD. All consecutive patients who presented to or were followed at the gastroenterology outpatient clinic and

inpatient ward between October 15, 2020, and October 15, 2021, were enrolled.

Data Collection

Data were recorded using a standardized follow-up form. The following parameters were collected:

Demographic and clinical characteristics, disease duration, number of comorbidities (including hypertension, diabetes mellitus, cardiovascular disease, chronic obstructive pulmonary disease, and chronic kidney disease), complications, treatments, laboratory findings, EIMs.

Assessment of Disease Activity

Disease activity was assessed using established indices.

- UC: Activity was assessed using the Truelove and Witts Index and the Mayo Score.^[7,8] Mild UC and Mayo endoscopic scores of 0–2 were considered inactive disease
- CD: Activity was assessed using the CD Activity Index (CDAI).^[9] A CDAI score <150 was considered inactive disease.

Assessment of EIMs

All patients underwent a multidisciplinary evaluation. Routine laboratory tests were performed in every patient at baseline, with additional advanced investigations completed as indicated for relevant organ systems.

- Rheumatologic Assessment: This included a physical examination of peripheral joints and the spine and radiographs in all patients. Sacroiliac magnetic resonance imaging was performed only in cases with suspected axial involvement. Ankylosing spondylitis and axial manifestations were classified according to the Assessment of Spondylo Arthritis International Society criteria.^[10]
- Dermatologic Assessment: This consisted of a complete skin and oral cavity examination. Previously documented dermatologic manifestations (e.g., erythema nodosum, pyoderma gangrenosum) were confirmed through chart review.
- Ophthalmologic Assessment: A standardized evaluation, including slit-lamp and fundoscopic examination, was performed by the same ophthalmologist for all patients.
- Hematologic Assessment: Manifestations were evaluated using complete blood count and anemia parameters. A peripheral smear was performed when necessary.
- Hepatobiliary and Genitourinary Assessment: These manifestations were assessed using laboratory markers, abdominal and urinary ultrasonography, magnetic resonance cholangiopancreatography, and autoimmune serology.

Table 1. Demographic and clinical characteristics of patients with ulcerative colitis and Crohn's disease

Variables	Ulcerative colitis (n=65)	Crohn's disease (n=56)	p
Female sex, n (%)	26 (40.0)	31 (55.4)	0.092
Smoking, n (%)	20 (30.8)	25 (44.6)	0.083
Chronic comorbidity, n (%)	19 (29.2)	8 (14.3)	0.049
Age (years), mean±SD	47.92 ± 12.99	40.04 ± 13.73	0.002
Age at diagnosis (years), mean±SD	39.63±12.42	35.51 ± 12.53	0.073
Surgical history, n (%)	6 (9.2)*	24 (42.9)*	<0.01

*: Gastrointestinal or appendectomy operations. Surgical history includes previous gastrointestinal surgery and/or appendectomy. SD: Standard deviation.

Inclusion Criteria

Patients were included if they met all of the following conditions:

1. Age ≥ 18 and < 90 years.
2. Presentation to or follow-up at the gastroenterology outpatient clinic or inpatient ward of the study center between October 15, 2020, and October 15, 2021.
3. A confirmed diagnosis of UC or CD based on clinical, endoscopic and/or histopathological findings.
4. Provision of written informed consent for participation in the study.

Exclusion Criteria

Patients were excluded if they met any of the following conditions:

1. Inability to determine disease activity due to prior total colectomy or permanent stoma.
2. Active severe infection, malignancy, or pregnancy during the study period.
3. End-stage liver disease or end-stage renal disease that could interfere with the evaluation of EIMs.
4. Missing or insufficient clinical data regarding primary study variables.
5. Refusal or inability to provide written informed consent.

Data Analysis

Statistical analyses were performed using IBM Statistical Package for the Social Sciences Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as frequency, percentage, mean±standard deviation, and minimum–maximum values. The normality of the distribution of quantitative data was determined using the Kolmogorov–Smirnov test. Continuous variables were compared using the Independent Samples t-test or the Mann–Whitney U test, depending on the distribution. Categorical variables were

evaluated using the Pearson Chi-square test, with Yates' continuity correction applied for 2×2 contingency tables, and Fisher's exact test was used when appropriate. A two-tailed $p < 0.05$ was considered statistically significant.

Results

A total of 121 patients were included in the study, consisting of 57 females (47.1%) and 64 males (52.9%). The mean age was 44.27 ± 13.86 years (range 18–75), and the mean age at diagnosis was 37.72 ± 12.59 years (range 14–71). UC patients had a significantly higher age at diagnosis compared with CD patients ($p < 0.05$). No differences were detected between UC and CD groups regarding gender, education level, family structure, or smoking status ($p > 0.05$), although smoking was more frequent in CD. Chronic comorbidities were more common in UC (Table 1). There was no significant difference between groups in terms of flare frequency ($p > 0.05$). However, surgical intervention was significantly more frequent in CD, with 42.9% having undergone gastrointestinal or appendectomy procedures ($p < 0.01$).

Comparison of biochemical and nutritional parameters between the groups is shown in Table 2. Reference ranges used to define biochemical abnormalities were as follows: C-reactive protein (CRP) 0–49.2 nmol/L, erythrocyte sedimentation rate (ESR) 0–20 mm/h, hemoglobin 12–16 g/dL for females and 13–17 g/dL for males, transferrin saturation 20–45%, ferritin 15–150 ng/mL, vitamin B12 200–900 pg/mL, folate 3–17 ng/mL, serum albumin 3.5–5.0 g/dL, and total protein 6.0–8.3 g/dL. The analysis showed a significantly higher prevalence of inflammatory markers and nutritional deficiencies in the CD cohort. Specifically, elevated CRP was significantly more frequent in CD patients (69.6%) than in UC patients (38.5%; $p = 0.001$). Anemia was also more common in the CD group (44.6%) compared to the UC group (26.2%; $p = 0.033$). Nutritional deficiencies were higher in CD. This included significantly higher rates of Vitamin B12 deficiency (19.6% in CD vs. 4.6% in UC;

Table 2. Comparison of biochemical parameters in patients with ulcerative colitis and Crohn's disease

Biochemical parameter	Ulcerative colitis (n=65) n (%)	Crohn's disease (n=56) n (%)	p
Elevated CRP (>49.2 nmol/L)	25 (38.5)	39 (69.6)	0.001*
Elevated ESR	20 (30.8)	25 (44.6)	0.115*
Anemia	17 (26.2)	25 (44.6)	0.033*
Iron deficiency (TSAT<%20)	18 (27.7)	25 (44.6)	0.052*
Low ferritin	13 (20.0)	8 (14.3)	0.408**
Vitamin B12 deficiency	3 (4.6)	11 (19.6)	0.022**
Folate deficiency	1 (1.5)	12 (21.4)	0.001**
Hypoalbuminemia	2 (3.1)	7 (12.5)	0.049***

*, Pearson's Chi-square test; **, Continuity correction; ***, Fisher's exact test. CRP: C-reactive protein; ESR: Erythrocyte sedimentation rate; SD: Standard deviation; TSAT: Transferrin saturation.

Table 3. Association of extraintestinal manifestations with ulcerative colitis and Crohn's disease

Extraintestinal manifestation	Ulcerative colitis (n=65) n (%)	Crohn's disease (n=56) n (%)	p
Hepatobiliary Manifestation	22 (33.8)	19 (33.9)	0.992*
Bone-joint Manifestation	19 (29.2)	16 (28.6)	0.936*
Skin-mucosal Manifestation	16 (24.6)	14 (25.0)	0.961*
Urinary Manifestation	19 (29.2)	5 (8.9)	0.005**
Ocular Manifestation	9 (13.8)	5 (8.9)	0.577**
Cardiovascular Manifestation	11 (16.9)	1 (1.8)	0.006***
≥1 EIM present	38 (58.5)	31 (55.4)	0.731*

*, Pearson's Chi-square Test; **, Continuity correction; ***, Fisher's exact test. EIM: Extraintestinal manifestations.

p=0.010) and folate deficiency (21.4% in CD vs. 1.5% in UC; p<0.001). Furthermore, hypoproteinemia (p=0.049) and hypoalbuminemia (p=0.049) were both significantly more prevalent in CD patients. Differences in elevated ESR, iron deficiency, and low ferritin levels were not statistically significant between the two groups.

EIMs were identified in 69 patients (57.0%). Their distribution was as follows: Hepatobiliary (33.9%), bone-joint (28.9%), skin-mucosal (24.8%), urinary (19.8%), ocular (11.6%), and cardiovascular system (9.9%) (Table 3). Hepatic steatosis represented the most common hepatobiliary manifestation (70.7%), followed by hepatomegaly (17%), cholelithiasis (9.8%), and primary sclerosing cholangitis (2.4%). Among musculoskeletal EIMs, isolated sacroiliitis and osteoporosis were the most frequent (each 28.6%), followed by peripheral spondylarthritis (25.7%) and ankylosing spondylitis (17.1%).

Skin-mucosal manifestations were observed in 30 patients, most commonly psoriasis (30.4%). Aphthous stomatitis was identified as the sole oral involvement in 8 patients (6.6%). Ophthalmic EIMs included uveitis (35.7%) and episcleritis

(21.4%), with all episcleritis cases detected during active CD. Urinary tract involvement was mainly renal calculi (25%). Cardiovascular EIMs consisted of thromboembolic complications in five patients.

Table 4 presents a detailed analysis of EIMs by comparing four distinct patient subgroups: Active UC, Inactive UC, Active CD, and Inactive CD. Accordingly, oral cavity manifestations were significantly linked to disease activity (p=0.018), being most frequent in active states and absent in inactive CD. Both cardiovascular (p=0.032) and urinary (p=0.046) manifestations also showed significant differences, with their prevalence being notably higher in UC patients, compared to CD patients. No significant associations were found for hepatobiliary (p=0.749) or bone-joint (p=0.240) involvement across the four groups. While the overall prevalence of having at least one EIM was high in all subgroups, there was no significant difference between them (p=0.861) (Fig. 1).

Discussion

The European Crohn's and Colitis Organisation emphasizes that EIMs are an essential component of IBD and

Table 4. Association of extraintestinal manifestations with disease activity in ulcerative colitis and Crohn's disease

Extraintestinal manifestation	Active UC (n=34) n (%)	Inactive UC (n=31) n (%)	Active CD (n=28) n (%)	Inactive CD (n=28) n (%)	p
Ocular manifestation	6 (17.6)	3 (9.7)	3 (10.7)	2 (7.1)	0.653
Oral cavity manifestation	3 (8.8)	1 (3.2)	4 (14.3)	0 (0.0)	0.018
Skin-mucosal manifestation	8 (23.5)	5 (16.1)	3 (10.7)	7 (25.0)	0.469*
Urinary manifestation	10 (29.4)	9 (29.0)	2 (7.1)	3 (10.7)	0.046*
Hepatobiliary manifestation	10 (29.4)	12 (38.7)	8 (28.6)	11 (39.3)	0.749*
Cardiovascular manifestation	6 (17.6)	5 (16.1)	1 (3.6)	0 (0.0)	0.032*
Bone-joint manifestation	13 (38.2)	6 (19.4)	6 (21.4)	10 (35.7)	0.240**
≥1 EIM	20 (58.8)	18 (58.1)	15 (53.6)	16 (57.1)	0.861**

*: Fishers' exact Test; **: Pearson's Chi-square Test. UC: Ulcerative colitis; CD: Crohn's disease; EIM: Extraintestinal manifestations.

should be integrated into overall disease management through a multidisciplinary approach.^[6] In line with these recommendations, our study systematically assessed not only intestinal disease activity but also the presence of EIMs. More than half of the patients exhibited at least one EIM, underscoring the clinical relevance of routine and structured EIM screening. No significant association was observed between age or gender and the occurrence of EIMs. Oral cavity involvement was strongly associated with active CD, whereas hepatobiliary manifestations were more

frequently observed during remission in both UC and CD, supporting the concept that each IBD phenotype exhibits a distinct EIM profile.

Venous thromboembolism (VTE) remains one of the most clinically significant EIMs in IBD. A large meta-analysis including more than three million patients reported that individuals with IBD have approximately twice the risk of VTE compared with the general population.^[11] Consistent with these findings, our study demonstrated an increased thrombotic risk, particularly among patients with UC

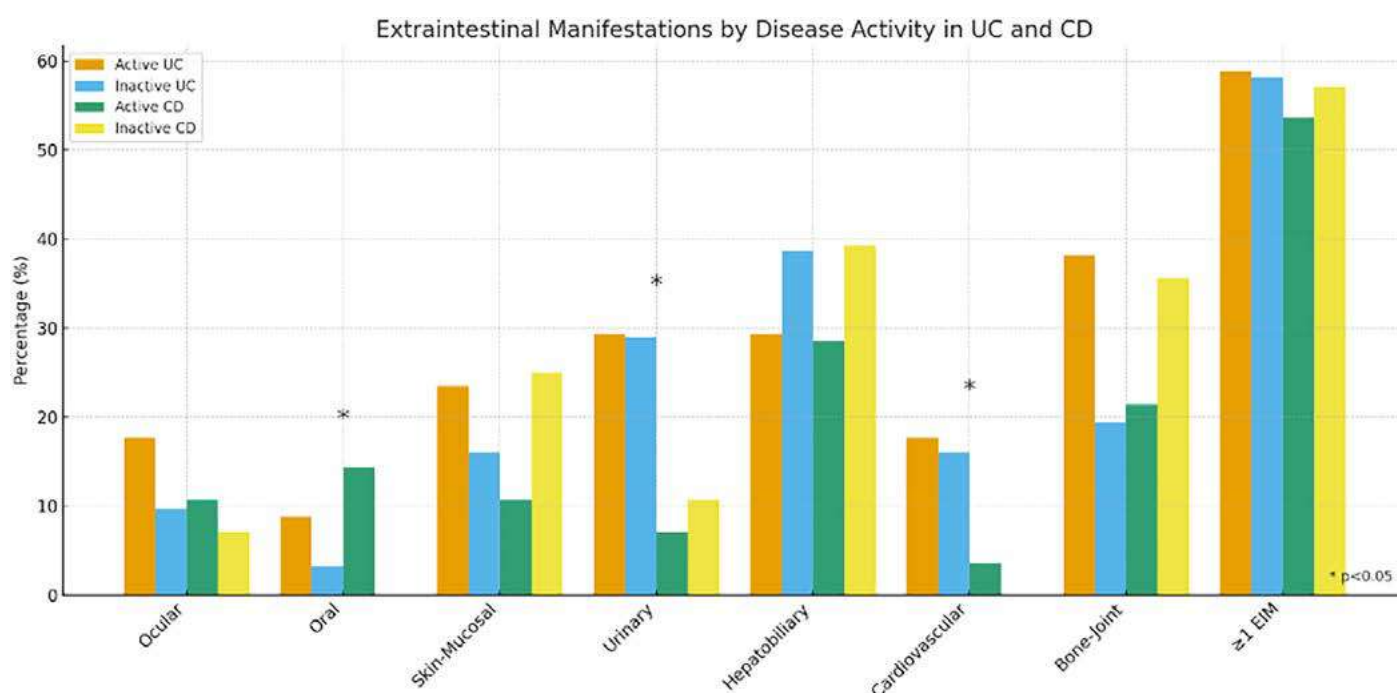


Figure 1. Distribution of extraintestinal manifestations according to disease activity in ulcerative colitis and Crohn's disease. Comparison of extraintestinal manifestations by disease activity in UC and CD. Percentages represent the proportion of patients within each subgroup exhibiting specific extraintestinal manifestations. Asterisks indicate statistically significant differences between active and inactive disease periods (*p<0.05). UC active/inactive and CD active/inactive groups are shown in different bar colors for visual clarity.

UC: Ulcerative colitis; CD: Crohn's disease; EIM: Extraintestinal manifestation.

during active disease. This highlights the importance of careful VTE risk assessment and appropriate prophylactic strategies during disease flares. A population-based Swedish study of 342 IBD patients revealed that the incidence and prevalence of anemia were significantly higher in CD (19.3/100 person-years; prevalence 28.7%) than in UC (12.9/100 person-years; prevalence 16.5%; odds ratio = 1.60; 95% confidence interval: 1.02–2.51).^[12] In our cohort, we similarly observed a higher anemia rate in CD, while most UC patients were in remission, which may explain the difference in anemia frequency. Among hepatobiliary manifestations, hepatic steatosis was the most frequently observed, which is consistent with the reported increased prevalence of non-alcoholic fatty liver disease in patients with IBD.^[13] This association has been attributed to chronic inflammation, metabolic alterations, and treatment-related hepatotoxicity.^[14] However, the absence of a healthy control group in our study limits the ability to fully evaluate the contribution of these environmental and metabolic factors. Musculoskeletal involvement consisted of isolated sacroiliitis, osteoporosis, peripheral spondyloarthritis, and ankylosing spondylitis. In our cohort, peripheral spondyloarthritis was more common in UC, whereas axial manifestations were more prevalent in CD, indicating distinct musculoskeletal phenotypes according to disease subtype. This finding aligns with previous reports suggesting variability in the frequency and pattern of musculoskeletal EIMs in IBD.^[15] The low HLA-B27 positivity observed supports current evidence that IBD-associated spondyloarthritis often develops in HLA-B27-negative patients and may present with a different clinical phenotype.^[16,17]

Skin-mucosal manifestations were detected at rates similar to previous studies, although specific lesions such as erythema nodosum and pyoderma gangrenosum were rarely observed, likely due to the small sample size and predominance of remission in our cohort. Ocular involvement in the form of episcleritis was identified only in active CD, supporting the concept that ocular inflammation is closely related to intestinal inflammatory activity.^[18,19] Among urinary manifestations, nephrolithiasis was the most common finding. Notably, urinary involvement was more frequent in UC, which contrasts with earlier studies. The lack of stone-type analysis may have contributed to this observation and highlights the need for careful metabolic evaluation in IBD patients.^[20,21] Oral cavity manifestations were significantly associated with active CD, consistent with previous evidence. In a large retrospective study including 676 patients with CD, Cagır et al.^[22] reported that

specific oral lesions, including orofacial granulomatosis and cobblestone appearance, were significantly associated with higher disease activity. This finding aligns with our study, in which oral manifestations were more common in patients with active CD. Although pulmonary findings have occasionally been described in patients with IBD, they are rare, non-specific, and are not classified as true EIMs.^[23] Since none of the patients in our cohort presented with respiratory symptoms, pulmonary involvement was not additionally evaluated in this study. Table 4 summarizes the relationship between each EIM and disease activity, demonstrating distinct clinical patterns between UC and CD.

Limitations

This study has several limitations that should be acknowledged. First, it was conducted at a single tertiary center with a relatively small sample size, which may limit the generalizability of the findings. Second, the predominance of patients in remission may have led to an underestimation of certain EIMs, particularly those known to fluctuate with disease activity. Third, the lack of detailed stone composition analysis and the absence of advanced diagnostic modalities for selected EIMs restricted more granular subgroup classification. In addition, the absence of a healthy control group limits the interpretation of hepatobiliary and metabolic abnormalities, as these findings cannot be compared with baseline rates in the general population. Furthermore, given the exploratory nature of the subgroup analyses and the large number of pairwise comparisons performed, the possibility of type I error cannot be excluded. Taken together, these limitations underscore the need for multicenter studies with larger and more diverse cohorts, supported by comprehensive diagnostic evaluations, to better elucidate the complex relationship between disease activity and EIM patterns.

Conclusion

This study demonstrates that EIMs are highly prevalent among patients with IBD, affecting more than half of the cohort. The patterns and systemic distribution of EIMs differed substantially between UC and CD, as well as between active and inactive disease states. Urinary and cardiovascular manifestations were more prominent in UC, whereas oral cavity, musculoskeletal, and ocular manifestations were predominantly associated with CD, especially during periods of active inflammation. These findings highlight that each IBD subtype exhibits a unique EIM profile, underlining the importance of phenotype-specific assessment and surveillance.

The results underscore the necessity of routine, structured, and multidisciplinary evaluation of EIMs as an integral part of IBD management. Incorporating musculoskeletal, hepatobiliary, dermatologic, ocular, and oral examinations into standard clinical follow-up may facilitate earlier detection of clinically meaningful but sometimes subtle manifestations. Early recognition and timely treatment of EIMs can reduce morbidity, improve overall quality of life, and potentially mitigate long-term complications.

Furthermore, the observed relationships between disease activity and certain EIMs – particularly oral cavity and cardiovascular manifestations – suggest that EIMs may serve as useful clinical indicators of systemic inflammatory burden. This relationship warrants closer attention in daily practice and may contribute to more comprehensive disease monitoring strategies.

Given the single-center nature of this study and the absence of a healthy control group, multicenter research involving larger and more diverse populations is needed to confirm these associations and to better delineate the biological mechanisms underlying EIM development in IBD. Future studies integrating advanced imaging, metabolic profiling, and longitudinal follow-up may provide deeper insight into the dynamic interplay between intestinal inflammation and extra-intestinal involvement.

Ethics Committee Approval: The Erciyes University Faculty of Medicine Clinical Research Ethics Committee granted approval for this study (date: 23.09.2020, number: 2020/476).

Informed Consent: Written informed consent was obtained from participants.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: Not declared.

Authorship Contributions: Concept: NSB, GCS; Design: NSB, GCS; Supervision: GCS; Resource: NSB, GCS; Materials: NSB, GCS; Data Collection or Processing: NSB, GCS, EÖS, YÖE, OE, DGS, ASŞ; Analysis or Interpretation: NSB, GCS, ASŞ; Literature Search: ASŞ, GCS; Writing: NSB, GCS; Critical Review: ASŞ, GCS.

Acknowledgments: We sincerely thank the gastroenterology clinic and inpatient ward nurses, as well as the laboratory and administrative staff of Erciyes University Faculty of Medicine, for their valuable assistance and dedication during the study period. We also appreciate the contributions of the rheumatology, dermatology, and ophthalmology specialists who participated in the multidisciplinary evaluations of our patients.

Peer-review: Double blind peer-reviewed.

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ORIGINAL ARTICLE

Renoprotective Influence of Quercetin Administration on Na⁺/K⁺-ATPase Levels and Indicators of Oxidative Stress in Rats with High Sucrose Intake

 Ayça Bilginoğlu Topcu

Department of Biophysics, Ankara Yıldırım Beyazıt University Faculty of Medicine, Ankara, Türkiye

Abstract

Introduction: This study aimed to examine the consequences of high sucrose intake (935 mM sucrose) on the kidney, concentrating on indicators of oxidative stress and renal Na⁺/K⁺-ATPase (NKA) protein level. Antioxidants that act as reducing agents, especially those that can capture reactive oxygen species, are protective effects against metabolic syndrome-induced renal deterioration.

Methods: In this study, we looked into the consequences of quercetin (15 mg/kg/day) administration for 2 weeks following high sucrose intake on plasma blood urea nitrogen, albumin, creatinine, urea, and uric acid levels and oxidative stress status in kidney tissue. We also investigated the possible changes in renal NKA protein levels due to kidney damage induced by high sucrose intake.

Results: High sucrose intake caused increased body weight, hyperinsulinemia, hypertriglyceridemia, insulin resistance, and deterioration of renal properties in rats. It also resulted in increased oxidative stress. However, quercetin administration improved glycemic control, renal function parameters, renal NKA protein levels, and oxidative stress in the kidney.

Discussion and Conclusion: Application of quercetin was found to have a beneficial impact on oxidative stress damage in the kidneys of rats given a diet high in sucrose.

Keywords: Kidney; Metabolic syndrome; Na⁺/K⁺-ATPase; Oxidative stress; Quercetin

Metabolic syndrome (MS), commonly known as insulin resistance syndrome, is characterized by hypertension, hyperglycemia, dyslipidemia, and abdominal obesity, affecting multiple organs, particularly within the cardiorenal system.^[1] Renal dysfunction in MS is believed to result from a combination of atherogenic dyslipidemia, obesity, endothelial dysfunction, hyperglycemia, and activation of vasoconstrictive pathways, mediated in part by systemic

release of glycosylated compounds, reactive oxygen species (ROS), and pro-inflammatory agents such as uric acid.^[2]

MS-induced oxidative stress is a key contributor to kidney injury, primarily through ROS generated from elevated blood glucose and free fatty acids. Impairments in renal function and redox regulation suggest involvement of the myeloperoxidase/hydrogen peroxide axis, likely mediated by lipid peroxidation, with increased plasma levels of malondialdehyde (MDA),

Cite this article as: Bilginoğlu Topcu A. Renoprotective Influence of Quercetin Administration on Na⁺/K⁺-ATPase Levels and Indicators of Oxidative Stress in Rats with High Sucrose Intake. Lokman Hekim Health Sci 2026;6(3):506–514.

Correspondence: Ayça Bilginoğlu Topcu. Ankara Yıldırım Beyazıt Üniversitesi Tıp Fakültesi, Biyofizik Anabilim Dalı, Ankara, Türkiye

E-mail: abilginoglu@aybu.edu.tr **Submitted:** 05.07.2025 **Revised:** 03.02.2026 **Accepted:** 06.02.2026 **Available Online:** 06.08.2026



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hydrogen peroxide, and myeloperoxidase serving as interrelated markers of oxidative damage.^[3]

Na⁺/K⁺-ATPase (NKA) is essential for maintaining renal ion homeostasis and is implicated in both renal and cardiovascular pathophysiology. Diabetes adversely affects renal recovery after ischemia-reperfusion injury, with altered NKA activity linked to tubular proliferation, capillary density, T cell infiltration, and inflammation.^[4] Angiotensin II has been shown to rapidly stimulate NKA activity via Ser938 phosphorylation, promoting its trafficking to the plasma membrane in proximal tubule cells, underscoring its role in renal function and blood pressure regulation.^[5] Moreover, targeting the DR region of NKA ameliorated cardiac hypertrophy and fibrosis in a 5/6 nephrectomy model, suggesting the therapeutic potential of NKA modulation in renal disease-associated cardiac complications.^[6]

Quercetin (3,3',4,5,7-pentahydroxyflavone) is a potent antioxidant flavonoid with recognized benefits for kidney health. In experimental diabetic nephropathy, quercetin protects renal cells from oxidative stress and apoptosis, while its antioxidant, anti-inflammatory, and cytoprotective actions reduce renal inflammation and fibrosis, highlighting its potential as a therapeutic agent in kidney diseases.^[7,8]

Considering that MS-induced oxidative stress impairs renal function and alters NKA expression, we hypothesize that quercetin supplementation may attenuate oxidative stress and restore NKA protein levels in the kidneys of high-sucrose-fed rats. By scavenging ROS, modulating adipokine signaling, and improving renal functional markers, quercetin is expected to exert renoprotective effects, offering insight into its potential to preserve renal homeostasis in MS.^[1,10]

Materials and Methods

Ethical Statement

This study was approved by the Ankara University Faculty of Medicine Animal Experiments Local Ethics Committee (2015-2-37). The study was conducted in accordance with the Declaration of Helsinki.

Study Design and Study Groups

The rats were randomly assigned to four experimental groups, as described below:

1. Control group (C, n=8): Rats received standard chow and water throughout the 20-week study period and were administered corn oil through gavage during the final 2 weeks to serve as a vehicle control for the quercetin-treated groups

2. High-sucrose-fed group (HSF, n=8): Rats were given 935 mM ($\approx 32\%$ w/v)^[11] sucrose in drinking water for 20 weeks to induce metabolic stress and received corn oil via gavage during the final 2 weeks as a vehicle control.
3. Control group treated with quercetin (Q, n=8): Rats received standard chow and water, and were administered quercetin dissolved in corn oil at 15 mg/kg/day via gavage during the final 2 weeks (Sigma-Aldrich, Missouri, USA).
4. Quercetin-treated high-sucrose-fed group (HS-Q, n=8): Rats received 935 mM ($\approx 32\%$ w/v) sucrose in drinking water for 20 weeks and were administered quercetin (15 mg/kg/day in corn oil) through gavage during the final 2 weeks.

The quercetin administration period was determined based on durations commonly used in the literature^[12] and on considering the potential effects of extended treatment on animal aging and the measured parameters. Both the C and HSF groups received corn oil through gavage to serve as appropriate procedural controls. Randomization was performed using numbers generated in Microsoft Excel.

Laboratory Animals and Care

Male Wistar Albino rats, 3 months old and weighing between 200 and 250 g, were utilized in the study. They were maintained under controlled conditions, including a 12-h light/dark cycle, a temperature of $24^{\circ}\text{C} \pm 2^{\circ}\text{C}$, and 35–60% humidity. The rats were provided with standard laboratory feed and had ad libitum access to water.

Laboratory Investigations

Measurement of Biochemical Parameters

The body weights of the rats were recorded weekly to monitor any changes. Following an overnight fast, fasting blood glucose (FBG) levels were measured in each experimental group every week throughout the study period. FBG was determined by collecting blood samples from the tail vein using a standard glucometer (ACCU-CHEK Performa Nano). At the end of the experimental period, insulin and triglyceride levels were measured in blood samples collected from the experimental groups using commercial kits (Cayman). The homeostatic model assessment of insulin resistance (HOMA-IR) was calculated using the formula: $\text{HOMA-IR} = (\text{FBG [mmol/L]} \times \text{fasting insulin [mU/L]}) / 22.5$. The HOMA- β index was determined using the formula: $\text{HOMA-}\beta = (\times 20 \text{ fasting insulin [mU/L]} / (\text{fasting glucose [mmol/L]} - 3.5))$.

Measurement of Renal Function Markers in Serum

Serum levels of renal function markers, including uric acid, urea, and creatinine, were determined using the Berthelot reagent method described by Akpotaire and Seriki,^[13] the enzyme colorimetric method by Ran et al.,^[14] and the method of Qin et al.,^[15] respectively. Serum albumin and blood urea nitrogen (BUN) levels were measured using quantitative diagnostic kits (Abcam, Cambridge, MA, USA).

Preparation of Renal Tissue Homogenates

Kidney tissues were homogenized in ice-cold Tris-HCl buffer (20 mM, pH 7.4) containing 150 mM NaCl, 2 mM KCl, 2 mM EDTA, 0.5 mM DTT, ×100 protease inhibitor cocktail, 0.4 mM PMSF, and 2% NP-40 using a Teflon homogenizer. Protein concentrations were quantified by the Bradford method (Bio-Rad), with bovine serum albumin used as the calibration standard.

Assessment of Oxidative Stress Markers in Kidney Tissue

The amount of reduced glutathione (GSH) in kidney tissue homogenates was determined according to the method described by Ellis.^[16] Superoxide dismutase (SOD) activity was measured using an enzymatic assay based on its ability to inhibit the reduction of nitroblue tetrazolium (NBT) by the xanthine–xanthine oxidase system, which generates superoxide radicals. One unit of SOD activity corresponded to 50% inhibition of NBT reduction. MDA levels were determined using the thiobarbituric acid reaction, and the intensity of the resulting pink coloration was measured spectrophotometrically at 532 nm. Total antioxidant status (TAS) and total oxidant status (TOS) were measured using commercial kits (Rel Assay Diagnostics).

Determination of NKA Protein Levels in Renal Tissue Homogenate

NKA protein expression was assessed by Western blotting. Kidney samples containing 20 µg of protein were separated on a 10% sodium dodecyl sulfate-polyacrylamide gel electrophoresis gel and subsequently transferred onto a nitrocellulose membrane. The membranes were incubated with specific primary antibodies against NKA (1:300, Santa Cruz Biotechnology) and β-actin (1:2000, Santa Cruz Biotechnology). After thorough washing, the blots were treated with a goat anti-mouse secondary antibody (1:12,000, Santa Cruz Biotechnology). Immunoreactive protein bands were visualized using an enhanced chemiluminescence (ECL) detection system (ECL; GE

Table 1. Body weights of experimental groups measured at the beginning and end of the experimental period

Parameters/ groups	Body weight (0 day) (g)	Body weight (after 20 weeks) (g)
C (n=8)	224.9±17.0	323.8±20.1
HSF (n=8)	225.8±19.1	422.0±20.1 ^a
Q (n=8)	225.3±13.3	328.4±25.1 ^b
HS-Q (n=8)	224.8±10.6	417.5±19.8 ^{a,c}

Different superscript letters indicate significant pairwise differences ($p < 0.05$): a: Versus C; b: Versus HSF; c: Versus Q. C: Control group, HSF: High sucrose-fed group, Q: Quercetin-treated group, HS-Q: Quercetin-treated high sucrose-fed group. All parameters are expressed as mean±standard deviation. n: Number of animals.

Healthcare Life Sciences, Budapest, Hungary). β-actin was used as an internal reference (loading control) to normalize protein levels. Band intensities were analyzed using ImageJ software (IJ 1.46r).

Statistical Analysis

Statistical analyses were performed using GraphPad Prism version 5.0 (GraphPad Software, Boston, MA, USA). Data are presented as mean±standard deviation. Normality and homogeneity of variances were assessed using the Shapiro–Wilk and Levene's tests, respectively, and all datasets met these assumptions. Comparisons among groups were performed using one-way analysis of variance followed by Bonferroni's post hoc test. Detailed results of these analyses are provided in the Supplementary Material.

Results

Influence of Quercetin on Metabolic Parameters

At the end of the twenty-week experimental period, the HSF group showed weight gain and central obesity compared with controls ($p < 0.001$), while quercetin supplementation partially attenuated weight gain ($p > 0.05$) (Table 1). Adiposity in the HSF group was associated with increased food and water intake. Metabolic parameters, including FBG, insulin, HOMA-IR, and triglycerides, were elevated in the HSF group compared with controls (FBG, insulin, HOMA-IR, TG; all $p < 0.001$). Quercetin administration reduced these elevations, although only TG levels were significantly lower in the HS-Q group compared with HSF ($p < 0.001$). No significant differences were observed between the control and quercetin-only groups (all $p > 0.05$) (Table 2).

Quercetin Ameliorated Renal Parameters in HSF Rats

Renal function parameters are presented in Table 2. The HSF group showed elevated serum urea, uric acid, creatinine, and

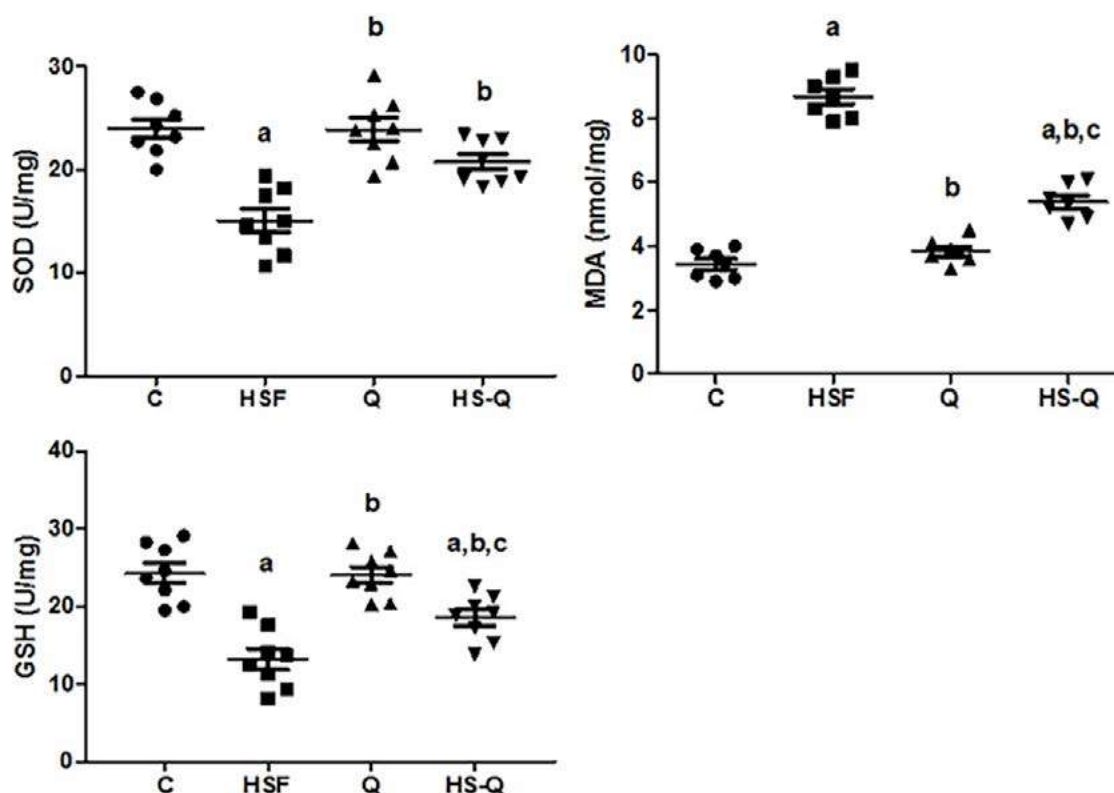
Table 2. Biochemical parameters of the experimental groups

Parameters/groups	C (n=8)	HSF (n=8)	Q (n=8)	HS-Q (n=8)
Urea (mg/dL)	20.1±5.14	49.7±5.26 ^a	21.0±3.82 ^b	32.5±6.07 ^{a,b,c}
Uric acid (mg/dL)	1.44±0.42	4.35±0.48 ^a	1.36±0.40 ^b	1.96±0.26 ^{b,c}
Creatinine (mg/dL)	0.65±0.24	1.54±0.35 ^a	0.59±0.29 ^b	1.05±0.24 ^{b,c}
Albumin (g/dL)	4.5±0.5	2.2±0.4 ^a	4.0±0.5 ^b	3.8±0.7 ^b
BUN (mg/dL)	32.2±6.1	54.1±5.5 ^a	30.7±4.5 ^b	49.7±6.9 ^{a,c}
Blood glucose (mg/dL)	302.3±53.8	435.8±34.1 ^a	3245.0±29.39 ^b	413.3±31.6 ^{a,c}
Insulin (ng/mL)	1.1±0.2	2.9±0.3 ^a	1.0±0.5 ^b	2.2±0.6 ^{a,c}
Triglyceride (mg/dL)	31.8±5.8	65.1±6.9 ^a	33.4±6.2 ^b	45.5±5.4 ^{a,b,c}
HOMA-IR	10.1±3.4	17.7±4.0 ^a	10.7±1.8 ^b	15.0±3.4
HOMA-β	0.52±0.04	0.46±0.03 ^a	0.49±0.04	0.47±0.04

Different superscript letters indicate significant pairwise differences ($p<0.05$): a: Versus C; b: Versus HSF; c: Versus Q. C: Control group; HSF: High sucrose-fed group; Q: Quercetin-treated group; HS-Q: Quercetin-treated high sucrose-fed group; BUN: Blood urea nitrogen; HOMA-IR: Homeostatic model assessment of insulin resistance. All parameters are expressed as mean±standard deviation. n: Number of animals.

BUN levels (all $p<0.001$), while serum albumin was decreased ($p<0.001$) compared with controls. Quercetin treatment attenuated these changes, restoring urea, uric acid, and albumin levels close to control values (all $p<0.001$). Creatinine

and BUN showed decreasing trends after quercetin treatment, although differences with controls were not statistically significant (creatinine, BUN; $p>0.05$). Quercetin alone did not affect basal renal parameters (all $p>0.05$).

**Figure 1.** Oxidative stress parameters measured in the kidney tissues of experimental groups.

The annotation "a" indicates a significant difference compared with the C group at $p<0.05$. The annotation "b" indicates a significant difference compared with the HSF group at $p<0.05$. The annotation "c" indicates a significant difference compared with the Q group at $p<0.05$. SOD: Superoxide dismutase; MDA: Malondialdehyde; GSH: Reduced glutathione; C: Control group; HSF: High sucrose-fed group, which received 935 mM sucrose in drinking water for 20 weeks; Q: Quercetin-treated group, administered 15 mg/kg/day by gavage during the last 2 weeks (Sigma-Aldrich, Missouri, USA); HS-Q: Quercetin-treated high sucrose-fed group, which received 15 mg/kg/day quercetin by gavage during the past 2 weeks.

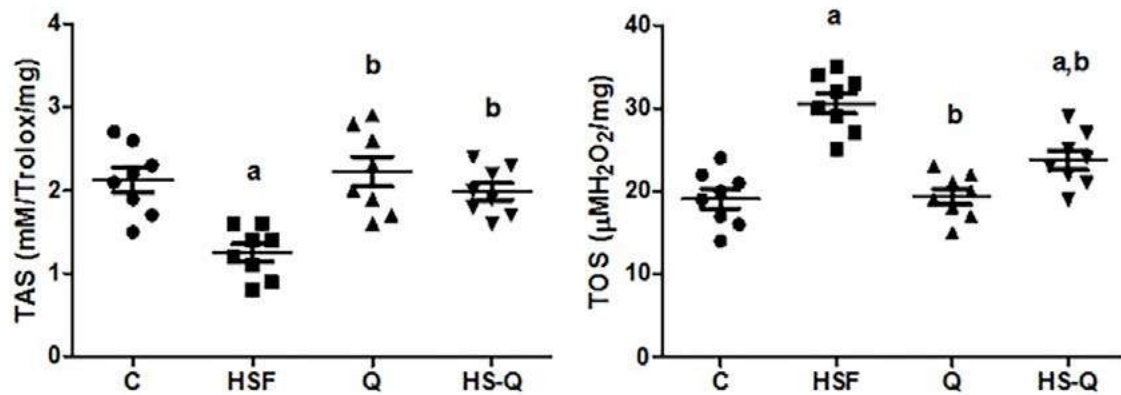


Figure 2. Total antioxidant status level and total oxidant status level measured in kidney tissues of experimental groups.

The annotation "a" indicates a significant difference compared with the C group at $p < 0.05$. The annotation "b" indicates a significant difference compared with the HSF group at $p < 0.05$. The annotation "c" indicates a significant difference compared with the Q group at $p < 0.05$. C: Control group; HSF: High sucrose-fed group, which received 935 mM sucrose in drinking water for 20 weeks; Q: Quercetin-treated group, administered 15 mg/kg/day by gavage during the past 2 weeks (Sigma-Aldrich, Missouri, USA); HS-Q: Quercetin-treated high sucrose-fed group, which received 15 mg/kg/day quercetin by gavage during the past 2 weeks.

Effects of Quercetin on Oxidative Stress Parameters in Renal Tissue

As shown in Figure 1, high-sucrose treatment increased oxidative stress, as indicated by decreased SOD activity and GSH levels ($p < 0.001$), and increased MDA concentrations ($p < 0.001$) compared with controls. Quercetin supplementation partially restored SOD ($p > 0.05$) and GSH ($p > 0.05$) levels and reduced MDA ($p < 0.001$). No significant differences were observed between the control and quercetin-only groups (all $p > 0.05$).

Influence of Quercetin on TAS and TOS Levels in Kidney Tissue

As shown in Figure 2, high-sucrose treatment impaired renal antioxidant defense, as indicated by decreased TAS activity ($p < 0.001$) and increased TOS levels ($p < 0.001$) compared with controls. Quercetin administration partially restored TAS ($p > 0.05$) and reduced TOS ($p < 0.001$). No significant differences were observed between the control and quercetin-only groups (all $p > 0.05$).

High Sucrose Intake Raised Levels of NKA Protein in the Tubules

As shown in Figure 3, high-sucrose treatment increased renal NKA protein levels compared with controls ($p < 0.001$). Quercetin administration partially reduced this elevation ($p > 0.05$), although the difference was not statistically significant. No significant differences were observed between the control and quercetin-only groups ($p > 0.05$).

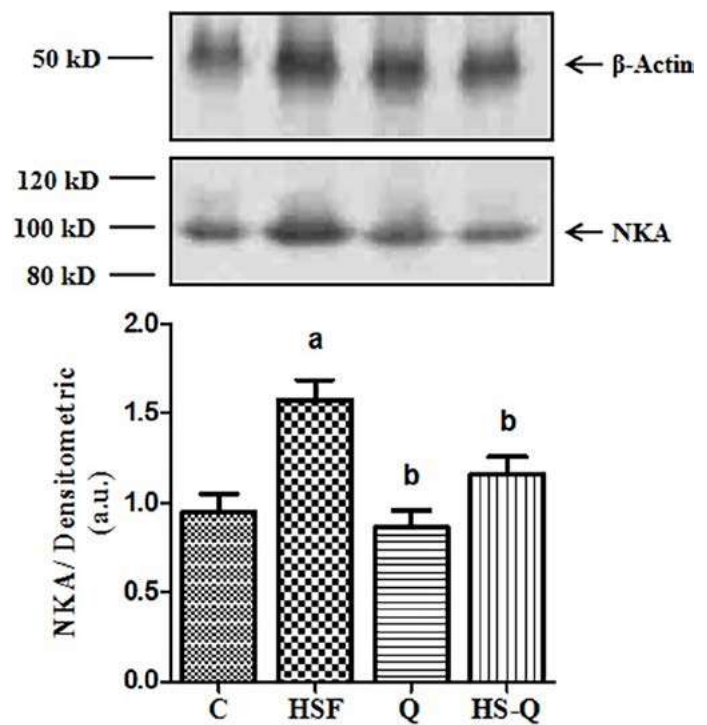


Figure 3. Tubular Na⁺/K⁺ ATPase (NKA) protein levels measured in kidney tissues of experimental groups. Upper figure: Representative examples of western blot analysis. Lower figure: Densitometric analysis of NKA protein levels in kidney homogenates.

The annotation "a" indicates a significant difference compared with the C group at $p < 0.05$. The annotation "b" indicates a significant difference compared with the HSF group at $p < 0.05$. The annotation "c" indicates a significant difference compared with the Q group at $p < 0.05$. Data are presented as mean $\pm$ standard deviation. n: number of animals=8. C: Control group; HSF: High sucrose-fed group, which received 935 mM sucrose in drinking water for 20 weeks; Q: quercetin-treated group, administered 15 mg/kg/day by gavage during the last 2 weeks (Sigma-Aldrich, Missouri, USA); HS-Q: Quercetin-treated high sucrose-fed group, which received 15 mg/kg/day quercetin by gavage during the past 2 weeks.

Discussion

Hyperglycemia, a defining feature of MS as outlined by the National Cholesterol Education Program Adult Treatment Panel III (ATP III), is a key driver of ROS production and oxidative stress.^[17] Elevated ROS disrupts insulin signaling and promotes insulin resistance,^[18] thereby contributing to the pathogenesis and progression of MS and its related complications.^[19] In this context, the present study investigated whether oral quercetin administration could attenuate renal oxidative damage, assessed through oxidative stress markers and NKA protein expression, as well as systemic metabolic parameters, including glucose, insulin, and HOMA-IR levels, in a high-sucrose-induced MS rat model. Furthermore, we examined whether quercetin's potential renoprotective effects are mediated through improvements in local renal parameters, systemic metabolic regulation, or both.

At the end of the experiment, rats receiving the high-sucrose diet exhibited increased body weight, abdominal obesity, insulin resistance, hyperglycemia, and elevated HOMA indices, confirming successful induction of MS. The absence of significant improvement in fasting glucose, insulin, and HOMA-IR following quercetin treatment suggests that the compound exerts limited influence on systemic glycemic control under the present conditions. This lack of systemic effect may relate to the relatively short treatment duration, as extending the quercetin exposure could have introduced confounding, age-related physiological changes in the animals.

Serum urea, uric acid, and creatinine are reliable systemic markers of renal function, with elevated levels reflecting impaired filtration and excretion. Consistent with previous findings that obesity and hyperglycemia cause renal dysfunction,^[20] high sucrose intake in our model increased these parameters. Quercetin supplementation effectively reversed these alterations, indicating a protective effect on renal excretory function. These observations are consistent with prior reports of antioxidant interventions in diabetic nephropathy models. For instance, curcumin treatment in streptozotocin-induced diabetic rats significantly reduced elevated serum urea, uric acid, creatinine, and BUN levels, indicating improved renal excretory function and mitigation of oxidative damage.^[21] Taken together, these results suggest that quercetin can restore kidney function parameters, likely by attenuating hyperglycemia-induced oxidative stress and preserving renal tissue integrity.

MS promotes lipid peroxidation of polyunsaturated fatty acids, leading to the formation of MDA, a key

marker of local oxidative stress. In this study, MDA concentrations were significantly elevated in the kidneys of high-sucrose-fed rats, while quercetin treatment markedly lowered them, indicating effective attenuation of oxidative stress. Similar reductions in renal MDA have been observed with other antioxidant interventions, such as Hibiscus sabdariffa supplementation in MS rats.^[22] The antioxidant effect of quercetin observed here likely reflects its ROS-scavenging ability and capacity to strengthen endogenous antioxidant defenses, thereby preventing lipid peroxidation-mediated injury.

Clinical studies in MS patients have reported diminished antioxidant defenses, reflected by decreased SOD activity and increased protein and lipid oxidation.^[23] Consistent with these findings, we observed that sucrose feeding significantly reduced renal SOD and GSH levels, which serve as local antioxidant parameters, reflecting impaired oxidative balance. Previous studies have also shown that oxidative alterations in diabetes vary depending on the disease stage and cellular compartment. For instance, transient increases in mitochondrial GSH and glutathione peroxidase activity occur during early experimental diabetes as compensatory responses to oxidative stress, before antioxidant systems become depleted.^[24] In contrast, the decline in total renal SOD and GSH observed in our model likely reflects exhaustion of these adaptive mechanisms under prolonged metabolic stress. Notably, the antioxidant effect of quercetin involves reinforcement of endogenous defense pathways and attenuation of oxidative injury in renal tissues.

While clinical interventions, such as SGLT2 inhibitors, have been shown to increase TAS levels without significantly altering TOS, indicating enhanced systemic antioxidant capacity rather than a reduction in oxidant load^[25] our high-sucrose feeding model decreased renal TAS and increased TOS, reflecting a disruption of redox homeostasis and an elevated local oxidative burden. Quercetin supplementation counteracted these changes, further supporting its renoprotective and antioxidant effects against metabolic-stress-induced oxidative injury.

A recently identified mechanism of ROS-mediated tubular injury involves the myo-inositol oxidizing enzyme, expressed in renal tubules and regulated by oxidative stress and hyperglycemia. Its overactivation contributes to tubulointerstitial damage, particularly under obese or diabetic conditions.^[26] Consistent with this mechanism, insulin resistance, abdominal obesity, and hyperglycemia in our model likely contributed to renal oxidative stress and subsequent tubular dysfunction.

In diabetic nephropathy, NKA upregulation has been associated with its mislocalization from the basolateral to apical membranes or into cytoplasmic regions, impairing physiological function despite higher expression.^[27] Thus, the increase observed in sucrose-fed rats may represent a maladaptive, functionally compromised state. Conversely, other studies have reported decreased NKA activity and mRNA expression in diabetic kidneys, both of which were partially restored by quercetin through its antioxidant action.^[28] In fructose-fed rats, quercetin improved ATP-binding affinity but did not fully restore catalytic activity (V_{max}), underscoring oxidative stress-induced structural and kinetic disruption of the enzyme.^[29] Therefore, quercetin's ability to normalize NKA levels in our model may reflect the prevention of pathological overexpression and mislocalization rather than simple downregulation. By mitigating oxidative stress and stabilizing NKA subunits, quercetin may help maintain appropriate enzyme localization and activity, thereby preserving sodium-driven glucose reabsorption and tubular homeostasis under metabolic stress. These findings are consistent with broader evidence of quercetin's renoprotective effects across diverse models of diabetic nephropathy.

Notably, quercetin administration in healthy rats did not significantly alter renal or oxidative parameters, indicating that its beneficial effects are more pronounced under metabolic or oxidative stress conditions.

Our findings indicate that administering 15 mg/kg/day of quercetin via gavage during the final two weeks of a 20-week MS induction in rats represents a short-term therapeutic intervention rather than a chronic treatment. Using body surface area normalization (K_m=6 for rats, K_m=37 for humans), this corresponds to a human equivalent dose of approximately 2.4 mg/kg, which falls within the lower range of doses reported as safe and biologically active in human clinical studies. The short duration was intentionally selected to avoid age-related physiological changes in the rats, which could confound metabolic, oxidative, and inflammatory parameters. While this regimen captures the acute corrective or antioxidant effects of quercetin, translating these findings to human metabolic disorders, such as obesity, insulin resistance, or dyslipidemia, would likely require longer treatment periods, formulations with enhanced bioavailability, or higher daily doses to achieve meaningful clinical outcomes. Furthermore, potential side effects in humans, including gastrointestinal discomfort, headache, or mild interactions with certain medications, should be carefully

considered when designing clinical interventions. These considerations highlight the importance of careful dose selection, treatment duration, and safety monitoring when extrapolating preclinical quercetin data to human applications.

Limitations

The current study has the following limitations: First, urine collection from the experimental groups was not performed, preventing measurement of proteinuria and albuminuria levels; and second, histological examination was not conducted.

Conclusion

Quercetin may enhance antioxidant capacity and provide a protective effect on renal function in rats exposed to high-sucrose diets. This protective effect appears to result from a direct local antioxidant action rather than indirect effects via systemic glycemic control. Rats fed a high-sucrose diet exhibited MS features, including abnormal fat accumulation, reduced insulin sensitivity, elevated triglycerides, and hyperglycemia, all of which were partially ameliorated by quercetin treatment, as reflected in improved renal function tests. By demonstrating renoprotective actions, including reduced oxidative stress and regulation of NKA expression, quercetin shows potential for kidney protection in conditions associated with MS or diet-induced renal stress. From a clinical perspective, these findings provide supportive evidence for exploring quercetin as a therapeutic adjunct; however, further human studies are needed to confirm its efficacy, optimal dosing, and safety profile before any clinical recommendations can be made.

Ethics Committee Approval: The Ankara University Faculty of Medicine Animal Experiments Local Ethics Committee granted approval for this study (date: 11.02.2015, number: 2015-2-37).

Informed Consent: An experimental study, not applicable.

Conflict of Interest: None declared.

Financial Disclosure: This study was supported by TUBITAK-SBAG-115S827 and the Project Office of Ankara Yıldırım Beyazıt University (Project No: 2864).

Use of AI for Writing Assistance: The author declared that artificial intelligence supported technologies were not used in the study.

Acknowledgments: Our sincere thanks go to Dr. Hilal Göktürk and Dr. Makbule Fulya Tutar Selçuk.

Peer-review: Double blind peer-reviewed.

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The Relationship Between Patient Safety Culture in Medication Administration and Nurses' Tendency Toward Medical Errors

 Sümeyye Akçoban¹,  Fatma Aslan²,  İsmail Dusak³

¹Department of Health Services, Hatay Mustafa Kemal University, Kırıkhan Vocational School, Hatay, Türkiye

²Department of Nursing, Hasan Kalyoncu University Faculty of Health Sciences, Gaziantep, Türkiye

³Palliative Care Unit, Şanlıurfa Mehmet Akif İnan Training and Research Hospital, Şanlıurfa, Türkiye

Abstract

Introduction: Medication administration is a critical process in healthcare, directly influencing patient safety. Nurses play a key role in this process and are expected to adopt a strong safety culture.

Methods: This descriptive and correlational study was conducted with 150 nurses working at a training and research hospital between October 15, and November, 1, 2025. Data were collected using "Nurse Demographic Information Form," "Patient Safety Culture Scale in Medication Administration," and "Tendency Towards Medical Errors Scale."

Results: The mean patient safety culture score in medication administration was high (82.06 ± 9.18), while the mean medical error propensity score indicated a low tendency toward errors (230.04 ± 15.08). A statistically significant and positive correlation was found between patient safety culture and medical error propensity scores ($r=0.502$, $p<0.001$). Considering that higher scores on the Medical Error Propensity Scale represent a lower tendency toward medical errors, this finding indicates that a stronger patient safety culture is associated with reduced error propensity. Nurses with longer professional experience demonstrated significantly higher patient safety culture scores, while nurses with postgraduate education demonstrated higher patient safety culture scores and lower self-reported medical error tendencies.

Discussion and Conclusion: Nurses with higher perceptions of patient safety culture tend to be associated with lower tendencies toward medical errors. Organizational strategies that support safety culture, continuous professional education, and balanced workload management may be associated with medical error tendencies and patient care quality.

Keywords: Medical errors; Nursing; Patient safety; Safety management

Medication administration is a fundamental component of patient care and a critical process that directly affects patient safety. Errors occurring in this process not only negatively impact the patient's health but may also lead to ethical, legal, and psychological consequences for

healthcare professionals. As healthcare professionals who play an active role in the medication administration process, nurses hold key positions in ensuring medication safety.^[1,2] The behaviors, values, and approaches exhibited by nurses during this process directly shape the culture of patient

Cite this article as: Akçoban S, Aslan F, Dusak İ. The Relationship Between Patient Safety Culture in Medication Administration and Nurses' Tendency Toward Medical Errors. Lokman Hekim Health Sci 2026;6(3):515–523.

Correspondence: Sümeyye Akçoban. Hatay Mustafa Kemal Üniversitesi, Kırıkhan Meslek Yüksekokulu, Sağlık Hizmetleri Bölümü, Hatay, Türkiye

E-mail: sumeyyea2016@gmail.com **Submitted:** 04.12.2025 **Revised:** 08.01.2026 **Accepted:** 10.02.2026 **Available Online:** 06.08.2026



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safety in medication administration.^[3] This culture refers to an approach that prioritizes safe practices, embraces learning from errors, supports open communication, and adopts system-based solutions.^[3,4] An established safety culture throughout the institution is of great importance, not only in enabling nurses to perform careful, attentive, and informed practices but also in preventing potential errors, encouraging incident reporting, and contributing to systemic improvements.^[5,6] Conversely, the tendency of nurses to commit medical errors is defined as a heightened susceptibility to unintended actions that may result from several contributing factors, such as insufficient knowledge, excessive workload, diminished attention, or physical and mental exhaustion.^[7] The literature demonstrates that a well-established patient safety culture substantially mitigates nurses' propensity for medical errors, whereas insufficient or poorly structured safety practices are associated with an elevated likelihood of errors and consequent patient harm.^[2,8] Therefore, it is important for nurses to internalize a culture of patient safety in medication administration to maintain safe medication practices. Moreover, evaluating nurses' tendency toward medical errors is critical for improving the quality of patient care and ensuring continuity in healthcare services.^[9,10]

A review of the literature reveals that studies have investigated either nurses' tendency toward medical errors or their patient safety culture separately.^[11–13] In a study conducted with nurses working in medical-surgical units, it was found that nurses had a positive perception of the patientsafetyculture.^[11] Another study that examined nurses' patient safety culture and related factors demonstrated that both individual (educational level) and institutional (unit of employment, approach after errors, and working hours) factors significantly influenced nurses' perceptions of patient safety culture.^[13] A previous study investigating nurses' propensity for medical errors reported that this tendency was notably higher among nurses employed in surgical units.^[11] Despite these findings, the literature lacks research specifically exploring how nurses' patient safety culture in medication administration relates to their likelihood of committing medical errors. In this context, the present study sought to examine the association between the patient safety culture in medication administration and nurses' tendency to make medical errors. Accordingly, this study was guided by the following questions:

- What are the levels of patient safety culture exhibited by nurses during medication administration?
- What is the extent of nurses' tendency to commit medical errors?

- Is there an association between nurses' patient safety culture in medication administration and their tendency to make medical errors?

Materials and Methods

Study Type, Place, and Time

The present research employed a descriptive and correlational design and was conducted among nurses working in a training and research hospital between October 15 and November 1, 2025. The study was reported in accordance with the recommendations outlined in the STROBE Statement.^[14]

Population and Sample

The study population consisted of 400 nurses employed at a training and research hospital, and the study sample consisted of 150 nurses actively involved in patient care services. A convenience sampling method was used, and nurses who met the inclusion criteria and agreed to participate were included in the study. Before data collection, an a priori power analysis was conducted using G*Power version 3.1.9.7. A two-tailed Pearson correlation analysis was planned to examine the association between nurses' patient safety culture in medication administration and their tendency toward medical errors. As no previous studies had directly investigated this relationship, Cohen's standardized effect size criteria were used to guide the power calculation.^[15] Accordingly, an anticipated medium effect size ($r=0.30$), an alpha level of 0.05, and a statistical power of 0.80 were used. The minimum required sample size was calculated as 84 participants. To increase statistical precision and account for potentially incomplete questionnaires, 150 nurses were recruited.

Inclusion Criteria

- Nurses who were not on scheduled annual leave,
- Nurses who were actively employed in the hospital during the study period,
- Nurses who voluntarily consented to participate in the research,
- Nurses who had no limitations preventing them from completing the data collection.

Data Collection Tools

The research data were gathered using the measurement instruments outlined below.

Nurse Demographic Information Form

This section, developed based on relevant literature, included 11 items addressing nurses' demographic characteristics, such as age, gender, marital status, professional tenure, and current unit of practice, as well as factors related to medical errors and medication administration.^[3,9,13]

Patient Safety Culture Scale in Medication Administration

The scale, developed by Özen and Çetin (2024) as a tool for evaluating safe medication management,^[3] comprises 14 items organized into three sub-dimensions: Importance (items 1–6), Prevention (items 7–11), and Devotion (items 12–14). The items in the devotion dimension were reverse-scored. Designed as a 7-point Likert-type instrument, the scale assigns scores from 1 to 7, ranging from “strongly disagree” to “strongly agree.” The total possible score ranged from 14 to 98, with higher scores reflecting a more robust patient safety culture in medication administration. In the original validation study, Cronbach's alpha coefficient was reported to be 0.81. In the current study, reliability analyses yielded alpha coefficients of 0.85 for the importance dimension, 0.80 for prevention, 0.87 for devotion, and 0.73 for the overall scale.

Tendency Toward Medical Errors Scale

The scale was developed and validated by Özata and Altunkan in 2010.^[16] It includes 49 items across 5 sub-dimensions that cover routine activities performed by nurses in patient care: Medication and Transfusion Practices (18 items), Hospital Infections (12 items), Patient Monitoring and Material Safety (9 items), Falls (5 items), and Communication (5 items). The scale is of Likert type and is evaluated in 5 categories: “1=never,” “2=very rarely,” “3=sometimes,” “4=usually,” and “5=always.” The scale was evaluated using the mean score, with values ranging from 1 to 5, where 1 represented the lowest and 5 the highest level. Higher mean scores approaching 5 indicate a reduced tendency to commit medical errors, whereas lower scores approaching 1 reflect an increased tendency. The overall scale score ranged from 49 to 245. In the original study by Özata and Altunkan, Cronbach's alpha coefficient was reported as 0.95. In the present study, reliability analyses produced alpha values of 0.91 for the Medication and Transfusion Practices sub-dimension, 0.90 for Hospital Infections, 0.86 for Patient Monitoring and Material Safety, 0.85 for Falls, 0.83 for Communication, and 0.95 for the total scale.

Data Collection

Data for this study were collected through face-to-face survey administration with nurses who voluntarily agreed to participate after obtaining ethical approval and institutional permissions. The data were gathered during the period determined by the researcher through direct interaction with the nurses working at the relevant healthcare institutions. Within the scope of the study, participants were provided with a demographic information form, the “Patient Safety Culture Scale in Medication Administration,” and the “Tendency Towards Medical Errors Scale.” The questionnaire was designed in a clear and comprehensible manner to facilitate participants' responses and was structured to be completed within approximately 10–15 min. During implementation, the researcher provided the necessary guidance and information to ensure that participants responded in line with the principles of confidentiality and anonymity. During the data collection process, the nurses' clinical workload was considered, and appropriate timeframes were selected; participation was based entirely on voluntariness.

Ethical Considerations

Before initiating the research, ethical approval was obtained from the Hatay Mustafa Kemal University Non-Invasive Research Ethics Committee (date: October 8, 2025; decision no: 30). Written authorization was obtained from the institution where the study was conducted. Before data collection, the nurses were informed in detail about the purpose, scope, and procedures of the study, and written informed consent was obtained from all participants. The principles of the Declaration of Helsinki were followed throughout the research process. Furthermore, permission to use the scales utilized in the study was obtained through email from the original authors who conducted Turkish validity and reliability studies.

Data Analysis

Data analysis was performed using the Statistical Package for the Social Sciences 25.0 statistical software package (IBM Corp., Armonk, NY, USA). Descriptive analyses, including frequency, percentage, mean, and standard deviation, were used to summarize the characteristics of the data. We assessed the normality of the distribution based on skewness and kurtosis values, and distributions with values between –1.5 and +1.5 were considered to meet the normality assumption.^[17] For variables that satisfied the normality criteria, independent samples t-tests were

used to compare differences between two groups, while one-way analysis of variance was applied for comparisons involving three or more groups. Correlation analyses were conducted to examine the relationships between the scale scores. All statistical analyses were performed at a 95% confidence level, with statistical significance set at $p < 0.05$.

Results

The nurses included in the study had a mean age of 30.06 ± 4.69 years old. Of the participants, 52.7% were female, and 47.3% were male. Regarding educational status, the highest proportion (88.0%) were bachelor's degree graduates. In terms of professional experience, 48.7% had 1–5 years of work experience. 34% of the nurses worked in internal medicine. Regarding work shifts, 76.7% worked in shifts, while 23.3% worked during daytime hours. Regarding shift length, 71.3% were assigned to 24-h shifts. Of the participants, 95.3% had received in-service training on medication errors, and 85.3% reported that they had never reported a medication error. Furthermore, 58.0% of the respondents expressed concerns about making medical errors (Table 1).

The mean total score of the Patient Safety Culture in Medication Management Scale was 82.06 ± 9.18 . The subdimension mean scores were 36.38 ± 4.34 for the importance subscale, 31.25 ± 3.28 for the prevention subscale, and 14.42 ± 6.44 for the dedication subscale. The mean total score on the medical error propensity scale was 230.04 ± 15.08 . The subdimension mean scores were as follows: Medication and transfusion applications 85.80 ± 5.37 , infection prevention 56.76 ± 4.16 , fall prevention 22.94 ± 2.26 , patient monitoring and material safety 41.33 ± 4.02 , and communication 23.20 ± 2.28 (Table 2).

A statistically significant difference was found in the total score of the Patient Safety Culture in Medication Management Scale according to the number of years of professional experience ($p = 0.012$). The highest mean score was observed in the group with ≥ 16 years of experience (87.20 ± 10.48). A significant difference was also identified based on educational status ($p = 0.010$), with the highest mean score (87.00 ± 9.64) belonging to participants with postgraduate degrees. No statistically significant differences were observed in the subscale scores of importance, prevention, and dedication with respect to gender, years of professional experience, or shift length ($p > 0.05$) (Table 3).

However, a statistically significant difference was found in the total score of the Medical Error Propensity Scale according to educational status ($p = 0.029$), with the highest mean score (238.66 ± 7.09) observed among participants with a postgraduate degree. A significant difference was

Table 1. Descriptive characteristics of nurses (n=150)

Variables	Mean $\pm$ SD (min-max)	
	n	%
Age	30.06 $\pm$ 4.69 (23–47)	
Gender		
Female	79	52.7
Male	71	47.3
Education status		
Secondary education	9	6.0
Associate degree	6	4.0
Bachelor's degree	132	88.0
Graduate degree	3	2.0
Years of professional experience		
1–5 years	73	48.7
6–10 years	50	33.3
11–15 years	17	11.3
16 years and above	10	6.7
Current clinical unit		
Internal medicine units	51	34.0
Surgical units	29	19.3
Intensive care units	49	32.7
Emergency service	21	14.0
Work schedule		
Day shift	35	23.3
Shift work	115	76.7
Shift length		
8 h	35	23.3
16 h	8	5.3
24 h	107	71.3
Received in-service training on medication errors		
Yes	143	95.3
No	7	4.7
Medication error reporting experience (If yes, please answer the next question)		
Yes	22	14.7
No	128	85.3
Experience of sanctions after reporting a medication error		
Yes	16	73.0
No	6	27.0
Concern about making a medical error		
Yes	87	58.0
Sometimes	46	30.7
No	17	11.3

SD: Standard deviation; %: Percentage.

Table 2. Distribution of mean scores of the Patient Safety Culture in Drug Administration Scale and the Medical Error Tendency Scale among nurses (n=150)

Scales	Number of items	Min-max score that can be obtained	Min-max points received	Mean±SD
Patient safety culture scale in medication management				
Importance	6	6–42	19–42	36.38±4.34
Prevention	5	5–35	13–35	31.25±3.28
Devotion	3	3–21	3–21	14.42±6.44
Total points	14	14–98	43–98	82.06±9.18
Tendency towards medical errors scale				
Medication and transfusion practices	18	18–90	66–90	85.80±5.37
Hospital infections	12	12–60	45–60	56.76±4.16
Falls	5	5–25	16–25	22.94±2.26
Patient monitoring and material safety	9	9–45	28–45	41.33±4.02
Communication	5	5–25	14–25	23.20±2.28
Total points	49	49–245	184–245	230.04±15.08

SD: Standard deviation.

Table 3. Comparison of nurses' patient safety culture in drug administration scale scores according to selected variables (n=150)

Patient safety culture scale in medication administration				
Variables	Importance	Prevention	Devotion	Total points
Gender				
Female	36.50±3.94	31.68±2.91	13.96±6.49	82.14±9.21
Male	36.25±4.77	30.77±3.62	14.94±6.40	81.96±9.21
p*	0.723	0.091	0.354	0.741
t**	0.355	1.700	-0.930	-0.332
Years of professional experience (years)				
1–5 ^a	36.27±4.14	31.10±3.45	14.54±6.68	81.93±9.31
6–10 ^b	36.76±4.56	31.44±2.87	14.46±5.95	82.66±8.35
11–15 ^c	34.94±3.88	30.35±3.53	12.58±7.08	77.88±9.09
16 years and above ^d	37.80±5.11	32.90±3.41	16.50±6.11	87.20±10.48
p*	0.342	0.254	0.490	0.012, d>b
F***	1.122	1.370	0.811	4.556
Education status				
Secondary education ^a	33.33±5.12	31.55±2.83	15.33±6.42	80.22±10.32
Associate degree ^b	37.83±3.31	32.33±3.20	14.66±3.98	84.83±4.35
Bachelor's degree ^c	36.53±4.27	31.18±3.34	14.23±6.58	81.95±9.27
Graduate degree ^d	36.00±5.29	31.33±3.21	19.66±2.30	87.00±9.64
p*	0.151	0.258	0.520	0.010 d>a
F***	1.792	0.855	0.757	4.621
Shift length				
8 h	35.25±4.57	30.62±3.76	13.82±6.76	79.71±9.49
16 h	37.50±3.20	32.25±3.28	11.75±6.15	81.50±9.79
24 h	36.67±4.30	31.38±3.11	14.82±6.36	82.87±8.98
p*	0.188	0.341	0.355	0.206
F***	1.693	1.083	1.042	1.595

* p: (p<0.05); **t: Independent t-test; ***F: One Way analysis of variance Test; a, b, c, d: Bonferroni Test statistics.

Table 4. Comparison of nurses' Tendency Towards Medical Errors Scale scores according to some variables (n=150)

Tendency towards medical errors scale						
Variables	Medication and transfusion practices	Hospital infections	Falls	Patient monitoring and material safety	Communication	Total points
Gender						
Female	86.15±4.91	56.50±4.39	22.77±2.50	41.12±4.51	23.10±2.57	229.65±16.20
Male	85.42±5.86	57.04±3.90	23.14±1.97	41.56±3.42	23.30±1.93	230.47±13.84
p*	0.409	0.433	0.322	0.509	0.578	0.741
t**	0.828	-0.786	-0.993	-0.662	-0.558	-0.332
Years of professional experience (years)						
1–5	85.05±5.60	56.50±4.10	22.86±2.41	40.91±4.46	22.91±2.52	228.28±15.48
6–10	86.44±5.18	57.34±3.88	23.14±2.04	42.12±3.31	23.68±1.83	232.72±14.00
11–15 years	85.47±5.30	55.76±4.61	22.05±2.27	40.05±3.66	22.41±2.34	225.76±15.42
16 years and above	88.50±4.08	57.40±5.23	24.10±1.91	42.60±3.94	24.20±1.75	236.80±14.51
p*	0.205	0.489	0.129	0.146	0.062	0.114
F***	1.547	0.813	1.917	1.821	2.499	2.018
Education status						
Secondary education ^a	87.66±3.50	57.00±4.21	23.55±1.94	40.44±3.16	23.22±1.85	231.88±9.31
Associate degree ^b	84.66±6.18	57.50±3.33	23.16±1.94	40.66±4.50	23.16±2.56	230.83±14.52
Bachelor's degree ^c	85.63±5.47	56.63±4.23	22.85±2.31	41.36±4.12	23.19±2.30	229.68±15.58
Graduate degree ^d	90.00±0.00	60.00±0.00	24.66±0.57	42.33±3.20	23.33±2.88	238.66±7.09
p*	0.350	0.546	0.457	0.829	1.000	0.029 d>b
F***	1.103	0.713	0.877	0.295	0.004	3.756
Shift length						
8 h ^a	85.14±4.92	54.97±4.69	22.14±2.82	40.08±5.36	22.62±3.00	224.97±17.68
16 h ^b	87.37±4.06	56.75±4.36	22.37±2.38	42.12±3.39	22.75±2.37	231.37±13.41
24 h ^c	85.90±5.60	57.34±3.82	23.25±1.99	41.68±3.48	23.42±1.97	231.60±14.02
p*	0.538	0.013 c>b	0.032 c>a	0.107	0.174	0.030 c>a
F***	0.622	4.489	3.535	2.273	1.771	3.640

*p: (p<0.05); **: Independent t-test; *** F: One Way analysis of variance Test, a, b, c, d: Bonferroni Test statistics.

also detected in the shift length (p=0.030). Furthermore, statistically significant differences were identified in the subscales of infection prevention (p=0.013) and fall prevention (p=0.032), with the highest mean scores in both subscales belonging to nurses working 24-h shifts. No statistically significant differences were found in the total or subscale scores based on sex or years of professional experience (p>0.05) (Table 4).

A statistically significant positive correlation was found between the total score of the Patient Safety Culture in Medication Administration Scale and the total score of the medical error propensity scale (r=0.502, p<0.001). Considering that higher scores on the medical error propensity scale indicate a lower tendency toward medical

errors, this finding suggests that a stronger patient safety culture is associated with reduced error propensity. At the subscale level, the Importance dimension showed significant positive correlations with medication and transfusion practices (r=0.321, p<0.001), infection prevention (r=0.319, p<0.001), fall prevention (r=0.335, p<0.001), patient monitoring and material safety (r=0.445, p<0.001), and communication (r=0.389, p<0.001). The Prevention dimension also demonstrated significant positive correlations with medication and transfusion practices (r=0.430, p<0.001), infection prevention (r=0.455, p<0.001), fall prevention (r=0.396, p<0.001), patient monitoring and material safety (r=0.514, p<0.001), and communication (r=0.458, p<0.001). In contrast, the

Table 5. The relationship between nurses' patient safety culture in drug administration scale scores and medical error tendency scale scores (n=150)

Tendency towards medical errors scale sub-dimensions and total scores						
PSCS-MM and sub-dimensions total score	Medication and transfusion practices	Hospital Infections	Falls	Patient monitoring and material safety	Communication	Total points
Importance						
r	0.321	0.319	0.335	0.445	0.389	0.460
p	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Prevention						
r	0.430	0.455	0.396	0.514	0.458	0.553
p	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Devotion						
r	0.187	0.206	0.134	0.034	0.068	0.110
p	0.022**	0.011**	0.103	0.683	0.409	0.182
Total Points						
r	0.466	0.478	0.430	0.408	0.407	0.502
p	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*

r=Pearson correlation; *: p<0.001; **: p<0.05. PSCS-MM: Patient safety culture scale in medication management.

Devotion dimension was significantly correlated only with medication and transfusion practices ($r=0.187$, $p=0.022$) and infection prevention ($r=0.206$, $p=0.011$) (Table 5).

Discussion

In this study, nurses demonstrated positive attitudes toward safe medication practices, as reflected by scores above the scale average, which may be attributed to ongoing professional education, institutional emphasis on patient safety, and the accumulation of clinical experience. Consistent with our findings, Özen and Çetin^[3] (2024) also reported that nurses exhibited positive attitudes toward safe medication practices. Similarly, in a study conducted by Aydınli and Cerit^[18] (2024) to assess medication safety competency levels among nurses in Türkiye, a high level of medication safety competency was identified, and it was emphasized that this competency was directly related to safety culture. The findings of the present study indicate that nurses have a high perception of safety culture in medication administration processes, consistent with similar results in the existing literature.

In contrast, this study found that nurses with 16 or more years of professional experience and those with postgraduate education had significantly higher patient safety culture scores. Similar findings have been reported in the literature. In their study on medication safety competence, Jung and Park^[19] (2025) observed that senior nurses demonstrated improvements in their perceptions

and attitudes toward medication safety as their years of experience increased. Moreover, a systematic review conducted by Zaitoun et al.^[20] (2023) indicated that nurses with advanced professional experience and academic education had stronger perceptions of medication safety culture, and that organizational support and continuous education reinforced this relationship. These findings suggest that the culture of patient safety in medication management is strengthened by clinical experience and higher educational attainment, likely because experienced and well-educated nurses are more aware of potential risks and adhere more rigorously to safe practices. In particular, the higher scores observed among nurses with 16 or more years of experience and those with postgraduate education indicate that experience and academic advancement are closely associated with safer medication practices.

In this study, nurses demonstrated a low propensity for medical errors. Moreover, nurses with postgraduate education and those working extended shifts exhibited significantly lower tendencies toward errors. Similarly, a previous study reported that nurses' likelihood of committing medical errors was low, with factors such as age, years of experience, and shift type influencing this tendency.^[21] İşçi and Altuntaş^[22] found that nurses with higher levels of professionalism had a significantly lower likelihood of making errors, emphasizing the role of educational background. Furthermore, a study conducted among intensive care nurses showed that attitudes toward medical errors and

error reporting were associated with several individual and professional characteristics, including age, clinical position, job satisfaction, and participation in relevant training programs.^[23] These findings suggest that educational and professional characteristics may be associated with nurses' self-reported tendency toward medical errors. However, the findings related to shift length should be interpreted cautiously and should not be considered evidence that longer shifts improve patient safety.

The study found that a stronger patient safety culture in medication management was associated with a lower propensity for medical errors. This finding is consistent with previous evidence indicating that stronger patient safety culture is associated with safer clinical practices and fewer adverse events, including medication-related events.^[4,8] Accordingly, nurses' adherence to safe medication practices and their reduced likelihood of committing errors appear closely linked to a well-established safety culture, which may foster vigilance, accountability, and consistent application of safety protocols. Institutional support aimed at strengthening safety culture may therefore help reduce medical errors and improve patient care quality.

Limitations

First, this study was conducted with nurses working in a single hospital, which limits the generalizability of the findings. The use of self-reported data based on participants' statements introduces the possibility that their responses may have been influenced by social desirability bias. External factors, such as environmental conditions and workload during the administration of the scales, also represent potential limitations that may have influenced the participants' responses.

Conclusion

The findings of this study indicate that nurses demonstrated a strong patient safety culture in medication management and exhibited a relatively low tendency to commit medical errors. A statistically significant positive association was observed between patient safety culture and Medical Error Propensity Scale scores, suggesting that a stronger safety culture is associated with safer medication practices and a lower error propensity. Clinical experience and higher academic education levels were found to be associated with this relationship. These results have important implications: in nursing education, integrating patient safety principles and promoting practical training can enhance safety awareness; in health policy, institutional strategies and continuous professional development programs can

reinforce a culture of safety; and in clinical nursing practice, fostering adherence to safe medication procedures can directly reduce medical errors and improve patient care quality. Initiatives by healthcare institutions aimed at reinforcing patient safety culture may therefore play a critical role in enhancing patient safety across these domains.

Ethics Committee Approval: The Hatay Mustafa Kemal University Non-Invasive Research Ethics Committee granted approval for this study (date: 08.10.2025, number: 30).

Informed Consent: Written informed consent was obtained from all participants.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: Artificial intelligence supported technologies were not used in this study.

Authorship Contributions: Concept: SA; Design: SA, FA, İD; Supervision: SA, FA, İD; Data Collection or Processing: SA, İD; Analysis or Interpretation: SA; Literature Search: SA, FA, İD; Writing: SA, FA, İD; Critical Review: SA, FA, İD.

Acknowledgments: We would like to thank all the nurses who participated in our study.

Peer-review: Double blind peer-reviewed.

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Parental Perception Versus Orthodontic Assessment of Early Treatment Needs in Pediatric Patients

 Roa Ahmed Ghanem¹,  Göksu Trakyalı²

¹Department of Orthodontics, Yeni Yüzyıl University Faculty of Dentistry, İstanbul, Türkiye

²Department of Orthodontics, İstanbul Nişantaşı University Faculty of Dentistry, İstanbul, Türkiye

Abstract

Introduction: Malocclusion is among the most common oral health problems in children, with potential effects on function, esthetics, and psychosocial well-being. Early orthodontic intervention can mitigate these consequences; however, parental awareness is critical in recognizing the need for treatment. This study aimed to compare parents' perception of their children's orthodontic treatment needs with professional assessment and to evaluate the prevalence of malocclusion in children.

Methods: A cross-sectional study was conducted on children aged 8–12 years and both of their parents attended the pedodontics clinic. Parents completed a 19-item questionnaire based on the esthetic component of the index of orthodontic treatment need (IOTN). Children were clinically examined by an orthodontist using IOTN and Angle's classification. Data were analyzed using Statistical Package for the Social Sciences v26 with Chi-square tests and correlation analysis. Associations between parental perception and professional assessment were analyzed using Pearson's Chi-square or Fisher's exact tests, as appropriate. Effect sizes were calculated using Phi coefficient or Cramer's V. Statistical significance was set at $p < 0.05$.

Results: The study included 298 children. The most prevalent malocclusion was Angle Class II (55%), followed by Class I (37.5%) and Class III (7.7%). More than half of the parents (51.3%) were unaware of early orthodontic treatment needs. A strong association was found between fathers' education level and correct estimation of children's dental appearance ($p < 0.001$, Cramer's $V = 0.555$). Mothers with higher education were significantly more accurate in assessing malocclusion ($p < 0.001$, Cramer's $V = 0.515$). Overall, parents' ability to correctly identify their child's malocclusion was limited.

Discussion and Conclusion: Parental awareness regarding children's malocclusion and the need for early orthodontic treatment was insufficient. Professional evaluation revealed that Class II malocclusion was the most prevalent type. Educational interventions targeting parents may improve awareness and timely orthodontic care.

Keywords: Awareness; Early orthodontics; Malocclusion; Parents' perception; Prevalence; Treatment need

Malocclusion is one of the most prevalent oral health problems after dental decay and periodontal disease, affecting both function and esthetics. It is defined as any deviation from normal occlusion, such as crowding, spacing,

or abnormal relationships between the jaws. Malocclusion may contribute to periodontal complications, impaired mastication and speech, increased risk of trauma, and psychosocial problems. A pleasing smile and harmonious

Cite this article as: Ghanem RA, Trakyalı G. Parental Perception Versus Orthodontic Assessment of Early Treatment Needs in Pediatric Patients. Lokman Hekim Health Sci 2026;6(3):524–530.

Correspondence: Göksu Trakyalı. İstanbul Nişantaşı Üniversitesi Diş Hekimliği Fakültesi, Ortodonti Anabilim Dalı, İstanbul, Türkiye

E-mail: goksu.trakyalı@nisantasi.edu.tr **Submitted:** 09.09.2025 **Revised:** 07.02.2026 **Accepted:** 10.02.2026 **Available Online:** 06.08.2026



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dentition, on the other hand, are closely linked with self-confidence and social acceptance, particularly during childhood and adolescence.^[1]

The etiology of malocclusion is multifactorial, involving genetic predisposition, environmental influences, deleterious oral habits such as thumb sucking, and developmental anomalies.^[2] Early identification and management are therefore essential to minimize complications. Interceptive orthodontic treatment during the mixed dentition stage has been shown to reduce the severity of developing malocclusions, create space for erupting permanent teeth, and improve oral health outcomes.^[3,4] For this reason, the American Association of Orthodontists recommends orthodontic evaluation by the age of seven.

To guide clinical decision-making and public health policies, various indices have been developed to measure orthodontic treatment needs. Among them, the index of orthodontic treatment need (IOTN) is one of the most widely used and validated tools. It comprises two components: The dental health component (DHC), which reflects the professional evaluation of treatment need, and the esthetic component (AC), which reflects the subjective perception of dental appearance.^[5] These indices are widely employed in epidemiological surveys and clinical research to provide objective criteria for treatment priority.^[6]

While professional evaluation is essential, the role of parents is central in initiating orthodontic treatment for children. Parents act as the primary decision-makers seeking care, and their awareness, attitudes, and socioeconomic status strongly influence treatment uptake. Several studies have demonstrated that parents may underestimate or fail to recognize their children's malocclusion, delaying timely intervention, and increasing the risk of more complex treatment in adolescence.^[7,8] Conversely, higher parental education levels have been associated with greater accuracy in identifying malocclusion and willingness to pursue orthodontic treatment.^[9]

Despite the importance of parental awareness, limited data exist in Turkey regarding how accurately parents perceive their children's orthodontic needs compared with professional assessment. Addressing this knowledge gap is crucial for improving preventive strategies, promoting timely orthodontic care, and informing public health policies.

This study aimed to (1) determine the prevalence of malocclusion among children aged 8–12 years, (2) evaluate parents' awareness and perception regarding their children's orthodontic treatment needs, and (3) compare parental assessments with professional evaluations using the IOTN.

Materials and Methods

Study Sample and Design

This cross-sectional study was conducted after receiving ethical approval from the Ethical Committee of Istanbul Yeni Yüzyıl University (Date: 06.07.2021, Decision: 2021/07/-695), and written informed consent was provided by all parents.

The sample size was determined using G*Power 3, which indicated a minimum of 210 participants to achieve adequate statistical power. However, the study sample, composed of 300 children aged 8–12 years and their parents, was obtained using convenience sampling from children attending routine dental visits at a single university clinic, and the power analysis was not intended to imply population representativeness. Two patients and their parents were excluded from the study due to incomplete questionnaires.

Exclusion criteria were age outside the 8–12 range or ongoing orthodontic treatment. Both parents completed a 19-item questionnaire adapted from previous studies^[10,11] as shown in Table 1. The first section gathered demographic data, while the second evaluated awareness of orthodontic treatment needs, oral habits, and esthetics. Parents were also asked to select the photograph that best matched their child's dentition from AC (Fig. 1) of the IOTN described by Brook and Shaw^[5] and modified by Richmond in 1990.^[12]

Children underwent intraoral examinations by a calibrated orthodontist under natural light. Evaluations were performed according to both the AC and DHC (Table 2)^[5] of the IOTN. The examiner also evaluated malocclusion according to Angle's Classification of Malocclusion.

This study was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis

Data were analyzed using Statistical Package for the Social Sciences version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated. Associations between categorical variables were evaluated using Pearson's Chi-square test. When expected cell counts were insufficient (i.e., cells with expected frequencies <5), Fisher's exact test was applied. Effect sizes for categorical comparisons were calculated using the Phi coefficient (ϕ) or Cramer's V, as appropriate for table dimensions. These effect size measures were used to quantify the strength of associations rather than correlation. Statistical significance was set at $p < 0.05$.

Table 1. Questionnaire used for this study

Section A										
Q1	Parent's Name and Surname:									
Q2	Child's Name and Surname:									
Q3	Address:									
Q4	Age of your child									
Q5	Father's level of education									
	()Primary school	()High school	()Bachelor degree	()Master degree	()Other					
Q6	Mother's level of education									
	()Primary school	()High school	()Bachelor degree	()Master degree	()Other					
Section B										
Q8	Do you observe any protrusion or forward inclination of your child's teeth?									
	()YES	()NO								
Q9	Do you think your child is interested in or desires to undergo orthodontic treatment?									
	()YES	()NO								
Q10	Which of the following reasons do you think applies to why your child should not undergo orthodontic treatment?									
	()My child is not concerned about the appearance of their teeth.									
	()My child has difficulty keeping their teeth clean.									
	()My child has difficulty coping with long and complex treatments.									
Q11	Have you heard about orthodontic treatment before?									
	()YES	()NO								
Q12	Do you think orthodontic treatment is costly?									
	()YES	()NO								
Q13	Do you think thumb sucking has an effect on the position of the front teeth?									
	()YES	()NO								
Q14	Have you seen anyone wearing braces?									
	()YES	()NO								
Q15	Have you ever undergone orthodontic treatment yourself?									
	()YES	()NO								
Q16	Has anyone ever advised you to have your child's teeth aligned?									
	()YES	()NO								
Q17	Are you aware that certain oral habits can be corrected through orthodontic treatment?									
	()YES	()NO								
Q18	Are you aware that teeth alignment can affect facial appearance?									
	()YES	()NO								
Q19	Select the number of the photo (AC component of IOTN) that most closely resembles your child's teeth appearance.									
	()1	()2	()3	()4	()5	()6	()7	()8	()9	()10

Results

At the beginning, 300 children and their parents were asked to fill in the questionnaires, but as parents of two children did not fill in the questionnaires as described, they were excluded from the study sample. The study sample was completed with 298 children and their parents.

Based on Angle's molar classification, the most prevalent malocclusion was Class II (55.0%), followed by Class I (37.5%) and Class III (7.7%). According to the IOTN, a considerable proportion of children demonstrated orthodontic treatment need.

Parental awareness was generally low: 51.3% of parents reported no knowledge of early orthodontic treatment,

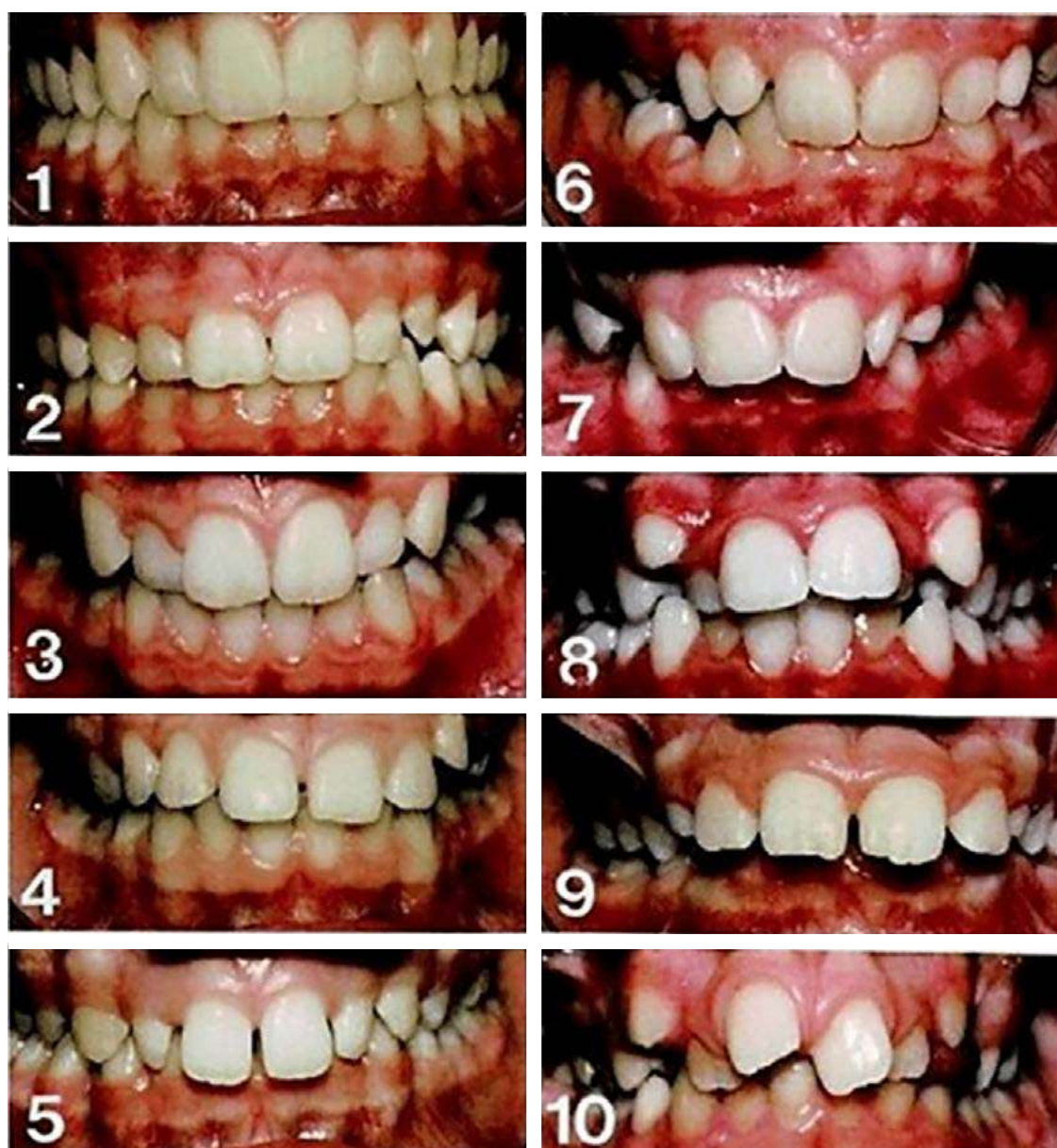


Figure 1. The esthetic component of the index of orthodontic treatment need (scale 1–10). 1–4: Little or no treatment need; 5–7: Borderline treatment need; 8–10: Great treatment need.

and fewer than half (48.7%) correctly matched their child's occlusion with the IOTN AC. Associations between parental perception and professional assessment were evaluated using Chi-square-based analyses, and effect sizes were interpreted using the Phi coefficient or Cramer's V.

Child's gender ($p=0.294$) and age ($p=0.199$) were not significantly associated with parental accuracy. A strong association was found between fathers' education level and accuracy of assessment ($p<0.001$, Cramer's $V=0.555$). Similarly, mothers with higher education were significantly more accurate in evaluating their child's occlusion ($p<0.001$, Cramer's $V=0.515$) (Table 3).

When considering both parents' accuracy, fathers were overall more accurate than mothers (57.3% vs. 43.2%, $p=0.017$, $r=0.138$) (Table 4).

According to the questionnaires, 54.4% of parents had heard of orthodontic treatment before, and they were correlated with significantly higher correct guessing (70.4%) than those who had not heard of it before (22.8%) ($p<0.001$, $r=0.474$) (Table 5).

Discussion

This study demonstrated that Class II malocclusion was the most common type among children in the study sample,

Table 2. The dental health component of the index of orthodontic treatment need (IOTN) (scale 1–5) reproduced from.^[12]

	M	O	C	D	O
IOTN 5	Cleft lip & Palate Impacted / Ectopic teeth Hypodontia >4 missing teeth	> 9mm Overjet > -3.5mm reverse Overjet			
IOTN 4	Supernumeraries Hypodontia <4 missing teeth	> 6mm Overjet -2mm to -3.5mm reverse Overjet	Crossbite with >2mm displacement between RCP and ICP	> 4mm contact point displacement	Deep Overbite + Trauma >4mm Anterior Open Bite
IOTN 3		> 4mm Overjet <-2mm reverse Overjet	Crossbite with >1mm displacement between RCP and ICP	<4mm contact point displacement	Deep Overbite (no trauma) <4mm Anterior Open Bite
IOTN 2		>2mm Overjet		<2mm contact point displacement	
IOTN 1				Minimal irregularity	

IOTN 1: Almost perfection (no treatment need); IOTN 2: Minor irregularities (little treatment need); IOTN 3: Greater irregularities which normally do not need treatment for health reasons (borderline treatment need); IOTN 4: More severe degrees of irregularity and these do require treatment for health reasons (treatment need); IOTN 5: Severe dental health problems (very great treatment need).

Table 3. A comparison of how accurately both parents assess their child's malocclusion according to their education

Education level	Father's education n (%)	NC n (%)	C n (%)	Mother's education n (%)	NC n (%)	C n (%)
Primary school	18 (6.1)	17 (94.4)	1 (5.6)	47 (15.8)	42 (89.4)	5 (10.6)
Middle school	16 (5.4)	14 (87.5)	2 (12.5)	31 (10.4)	22 (71)	9 (29)
Secondary school	147 (49.5)	102 (69.4)	45 (30.6)	119 (39.9)	70 (58.8)	49 (41.2)
Bachelor's degree	105 (35.4)	18 (17.1)	87 (82.9)	95 (31.9)	18 (18.9)	77 (81.1)
Master's degree	12 (4)	3 (25)	9 (81.8)	6 (2)	0 (0)	6 (100)
Total	298 (100)	154 (51.5)	144 (48.5)	298 (100)	152 (51)	146 (48.7)

NC: Not accurate evaluation of a child's orthodontic treatment need; df: degree of freedom; C: Accurate evaluation of a child's orthodontic treatment need. Pearson's Chi-square test was used for comparisons with adequate expected cell counts; $\chi^2=18.42$, $df=4$; Fisher's exact test was applied for education categories with small, expected frequencies <5. Effect size: Cramer's V. Father's education: $p<0.001$, Cramer's V=0.555. Mother's education: $p<0.001$, Cramer's V=0.515.

Table 4. A comparison of how accurately both parents assess their child's malocclusion

Parent	Total n (%)	NC n (%)	C n (%)	Significance
Father	298 (50)	127 (42.7)	171 (57.3)	$p=0.017$
Mother	298 (50)	169 (56.8)	129 (43.2)	$\varphi=0.138$
Total	596 (100)	296 (51.3)	300 (48.7)	

NC: Not accurate evaluation of a child's orthodontic treatment need; df: degree of freedom; C: Accurate evaluation of a child's orthodontic treatment need. Pearson's chi-square test; $\chi^2=11.84$, $df=1$. Effect size: Phi coefficient ($\varphi=0.138$). Significance: $p=0.017$ ($p<0.05$).

consistent with earlier studies in Turkey and internationally, although prevalence rates vary depending on diagnostic methods and sample characteristics.^[13,14]

In several studies conducted in the same region as the present study, authors indicated a slight to no treatment need in similar age groups.^[15,16] Consistent with the findings

Table 5. Parental perception of their child's dental appearance in relation to prior awareness of orthodontic treatment

Have you heard of orthodontic treatment before?	Total n (%)	NC n (%)	C n (%)	Significance
No	136 (45.6)	105 (77.2)	31 (22.8)	$p<0.001$
Yes	162 (54.4)	48 (29.6)	114 (70.4)	$\varphi=0.474$
Total	298 (100)	153 (51.3)	145 (48.7)	

NC: Not accurate evaluation of a child's orthodontic treatment need, df: degree of freedom; C: Accurate evaluation of a child's orthodontic treatment need. Pearson's Chi-square test; $\chi^2=66.99$, $df=1$. Effect size: Phi coefficient ($\varphi=0.474$). χ^2 test result: $p<0.001$.

of the present study, a recent investigation also reported a statistically significant discrepancy between professional assessments and parental evaluations based on the DHC component of the IOTN.^[17]

In a study demonstrating the relationship between classification of malocclusion and self-perception of the orthodontic treatment need, the IOTN-AC (self-perception) scores, in which children with Class II malocclusion evaluated their dental status according to their own esthetic perceptions, were found to be significantly higher.^[18] Controversially, in the present study, the orthodontic treatment need scores for parents' assessments were significantly lower than the professional scores. Variations between the current findings and those reported in previous studies may stem from differences in participant demographics, including age and ethnic composition, indicating the need for additional investigations to examine these influences more comprehensively.

Parental awareness of orthodontic treatment needs was found to be insufficient, as more than half of the participants lacked knowledge of early intervention, and fewer than half correctly identified their child's malocclusion. This finding aligns with previous studies indicating that parents often underestimate orthodontic problems.^[7,8]

Although the observed associations were statistically significant, the effect sizes indicated a moderate practical impact. These findings suggest that parental education level contributes meaningfully to awareness of orthodontic treatment needs, which may influence the timing of care-seeking behavior, even if it is not the sole determining factor.

Since parents are responsible for initiating treatment, a lack of awareness may lead to delays, which in turn increases treatment complexity. From the age of eight, parents should have their children examined for orthodontic diagnosis every year to detect Class II malocclusions at early ages and start preventive or even orthopedic treatments to prevent more complex orthodontic and skeletal treatments in the future.

Parental education emerged as a significant factor influencing accuracy. Both fathers and mothers with higher education were more likely to correctly assess their child's dental appearance, in agreement with previous research linking socioeconomic status to health awareness.

^[9] Interestingly, fathers demonstrated higher accuracy overall, which may reflect gender differences in health literacy within the study population.

Another aim of the present study was to compare parental assessments with professional evaluations using the IOTN. This comparison was addressed through categorical association analyses based on IOTN-AC classifications, which quantified discrepancies between parental perception and

professional assessment. While formal agreement statistics were not applied, the analyses clearly demonstrated limited concordance between parents and professionals.

These results highlight the need for community-based educational programs and school-based dental health initiatives to improve parental awareness. Earlier recognition of malocclusion can enhance treatment outcomes and reduce complexity and cost.^[3,19]

Strengths of this study include its large sample size and use of validated indices. Although a priori sample size calculation was performed to ensure adequate statistical power, the use of convenience sampling from a single university clinic limits the generalizability of the findings. Therefore, caution is warranted when extrapolating the results to the general population. The cross-sectional design and reliance on parental self-report may also introduce bias. Future multicenter studies are recommended to confirm these findings and to evaluate how parental awareness influences actual treatment-seeking behavior and outcomes. Overall, the evidence supports the incorporation of both educational initiatives and clinical strategies to more effectively address orthodontic needs and enhance oral health outcomes within children and the wider community.

Conclusion

Class II malocclusion was the most prevalent type among children included in the study sample. Parental awareness of orthodontic treatment needs was insufficient, and higher education was associated with greater accuracy in perception. These findings emphasize the importance of parental education to promote early orthodontic evaluation and timely treatment.

Ethics Committee Approval: The Istanbul Yeni Yüzyıl University Ethics Committee granted approval for this study (date: 06.07.2021, number: 2021/07/-695).

Informed Consent: Written informed consent was provided by all parents.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: The authors acknowledge the use of ChatGPT (<https://chat.openai.com/>) only to provide final grammar and language check.

Authorship Contributions: Concept: RAG, GT; Design: RAG, GT; Supervision: RAG, GT; Resource: RAG; Materials: RAG; Data Collection or Processing: RAG; Analysis or Interpretation: RAG, GT; Literature Search: RAG, GT; Writing: RAG; Critical Review: GT.

Acknowledgments: The authors would like to express their deepest gratitude to the staff of the Pedodontics Department at Yeni Yüzyıl University Dental Hospital for their help and patience.

Peer-review: Double blind peer-reviewed.

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REVIEW

The Potential Impact of Climate Change on Endemic *Bacillus anthracis* Infection in Türkiye*

 Fatih Büyük¹,  Callum Cooper²,  Özgür Çelebi³,  Yaren Ersoy¹,  Mitat Şahin^{1,4},
 Mehmet Doğanay⁵,  Les Baillie⁶

¹Department of Microbiology, Faculty of Veterinary Medicine, Kafkas University, Kars, Türkiye

²School of Pharmacy and Pharmaceutical Sciences, Faculty of Health Sciences and Wellbeing, University of Sunderland, Sunderland, UK

³Department of Medical Microbiology, Faculty of Medicine, Kafkas University, Kars, Türkiye

⁴Department of Microbiology, Faculty of Veterinary Medicine, Kyrgyz-Turkish Manas University, Chingiz Aitmatov Campus, Djal, Bishkek, Kyrgyzstan

⁵Department of Infectious Diseases, Faculty of Medicine, Lokman Hekim University, Ankara, Türkiye

⁶Department of Microbiology, Faculty of Pharmacy and Pharmaceutical Sciences, Cardiff University, Cardiff, UK

Abstract

The impact of climate change is accelerating around the world, with effects ranging from increased global temperatures to changes in rainfall and drought patterns. For zoonotic diseases, there is an intrinsic link between the environment and incidence, with more extreme weather events leading to changes in vector behavior, changing epidemic dynamics over time. Within Türkiye, temperatures are predicted to increase by 5–6°C in inland regions and 4–5°C in coastal regions by 2100, whereas the level of precipitation is estimated to vary wildly depending on region. Anthrax is an endemic disease in several regions within Türkiye, capable of causing serious infections in both humans and animals and is caused by the Gram-positive, spore-forming organism *Bacillus anthracis*. Although reported case numbers are limited, *B. anthracis* is well adapted to survival in adverse environmental conditions by forming spores, enabling it to survive outside of a suitable host for prolonged periods of time, and as such, climate change presents an opportunity for the organism. In this review, the potential impact of climate change on *B. anthracis* will be evaluated.

Keywords: Anthrax; Climate change; Türkiye; Zoonotic diseases

Climate change is among the most pressing issues facing humanity today, with temperature rises of approximately 1°C since 1900 that are predicted to continue increasing unless substantial efforts are made to reduce carbon footprints. Rising temperatures have been linked to a wide range of adverse

weather events, from increased rainfall and drought to more extreme events such as hurricanes and earthquakes. These climate-related changes can significantly affect both human and animal populations, leading to increased migration and shortages of food and other essential resources.^[1]

*The editor did not contribute to the review process for this article; the process was conducted by associate editors and subject editors.

Cite this article as: Büyük F, Cooper C, Çelebi O, Ersoy Y, Şahin M, Doğanay M, Baillie L. The Potential Impact of Climate Change on Endemic *Bacillus anthracis* Infection in Türkiye. Lokman Hekim Health Sci 2026;6(3):531–544.

Correspondence: Fatih Büyük, M.D. Kafkas Üniversitesi Veteriner Fakültesi, Mikrobiyoloji Bölümü, Kars, Türkiye

E-mail: fatihbyk08@hotmail.com **Submitted:** 11.09.2025 **Revised:** 18.09.2025 **Accepted:** 29.09.2025 **Available Online:** 13.05.2026



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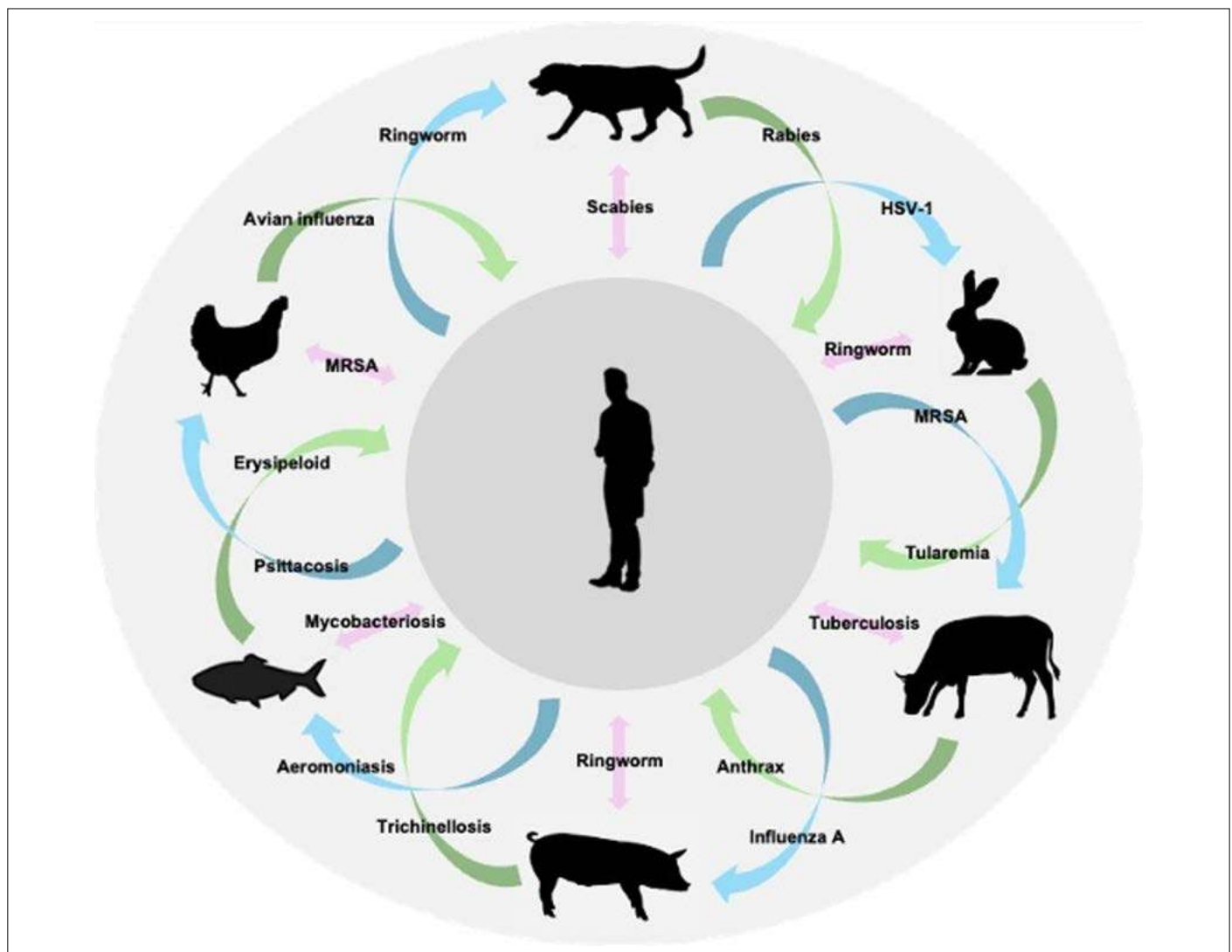


Figure 1. Classification of zoonotic infections based on the transmission from the source to the final host. Green curved arrows indicate diseases transmitted from animals to humans (anthropozoonosis), blue curved arrows indicate diseases transmitted from humans to animals (zooanthropozoonosis), and pink arrows indicate diseases transmitted in both directions (amphixenosis) (depicted by Fatih Büyük).^[6]

Türkiye now accounts for approximately 1% of global emissions and has seen a steady increase in the total amount of greenhouse gases emitted since the 1980s. This increase has been accompanied by projected temperature increases of 5–6°C in inland regions and 4–5°C in coastal areas, compared to the average of 1961–1990.^[2] An increasing temperature trend is projected alongside decreasing levels of precipitation until the end of the century using RCP4.5 and RCP8.5 climate scenarios in the HadGEM2-ES global climate model.^[2–4] The different regions within Türkiye may vary in their susceptibility to adverse weather events, as well as the types of adverse weather effects they may experience, based on their local microclimate.^[5]

Zoonoses are diseases transmitted between animals and humans, classified by direction as animal-to-human,

human-to-animal, or both (Fig. 1).^[6] More than 200 zoonotic diseases have been identified, with approximately 60% of all human pathogens and 75% of emerging infectious diseases believed to have originated from animals.^[7] Several factors contribute to the emergence of zoonoses, including globalization, international trade, land-use changes, and climate change.^[1] While such factors constantly fluctuate over time, zoonotic diseases often disproportionately impact groups from low and middle-income countries and globally are responsible for almost 2.5 billion cases of human infection and 2.7 million human deaths annually.^[8]

Türkiye is a “biological crossroads” containing different ecosystems in which over 20,000 recorded animal species are found.^[9] Türkiye, with its location between Europe, Asia, and the Middle East, creates a mosaic of microclimates.

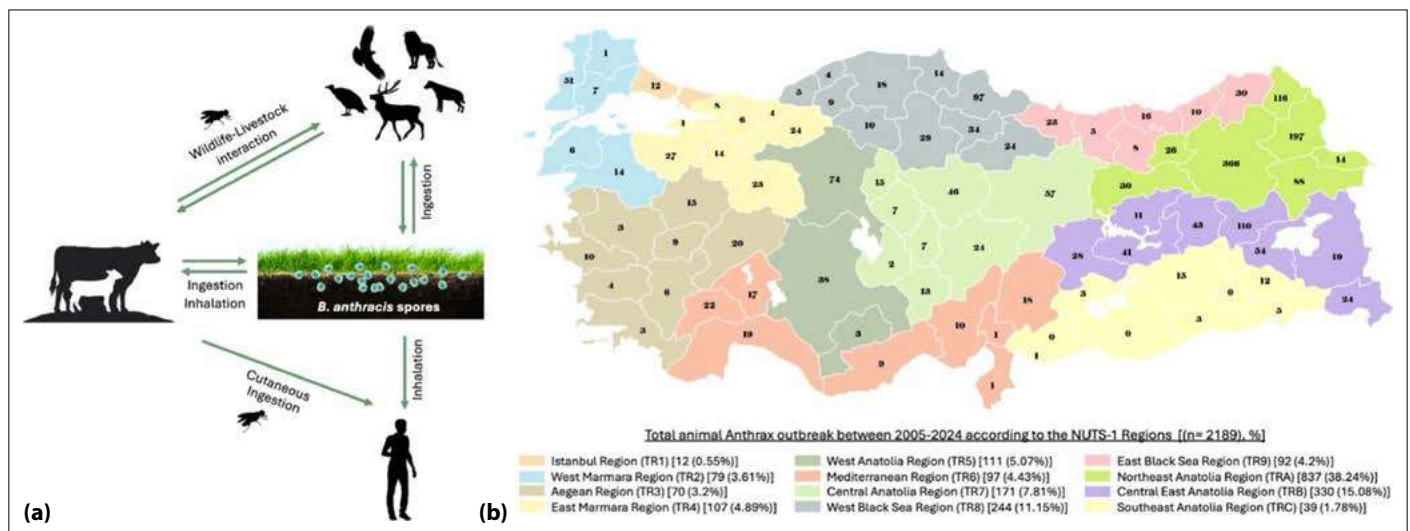


Figure 2. (a) Environmental persistence and transmission of *B. anthracis* (adapted from^[12]) (Depicted by Fatih Büyük); **(b)** Geographic distribution of animal anthrax outbreaks by NUTS-1 regions in Türkiye (adapted from^[15]).

These are localized climatic zones that differ from the surrounding broader regional climate, shaped by factors such as elevation, proximity to seas, vegetation, and human activity.^[10] This range of ecosystems provides a wide range of potential wild and domesticated animal reservoirs for zoonotic infections and contains a number of regions that contain endemic zoonotic diseases (Table 1).^[11]

The current review focuses on the potential impact of climate change on endemic *Bacillus anthracis* within Türkiye. To prepare the article, a structured literature search was performed using the keywords “climate change,” “zoonotic diseases,” “anthrax,” “*Bacillus anthracis*” and “Türkiye” across PubMed, Web of Science, and the official websites of the Turkish Ministry of Health, the Turkish Ministry of Agriculture and Forestry, and the World Health Organization. The search was limited to publications from 2000 to 2025 and included studies in English and Turkish that focused on Türkiye or presented relevant regional data. Gray literature and national surveillance data were also reviewed to provide local context. Articles without empirical findings, duplicates, or those not addressing the intersection of climate change and anthrax were excluded.

Current Perspectives on *B. anthracis* in Türkiye

B. anthracis is a Gram-positive, spore-forming microorganism that causes both human and animal anthrax,^[12] which is estimated to have cost the Turkish economy approximately \$3.8 m in purchasing power parity in 2018 alone.^[13] Due to its ability to form spores, it can survive in the environment for prolonged periods, remaining dormant until a suitable host is infected, at which point it transforms into

vegetative cells and proliferates (Fig. 2a). Human infection usually occurs as a result of contact with contaminated environments, animals, or animal products.^[12]

Anthrax is a sporadic disease; however, based on its spatiotemporal distribution, it is classified into enzootic, hyperendemic, or sporadic anthrax ecological regions.^[14] In this study, we adopted relative endemicity thresholds based on the reported case rate per region in Türkiye; regions accounting for more than 40% of total national cases were considered hyperendemic (none at present), 10–40% were enzootic (TRA, TRB), and <10% were sporadic (the other NUTS-1 regions). These definitions are consistent with those previously applied in regional epidemiological contexts. Based on these thresholds, there are no hyperendemic areas for *B. anthracis* in Türkiye; however, the cumulative prevalence in the Northeast Anatolia Region (TRA) and the Central East Anatolia Region (TRB) has brought the Eastern Anatolia region within these limits.

Between 2005 and 2024, of the 2189 animal anthrax outbreaks reported in Türkiye, 38.24% occurred in the Northeast Anatolia Region and 15.08% in the Central East Anatolia Region.^[15] These regions accounted for the highest incidence rates for the 1,080 human anthrax cases observed between 2009 and 2018, making them the regions with the highest incidence rates.^[16] These regions also coincide with regions where zoonotic transmission and human–animal interaction are high (Fig. 2a, b). These include Kars, Erzurum, Ardahan, and Muş, which are not only agriculturally active but also climatically vulnerable – experiencing seasonal snowmelt that may facilitate spore reactivation and surface exposure. In TR5 and TR7 regions,

Table 1. Zoonotic disease risks in relation to regional and microclimatic variation in Türkiye: A NUTS-based spatial analysis (information obtained from^(11,42))

Region	Region (NUTS-1/ NUTS-2)	Climate type	Microclimate features (NUTS-3)	Zoonoses at risk	Probability of anthrax occurrence	Influencing local factors
Marmara	Istanbul Region (TR1)	Mixed (Mediterranean, oceanic, and continental)	- Urban heat islands are strong in Istanbul (TR100) and Bursa (TR411). - The Sea of Marmara moderates the climate in coastal zones (TR100, TR421, TR425, TR411, TR221, TR211, and TR222). - Forested uplands (e.g., Yalova [TR425] and Bilecik [TR413]) show cooler, more humid microclimates.	West Nile Virus, Leptospirosis, Salmonella, Anthrax	Low-Medium	There may be risks in areas where rural animal husbandry is practiced. - Rural animal husbandry practices - Increased urbanization - Environmental conditions - Inadequate carcass disposal practices - Limited awareness or education
	Istanbul Subregion (TR10)					
	West Marmara Region (TR2)					
	Tekirdağ (TR21)					
	Balıkesir Subregion (TR22)					
Aegean	East Marmara Region (TR4)	Transitional Mediterranean– semi-arid inland	- Coastal areas (TR310, TR321, TR323, and TR221) experience humid, mild winters. - Inland parts like Uşak (TR334) or Afyon (TR332) show more continental features-colder winters, hotter summers. - The Meander River basin (TR321, TR322, TR332, and TR334) fosters unique agricultural microclimates.	West Nile Virus, Brucellosis, Anthrax, Leishmaniasis, Toxoplasmosis	Medium	The risk may increase in rural areas where livestock farming is practiced. - Inadequate vaccination coverage and carcass disposal practices - Lack of veterinary infrastructure - Increased interaction between wildlife and livestock - Limited awareness or education
	Bursa Subregion (TR41)					
	Kocaeli Subregion (TR42)					
	Izmir Subregion (TR31)					
	Aydın Subregion (TR32)					
Central Anatolia	Manisa Subregion (TR33)	Semi-arid continental	- Large daily temperature variations. - Urban areas (e.g., Ankara [TR510], Konya [TR521]) show strong urban heat island (UHI) effects. - Irrigated agricultural zones (e.g., Konya Plain [TR521, TR522, TR712, TR713, TR714, and TR721]) create localized humid zones compared to the surrounding dry steppe.	Tularemia, Brucellosis, Q Fever, Anthrax, Hantavirus, Avian Influenza	Extremely high	Spores may come to the surface, contact between animals increases, and the risk of infection rises with the shrinking of pastures. - Soil disturbance due to overgrazing or land degradation - Reduced pasture availability, higher animal density, and contact between animals - Increased contact with contaminated soil or vegetation
	West Anatolia Region (TR5)					
	Ankara Subregion (TR51)					
	Konya Subregion (TR52)					
	Central Anatolia Region (TR7)					
	Kırıkkale Subregion (TR71)					
	Kayseri Subregion (TR72)					

Table 1 (cont). Zoonotic disease risks in relation to regional and microclimatic variation in Türkiye: A NUTS-based spatial analysis (information obtained from^(11,42))

Region	Region (NUTS-1/NUTS-2)	Climate type	Microclimate features (NUTS-3)	Zoonoses at risk	Probability of anthrax occurrence	Influencing local factors
Eastern Anatolia	Northeast Anatolia Region (TRA) • Erzurum Subregion (TRA1) • Ağrı Subregion (TRA2) Central East Anatolia Region (TRB) • Malatya Subregion (TRB1) • Van Subregion (TRB2)	Harsh continental	• High elevation (average >1500 m) leads to cold, subalpine microclimates, especially in Kars (TRA22), Erzurum (TRA11), and Ardahan (TRA24). • Snow cover persists longer, influencing local hydrology and agriculture. • Valleys may exhibit slightly warmer, more sheltered microclimates.	Tularemia, Anthrax, Crimean-Congo Hemorrhagic Fever, Hantavirus	High	Sudden rainfall can cause spores to surface, continuing the cycle of traditional animal husbandry. • May risk of contamination of soil with spores and exposure of animals • Traditional livestock farming practices • Animals grazing in contaminated areas after rainfall • Limited adaptation to climate variability
Southeastern Anatolia	Southeast Anatolia Region (TRC) • Gaziantep Subregion (TRC1) • Şanlıurfa Subregion (TRC2) • Mardin Subregion (TRC3)	Hot semi-arid	• Very hot summers (up to 45°C), with mild winters. • The GAP irrigation project has introduced local humidity and vegetation changes, altering microclimates in areas like Şanlıurfa (TRC21) and Diyarbakır (TRC22). • Mountainous zones near Siirt (TRC34) and Hakkâri (TRB24) are cooler and wetter.	Crimean-Congo Hemorrhagic Fever, Leishmaniasis, Hydatid Disease, Brucellosis, Tuberculosis, Anthrax	Medium-High	New moist areas can activate anthrax, and spread is possible through small livestock farming. • Formation of new moist areas • Activation of dormant <i>B. anthracis</i> spores • Small-scale or traditional livestock farming practices
Mediterranean	Mediterranean Region (TR6) • Antalya Subregion (TR61) • Adana Subregion (TR62) • Hatay Subregion (TR63)	Hot-summer Mediterranean	• Hot, dry summers; mild, wet winters. • Coastal plains (e.g., Antalya [TR611], Mersin [TR622]) are warmer and more humid than upland areas such as Isparta (TR612) and Burdur (TR613). • Sea breezes and topography (e.g., Taurus Mountains [TR611, TR622, TR621, TR631, TR612, TR613, and TR323]) shape local climates.	Leishmaniasis, West Nile Virus, Brucellosis, Anthrax	Medium	Temperature increases may pose risks in new areas, but humid climates may mitigate the risk • Expand the potential range of anthrax outbreaks • Drier soils may favor spore longevity • High humidity levels may reduce spore survival
Black Sea	West Black Sea Region (TR8) • Zonguldak Subregion (TR81) • Kastamonu Subregion (TR82) • Samsun Subregion (TR83) East Black Sea Region (TR9) • Trabzon Subregion (TR90)	Humid oceanic	• One of the most uniformly humid areas of Türkiye, especially in the eastern Black Sea (Rize [TR904], Artvin [TR905]). • Dense forest cover regulates temperature and humidity. • Inland microclimates become drier and more continental beyond the coastal mountains.	Leptospirosis, Anthrax, Hantavirus, Lyme Disease, Salmonella	Low	The likelihood of flooding is low; however, excessive rainfall may pose a local risk. • Excessive rainfall may saturate the soil, bringing <i>B. anthracis</i> spores to the surface • Temporary water accumulation in low-lying areas may concentrate livestock activity • Localized microflooding may disrupt spore-containing soil layers

where human cases are endemic and animal outbreaks are sporadic, increasing temperatures and droughts associated with climate change could bring spores to the surface and increase contact between animals due to shrinking pastures, thereby raising the risk of infection. Similarly, the West Black Sea Region (TR8) and the East Black Sea Region (TR9), where meso-endemic (11.15%) or hypo-endemic (4.2%) outbreaks have been observed,^[15] may be increasingly affected by sudden floods and irregular rainfall patterns (Table 1).

The prevalence of anthrax in Türkiye is therefore closely related to climatic patterns, microclimatic conditions, and broader environmental factors. While the risk remains highest in arid and continental climate regions, particularly during the summer, emerging evidence suggests that the activation cycle of *B. anthracis* spores may shift in response to climate change.^[17] Consequently, there is a growing concern that anthrax may expand into previously unaffected regions due to increased soil disturbance, water contamination, and altered ecological balances. These changing environmental dynamics underscore the need to re-evaluate anthrax control strategies not only in historically endemic zones but also in regions undergoing climate-related transitions, which will be discussed further in the following section.

The Potential Impact of Climate Change on *B. anthracis* in Türkiye

Anthrax is recognized as a global threat affecting wildlife, livestock, and human health. The environmental spread of *B. anthracis* or its spores is influenced by a range of biotic (e.g., insects, birds, and animals), abiotic (e.g., climate change, water, and soil), and anthropogenic (e.g., human activities, poverty, and conflict) factors. Climate change alters environmental variables such as precipitation, cloud cover, and wind speed, with even slight increases –such as 1 mm of rainfall, 1 h of daily cloud cover, or 1 knot of wind speed being associated with rises in anthrax outbreaks by 9.5, 36.7, and 107 times, respectively.^[18] Moreover, climate change may shift the geographic distribution of anthrax by directly or indirectly affecting the underlying biotic and abiotic conditions that determine pathogen persistence.^[19]

Climate change is increasingly recognized as a key driver of infectious disease dynamics, particularly for environmentally persistent pathogens such as *B. anthracis*. Climatic and ecological changes – such as rising temperatures, altered precipitation regimes, thawing permafrost, and shifts in vegetation cover can significantly

impact the environmental persistence, reactivation, and transmission pathways of anthrax spores. These are not isolated factors but interact with local ecological and agricultural practices, increasing the risk of exposure to animals and humans. In Türkiye, diverse climatic zones are exposed to varying climate-related pressures, resulting in region-specific risks. The following section outlines how these multifactorial influences shape the epidemiology of anthrax in different parts of the country.

Increased Temperature

Rising ambient and soil temperatures can enhance *B. anthracis* spore viability and accelerate the decomposition of infected carcasses, facilitating the release and reactivation of spores into the environment.^[19] In Türkiye, such effects are particularly relevant in Eastern and Central Anatolia, as well as Southeastern Anatolia (NUTS regions: TRA, TRC, TR7), where long, dry summers and continental climates prevail. These areas have historically reported higher anthrax incidence and are increasingly vulnerable to climate-induced ecological shifts (Table 1, 2).

From an environmental standpoint, elevated temperatures lead to greater soil desiccation, which may promote the aerosolization of dormant spores. This process not only increases environmental contamination but may also shift the dominant route of transmission – from the more common gastrointestinal form associated with ingestion of contaminated materials to inhalational anthrax, which carries a higher mortality risk and presents greater public health concerns. As such, it may be possible for spores to spread to areas far from the original contamination sites located throughout Türkiye, thereby increasing the likelihood of exposure to humans and animals.

Furthermore, increased temperatures may extend the active period of vectors, as discussed in the vector section. Prolonged warm seasons also impact vegetation cover and animal grazing patterns, causing livestock to forage closer to the soil where spores may concentrate during dry spells.^[20] This behavioral change further heightens contact between animals and contaminated substrates. It is especially relevant to the Mediterranean (TR6), the West Black Sea (TR8), and the East Black Sea Region (TR9), as well as the Central Anatolia (TR7) and the Southeastern Anatolia Region (TRC) (Table 1, 2).

Permafrost and Snow Melting

Active layers (soil zones above the permafrost) serve as long-term reservoirs for infected animal carcasses and

Table 2. Potential impacts of climate change on anthrax transmission dynamics in Türkiye: Mechanisms and regional vulnerabilities

Climate change factor	Mechanism of influence	Potential impact on anthrax transmission	Regions in Türkiye affected
Increased temperature	Increased temperature enhances spore viability and accelerates carcass decomposition, while elevated soil temperatures may further facilitate the reactivation of <i>B. anthracis</i> spores.	Increases spore exposure and transmission risk.	Eastern and Central Anatolia, Southeastern Anatolia (TRA, TRC, and TR7)
Permafrost thaw/freeze-thaw cycles	Thawing of periglacial or high-altitude soils can reactivate dormant spores, as frozen ground releases old animal carcasses and previously buried <i>B. anthracis</i> spores to the surface.	May trigger the re-emergence of anthrax in historically inactive areas and increase the risk of new outbreaks.	Eastern Black Sea Mountains, Taurus Mountains, volcanic cones (TRA, TRC, and TR7)
Heavy rainfall and flooding	Heavy rainfall and flooding can mobilize spores from contaminated soil into water systems and grazing areas, whereas extreme weather events may force animals to congregate in these high-risk zones, increasing the likelihood of transmission.	As animals and humans are increasingly exposed to contaminated environments, the chain of infection can accelerate.	West and East Black Sea, parts of Marmara and Mediterranean (TRA, TR1, TR6, TR8)
Drought and soil degradation	Drought and soil degradation increase soil spore concentration, while limited water sources and extreme weather events cause livestock to congregate densely, enhancing the risk of transmission.	Increased contact between animals and contaminated soil can lead to an accelerated chain of infection.	Central Anatolia, Southeastern Anatolia (TRC, TR7)
Snowmelt events	Washes spores from buried carcasses to the surface.	Leads to localized outbreaks during spring/summer	Kars, Erzurum, Ardahan, Muş (TRA and TRB)
Changes in vegetation patterns	Alters grazing routes and habitat use. Altered pathogen distribution and host behavior can increase exposure and burden immune systems.	May bring susceptible animals into contact with contaminated sites. May weaken or overwhelm immune tolerance, thereby increasing the risk of anthrax	Nationwide, particularly rural pasturelands (TRA, TRC, TR1, TR3, TR6, TR7, TR8, and TR9)
Increased insect activity (e.g., biting flies)	Warmer, wetter conditions boost vector populations.	Possible mechanical transmission, especially in outbreak zones.	Regions with livestock density and wet summers (TR1, TR6, TR8, and TR9)
Animal migrations and dispersal	Alters wildlife and livestock movement patterns and habitat in search of resources.	Anthrax can be transported to new areas.	Steppe zones, transhumance routes, and drought-affected regions (TRA, TRC, TR3, and TR7)
Increased human–animal interaction	With the expansion of agricultural areas, human activity increases in risky areas.	Raises the likelihood of zoonotic spillover and human infection.	Rural areas with expanding agricultural activity (TRA, TRC, TR1, TR3, TR6, and TR7)
Impact on Health Infrastructure	Climate change can strain healthcare systems.	Delays in diagnosis, surveillance, and response capacity.	Vulnerable and under-resourced rural regions (TRA, TRC, TR7, and TR9)

anthrax spores, potentially facilitating disease transmission during seasonal thawing. Epidemiological models adapted to Arctic conditions indicate that the deepening of these active layers – particularly in unusually warm years – significantly increases the risk of anthrax outbreaks. Indeed, the cause of a recent anthrax outbreak in reindeer in Siberia was reported to be related to the presence of

infected carcass spores released from permafrost thawing from active layers due to rising temperatures.^[21]

Although there are no classical permafrost zones in Türkiye, localized periglacial conditions exist in regions such as the Eastern Black Sea Mountains, the Taurus Mountains, and high volcanic cones,^[22] where freeze-thaw processes may pose future risks of spore release.



Figure 3. Examples of improper anthrax-contaminated waste management practices in endemic regions of Türkiye. **(a)** A potentially infected piece of cardboard exposed to open air; **(b)** A contaminated cattle hide placed on a barn roof; **(c)** A decomposing carcass in a public dump site. These images reflect weak biosecurity infrastructure and emphasize the risk of environmental contamination in the absence of comprehensive control measures, particularly under climate-stressed conditions. (All photos were obtained from the collection of Mitat Şahin [Kafkas University / Kyrgyz-Turkish Manas University], Özgür Çelebi [Kafkas University], and Fatih Büyük [Kafkas University]).

Even under current climatic conditions, other factors may be contributing to the formation of anthrax hotspots in these colder areas. Provinces such as Kars, Ardahan, Erzurum, Ankara, Konya, and Kayseri (NUTS regions: TRA, TR5, and TR7) are characterized by cold, arid, or increasingly drought-prone climates, limited resources, harsh environmental constraints and insufficient implementation of biosecurity measures (e.g., proper carcass disposal or disinfection protocols per^[23]) may lead to improper handling of infected animals or materials. Such practices, exemplified in Fig. 3a–c, can contribute to persistent environmental contamination^[24] and facilitate future outbreaks.

Higher Rainfall and Flooding

Heavy spring rains followed by hot, dry summers often result in localized flooding and are increasingly associated with outbreaks of animal anthrax. This association is now considered part of current perspectives on the ecological effects of climate change on zoonotic disease patterns.^[25] Excessive rainfall, flotation, and flooding can carry *B. anthracis* spores into the rhizosphere of the soil or local watering holes, where the spores can germinate and multiply.^[26] This period of abundant water, followed by dry weather, will lead to water evaporation, which will concentrate the spores and increase the infective dose levels.^[27]

Germinating spores may facilitate the transfer of genetic material or the emergence of cross-species variants.^[26] While these processes occur under current conditions, emerging evidence suggests that climate change – especially through drought stress, altered precipitation patterns, and increased environmental disturbance – may accelerate horizontal gene transfer and microbial evolution

in soil ecosystems (e.g., enhanced genetic exchange under drought conditions)^[28] and create opportunities for cross-over variants such as those observed in the *Bacillus cereus* group.^[27] These mutant bacteria may evolve to pathogenicity and cause clinical pictures that do not correspond to classical anthrax, or they may have the potential to be used as biological agents instead of *B. anthracis*.^[29] Given that a cow dying of anthrax sheds approximately 1012 spores, soil containing untreated or flood-prone spore-laden animal burials (Fig. 4a–c) – which are common in Türkiye, particularly in the Eastern Anatolia Region (TRA, TRB) – constitutes not only a persistent infection source but also a genetic reservoir of *B. anthracis* that may be diagnostically overlooked.

Currently, such improper carcass disposal contributes to the formation of endemic hotspots. However, under projected climate change scenarios, increasing flood events, soil degradation, and competition for grazing land may bring animals and humans into closer contact with these contaminated sites. Without improved disposal practices and biosecurity measures, these conditions could promote the expansion of anthrax-endemic areas and potentially support the evolution or emergence of novel or resistant *B. anthracis* strains. Furthermore, surface runoff or superficial flooding caused by intense rainfall on sloped or impermeable surfaces – referred to as pluvial flooding – can transport *B. anthracis* spores over short or long distances from contaminated sites, leading to the formation of new hotspots.^[24] This risk is not limited to rural or grazing areas; with increasing urbanization, impermeable urban surfaces can exacerbate runoff dynamics, potentially facilitating the spread of spores into peri-urban environments where human–animal interactions may also occur.

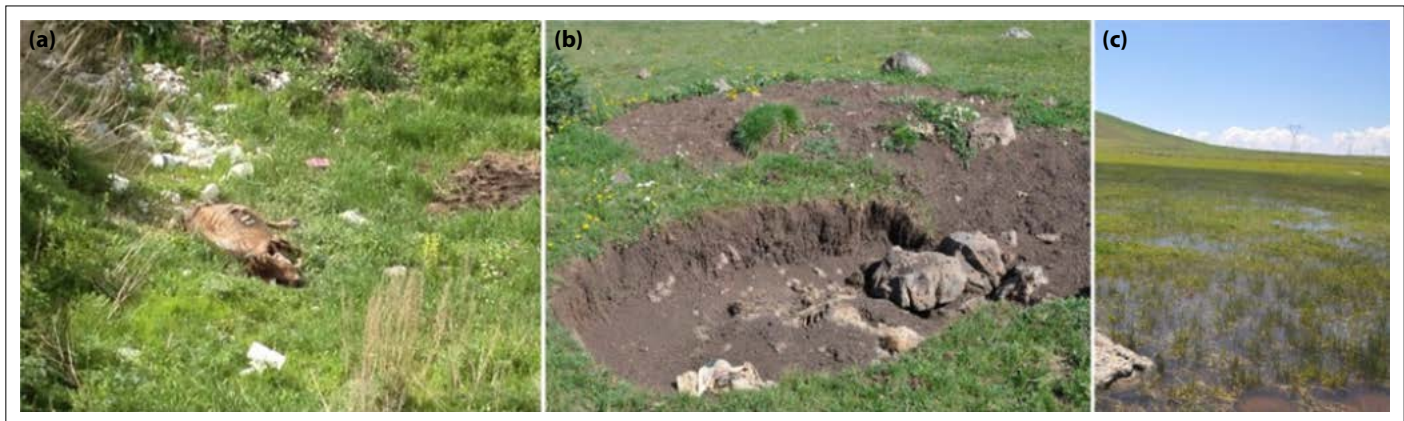


Figure 4. Potential climate-sensitive sources of anthrax contamination triggered by flooding or surface runoff. **(a)** A large, shallow burial pit containing an untreated anthrax-infected cattle carcass, vulnerable to spore flotation during heavy rainfall; **(b)** A superficially buried, four-cornered anthrax grave with minimal protective coverage, exposed to pluvial flooding and erosion; **(c)** A contaminated lowland area visibly impacted by recent rain-induced surface water movement, representing a potential dispersal zone for *B. anthracis* spores. (All photos were obtained from the collection of Mitat Şahin [Kafkas University / Kyrgyz-Turkish Manas University], Özgür Çelebi [Kafkas University], and Fatih Büyük [Kafkas University]).

Increasing evidence suggests that flooding and other hydrological events linked to climate change may elevate the risk of anthrax outbreaks by mobilizing *B. anthracis* spores from contaminated soils. This risk is particularly relevant in Türkiye, where a significant number of settlements – including those in the Istanbul Region (TR1), the West Marmara Region (TR2), the East Marmara Region (TR4), the West Black Sea Region (TR8), and the East Black Sea Region (TR9) – are located on geomorphologically sensitive landscapes such as floodplains, dry riverbeds, and alluvial soils. These low-lying areas are especially vulnerable to increased precipitation and surface water accumulation, which may facilitate the horizontal spread of spores.

For instance, the most recent major flooding event occurred in the Western Black Sea Region (TR8) in 2021. Although no direct anthrax cases were reported in connection with the floods,^[30] the potential for future outbreaks remains high due to the ecological vulnerabilities of such regions. In addition, in the Northeast Anatolia Region (TRA) and the Central East Anatolia Region (TRB), climatic shifts are expected to increase freeze-thaw cycles and snowmelt during spring (Table 1, 2). These processes may lead to water table fluctuations and facilitate vertical movement of *B. anthracis* spores to the surface, thereby expanding the risk of soil contamination and disease transmission.

Animal Migrations, Habitat Changes, and Human–Animal Interactions

The current geographical distribution of *B. anthracis* has been shaped as a result of long-term activities such as historical human settlements, trade routes, and animal

migrations.^[31] However, this distribution is now being reshaped by climate change. Climate change redefines not only environmental boundaries but also alters epidemiological boundaries, significantly impacting the dynamics of zoonotic disease spread. Zoonotic diseases such as anthrax have the potential to emerge in new geographical areas as a result of changing animal behavior, habitat shifts, and increased human–animal interactions due to climate change. In particular, environmental variables such as increasing temperatures, decreasing soil moisture, and thawing of permafrost regions facilitate conditions in which *B. anthracis* spores can survive in soil, potentially causing previously inactive spores to become pathogenic again.^[17]

Climate change is also causing many animal species to change their habitats. Rising temperatures and droughts are forcing species to migrate to cooler or more ecologically favorable regions – often to the north or higher altitudes. Changes in food and water resources are reshaping these migration routes and exposing animals to different ecosystems and thus new microbial environments.^[31] Environmental factors, alongside host behaviors, shape exposure levels to *B. anthracis* and immune responses in host species. Variables such as vegetation, rainfall patterns, and forage availability influence exposure frequency and dose, causing variations in host immune responses.^[32] Climate-related environmental changes may disrupt this balance. Climatic events like sudden rainfall, drought, or temperature fluctuations can alter pathogen distribution and host behavior, increasing exposure and burdening immune systems. This may weaken or overwhelm immune

tolerance, thereby increasing the risk of anthrax. Thus, climate-induced changes can complicate disease dynamics by affecting both pathogen ecology and host immunity.

Prolonged droughts in the Mediterranean Region (TR6) and the Southeastern Anatolia Region (TRC) of Türkiye may force wildlife to migrate to higher and cooler areas in the Northeastern Anatolia Region (TRA) and the West Black Sea Region (TR8), which maintain relatively stable water and vegetation profiles. Similarly, in the West Anatolia Region (TR5), where intensive land use and desertification are prevalent, a gradual movement of species toward the Central Anatolia Region (TR7) and the East Marmara Regions (TR4) may be observed, potentially altering interregional ecological interactions. These changes may increase the likelihood of contact between species, as well as the risk of exposure to new microbial environments and zoonotic pathogens such as *B. anthracis*.

In biogeographically strategically located countries such as Türkiye, both local climate change (Table 1) and the intersection of African-Central Asian wildlife migration routes may lead to the emergence of new infectious disease risks. Climate change is driving wild animals to move increasingly toward urban areas in search of food and water. This will increase their contact with contaminated environments such as garbage dumps or shallowly buried animal graves (Fig. 3c, 4a, b), which may increase the risk of anthrax transmission and may even increase the risk of human–animal conflict. This risk is not uniform across the country but varies by region. For example, urban expansion in the Istanbul Region (TR1) and the West Marmara Region (TR2) is extending into surrounding forested areas, thereby bringing wildlife into closer proximity with human settlements. In contrast, intensifying drought conditions in the Mediterranean Region (TR6) and the Southeast Anatolia Region (TRC) are reducing access to natural water sources, pushing wild animals toward irrigated agricultural areas or urban peripheries. Furthermore, in the Northeast Anatolia Region (TRA) and the Central East Anatolia Region (TRB), the risk of exposure may increase due to both local and migratory animals passing through old burial grounds or contaminated pastures (Fig. 4a–c).

Changes in Vegetation Cover

Climate change-induced changes in vegetation cover – such as the decline of grasslands, changes in plant species, and deterioration of grassland quality – may alter the grazing behavior and migration routes of both farm animals and wild herbivores across Türkiye.^[9] These ecological changes may increase the likelihood of animals entering areas

where *B. anthracis* spores, which may be dormant in the soil, are present. This risk is particularly likely in the Northeast Anatolia Region (TRA) and the Southeast Anatolia Region (TRC). Similarly, increased drought and land use pressure in the Central Anatolia Region (TR7) and the West Black Sea Region (TR8) may push grazing activities into marginal lands, increasing the likelihood of exposure to contaminated soil. In addition, in regions such as the Istanbul Region (TR1), the Aegean Region (TR3), and the Mediterranean Region (TR6), the urban-rural interface is expanding toward traditional grazing areas, increasing animal density and interspecies interactions. These overlapping pressures may facilitate the spread of anthrax not only among livestock populations but also across administrative boundaries through changing migration routes. Therefore, changes in vegetation cover may function as a critical ecological factor in the reactivation and spread of anthrax across Türkiye's diverse biogeographic landscapes.

Vectors

Several insect species, including biting flies (*Tabanus* and *Stomoxys*) and non-biting blowflies (*Calliphoridae*), have been experimentally and historically associated with the mechanical transmission of anthrax. Mosquitoes (*Aedes* spp.) have also shown potential in laboratory settings, but their role in natural outbreaks remains unclear.^[12]

In Türkiye, where diverse climatic and ecological conditions support the proliferation of vector species such as mosquitoes and ticks,^[33] the potential for vector-borne anthrax transmission is theoretically present but epidemiologically marginal. Meteorological factors are thought to contribute to the spread of anthrax by facilitating the development of biting flies.^[21] The risk becomes more relevant only when seasonal population peaks of vectors coincide with the presence of *B. anthracis*-infected animal carcasses, which may occasionally occur in endemic zones. This convergence is more likely in rural and livestock-dense regions such as the Southeast Anatolia (TRC), the Central Anatolia Region (TR7), and the Eastern Anatolia (TRA, TRB), where animal deaths may go unnoticed or improper carcass disposal practices prevail. However, current evidence does not support the long-distance spread of anthrax spores through flies or ticks; their role is limited to localized amplification under specific environmental conditions.^[12] Thus, although Türkiye's regions such as the Mediterranean Region (TR6) and the Black Sea Region (TR8, TR9) offer suitable habitats for mosquito development, the overall contribution of arthropod vectors to anthrax transmission remains low. Consequently, while climate-induced increases

in vector populations may pose theoretical risks, these are insufficient on their own to drive anthrax outbreaks across Türkiye's NUTS regions without concurrent factors such as carcass exposure or endemic presence of the pathogen.

Successive Effects: Migration and Disasters

Although anthrax is not categorized as an epidemic disease with direct devastating effects such as cholera, tetanus, rabies, and typhoid, it is an important zoonotic infection whose incidence can increase in situations of environmental stress, disruptions in health systems, and mass mobility. The spread of anthrax and similar diseases can accelerate, particularly during societal breakdowns such as war, economic crisis, and natural disasters. Such crises may be expected to become more frequent and severe with climate change. The risk of anthrax reemerging in Türkiye varies according to the NUTS regions shaped by climate-induced migration, disaster exposure, and systemic health vulnerabilities. Although Türkiye is not currently in an active war zone, the Istanbul Region (TR1), the Southeast Anatolia Region (TRC), and the Mediterranean Region (TR6) have become important transit and shelter areas for migrants. Factors such as drought, floods, and agricultural collapse due to climate change are also expected to increase these migration movements. This creates not only a demographic but also a health-related burden.

The re-emergence of infections such as multidrug-resistant bacterial infections, tuberculosis, measles, leishmaniasis, and hepatitis A in migrant communities poses risks to both the local population and health systems.^[34] Deteriorating living and hygiene conditions due to climate change are a major risk factor for the spread of infections such as anthrax, especially those transmitted through the skin. In migration settings where acute wound care and preventive health services are inadequate, the risk of transmission through contaminated animal products or environmental contact increases. The case of Türkiye, accused of being an accidental source of a strain of anthrax through heroin use, a new route of transmission for anthrax, and later cleared only as a transit country,^[35] is another clear example of the risk of anthrax for migrants or refugees and the damage to the country's reputation. In addition, in agricultural transition zones such as the West Anatolia Region (TR5) and the Mediterranean Region (TR6), where mobile populations intersect and animal disease surveillance is inadequate, and in the Southeast Anatolia Region (TRC) and the Central East Anatolia Region (TRB), which face socioeconomic vulnerability and historical anthrax endemicity, due to their proximity to migration routes and limited veterinary

infrastructure, may facilitate the emergence or undetection of not only anthrax but also other transboundary diseases such as the SAT-2 variant of foot-and-mouth disease.^[36]

While no direct link has been established between earthquakes and natural anthrax outbreaks in the literature to date, seismic events may act as secondary triggers for environmental zoonotic disease risks under certain ecological and infrastructural conditions. For instance, the 2023 Kahramanmaraş Earthquake, which affected 11 provinces in the Southeastern Anatolia (TRC), Central Anatolia (TRB), and Eastern Anatolia (TRA) regions, may reveal the potential for indirect but significant risks related to environmental zoonotic diseases such as anthrax. These risks could be exacerbated by earthquake-induced soil degradation, exposing contaminated animal burial sites and creating alkaline soil conditions conducive to the survival of *B. anthracis* spores, particularly in areas rich in calcium, magnesium, and iron. The long-standing practice of shallow or unmarked animal burial in rural areas of these regions (according to Turkish legislation^[23]) could further exacerbate this threat. These indirect risks may be amplified when coupled with climate stressors such as rising temperatures, droughts, or flooding, all of which alter soil microbial dynamics and ecosystem balance. Moreover, post-disaster displacement and migration into already climate-stressed NUTS regions (TRB, TRC, and TR6) may further strain health infrastructure and complicate surveillance efforts for cutaneous anthrax and other zoonotic infections. In contrast, regions such as the West Anatolia Region (TR5) and the Mediterranean Region (TR6), which are less affected by seismic activity, face higher risks due to secondary effects such as increased climate migration and ecological pressure. Although more empirical evidence is needed to establish a clear link between earthquakes and anthrax reactivation, the convergence of climate change, migration, and environmental disruption warrants a multi-hazard approach in disease preparedness and policy planning.

Clinical and Research Consequences

Anthrax remains endemic in several regions of Türkiye, notably in the Northeast Anatolia (TRA), the Central East Anatolia (TRB), and parts of the Black Sea Region (TR8, TR9).^[16,30]

Although national surveillance and vaccination programs^[23] have contributed to a gradual decline in reported cases, their effectiveness remains uneven due to socioeconomic disparities, limited public awareness, and region-specific challenges such as climate vulnerability and inadequate infrastructure.

From a clinical perspective, cutaneous anthrax continues to be the most frequently diagnosed form in Türkiye, particularly in rural, livestock-dependent areas.^[16,30] However, climate-induced changes in spore dynamics (e.g., aerosolization) may increase the risk of more severe forms such as inhalational anthrax, which has higher mortality and requires a rapid and specialized clinical management. In addition, increased environmental exposure through flooding, soil disruption, or improper carcass disposal can also complicate differential diagnosis in endemic settings.

From a research perspective, the prolonged environmental persistence of the *B. anthracis* spores poses a significant challenge for sustainable land use, particularly in the absence of effective remediation strategies. Current regulations in Türkiye focus only on the disinfection of contaminated facilities,^[23] and carcass disposal methods such as burial with quicklime, whose effectiveness remains questionable,^[37] generally leave contaminated pastures untreated. The lack of environmentally sustainable decontamination techniques, coupled with the risk of reactivation of dormant spores due to climate change, highlights the urgent need to identify and map undocumented “hidden hotspots.” Addressing this research gap will require integrating local ecological knowledge, especially from farming communities, with geospatial and molecular tools to enhance hotspot prediction and inform the development of environmentally friendly remediation methods, which preserve both soil usability and ecological balance.^[38,39]

Moreover, global evidence reinforces anthrax as a climate-sensitive zoonosis. Outbreaks in Sub-Saharan Africa, Central Asia, and Siberia have been linked to extreme weather events that disturb contaminated soils and facilitate spore reactivation.^[19] Climate-based modeling studies from Kenya, Zimbabwe, and Bangladesh further suggest that anthrax risk zones may expand or shift due to changes in temperature, precipitation, and land use.^[40,41] These findings underscore the importance of integrating climate projections into Türkiye’s national risk mapping and developing interdisciplinary, climate-informed surveillance and mitigation strategies.

Conclusion

Anthrax continues to pose a significant public health and veterinary threat in Türkiye, particularly in endemic regions such as Eastern Anatolia. While current control efforts have reduced incidence, climate change introduces new ecological pressures that may alter the distribution, frequency, and severity of future outbreaks. A multidisciplinary and proactive approach is therefore

essential to prevent the re-emergence or expansion of anthrax in both endemic and previously unaffected areas. To enhance national preparedness and resilience, the following policy and practice priorities are thus proposed: (i) national risk maps should be updated by integrating regional climate projections, ecological vulnerability, and historical epidemiological data, (ii) vaccination and surveillance programs must be sustained and expanded to encompass areas identified as at risk under future climate scenarios, (iii) environmentally friendly decontamination strategies and biosecure carcass disposal methods should be developed, standardized, and widely implemented, (iv) cross-sectoral coordination between health, veterinary, environmental, and agricultural authorities should be reinforced within the One Health framework, (v) public education and community engagement should be prioritized to ensure local compliance and timely reporting, particularly in rural or climatically sensitive areas, (vi) research funding and capacity building should be supported for innovation in climate–pathogen dynamics, spore ecology, and sustainable remediation techniques.

Ethics Committee Approval: Ethical approval was not required for this study since this is a review article.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: Non declared.

Authorship Contributions: Concept: FB, MD; Design: FB, CC, YE, MD; Supervision: OC, MS, LB; Resource: FB, CC, YE; Materials: FB, CC; Data Collection or Processing: FB, YE; Analysis or Interpretation: FB, CC, OC, MD, MS; Literature Search: FB, CC, YE; Writing: FB, CC, MD; Critical Reviews: CC, OC, MS, LB.

Peer-review: Double blind peer-reviewed.

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REVIEW

Dental Fiber Post Systems: A Literature Review

 **Ecem Kuşçu Baran**

Department of Endodontology, Lokman Hekim University Faculty of Dentistry, Ankara, Türkiye

Abstract

Endodontically treated teeth (ETT) with significant tissue loss commonly require intraradicular post systems to support the coronal restoration and restore function and esthetics. These posts, which are placed within the root canal, have been manufactured from various materials and in different designs throughout history. Today, fiber posts are favored because of their physical properties similar to dentin, esthetic advantages, ease of use, and compatibility with adhesive techniques. This review aims to evaluate the general characteristics of currently used fiber post systems for the restoration of ETT, examine clinically observed failures and their causes, and discuss application principles alongside recent clinical studies.

Keywords: Glass fiber post; Post core systems; Survival

The long-term survival of endodontically treated teeth (ETT) largely depends on the success of the coronal restoration, which prevents microbial leakage and restores function and esthetics by replacing lost tooth structure.^[1,2] In cases where coronal walls are absent, intraradicular posts are required to retain the coronal restoration.^[3]

Metal post systems were widely utilized; however, due to disadvantages such as susceptibility to corrosion and high elastic modulus, the clinical use of metal posts has declined.^[4,5] To overcome these limitations, fiber-reinforced posts have been widely adopted in dentistry.^[6] These posts demonstrate a modulus of elasticity comparable to that of dentin, which enables more uniform distribution of occlusal forces along the root structure and reduces the risk of catastrophic root fracture.^[7] The most common failure mode of metal posts is root fracture, whereas that of fiber posts is loss of retention. Factors such as limited

isolation control, accumulation of secondary dentin or cement, and the passive fit of fiber posts reduce their ability to bond effectively to the root dentin.^[8]

Unlike previous reviews focused on traditional fiber or metal post systems, this paper integrates recent literature published between 2017 and 2025. It highlights emerging technologies such as computer-aided design/computer-aided manufacturing (CAD/CAM) and 3D-printed post systems. It also synthesizes clinical determinants, mechanical properties, and failure mechanisms to establish a modern and clinically oriented framework for post selection and performance evaluation.

This review aims to provide a comprehensive and up-to-date overview of dental fiber post systems, focusing on mechanical properties, clinical indications, failure patterns, and advances such as CAD/CAM-fabricated and 3D-printed posts. A comprehensive literature search was conducted to ensure an evidence-based narrative.

Cite this article as: Kuşçu Baran E. Dental Fiber Post Systems: A Literature Review. Lokman Hekim Health Sci 2026;6(3):545–553.

Correspondence: Ecem Kuşçu Baran. Lokman Hekim Üniversitesi Diş Hekimliği Fakültesi, Endodontoloji Anabilim Dalı, Ankara, Türkiye

E-mail: ecem.kuscu@lokmanhekim.edu.tr **Submitted:** 20.05.2025 **Revised:** 02.01.2026 **Accepted:** 03.01.2026 **Available Online:** 06.08.2026



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Review Methodology

A comprehensive literature search was conducted in PubMed, Scopus, and Web of Science databases for articles published between 2017 and 2024. The following keywords were used: "fiber post," "dental post system," "glass fiber post," "CAD/CAM post," "3D printed post," "mechanical properties," "failure modes," and "clinical performance."

Inclusion Criteria

- Peer-reviewed articles published in English between 2017 and 2024
- Studies evaluating mechanical properties, clinical behavior, or survival outcomes of fiber, metal, CAD/CAM, or 3D-printed post systems.

Exclusion Criteria

- Non-English publications
- Abstracts without full text
- Case reports, conference proceedings, and letters to the editor
- Studies unrelated to post-endodontic or indirect restorations.

Titles and abstracts were screened for relevance, and full texts of those meeting the inclusion criteria were evaluated. In addition, reference lists of included articles were reviewed to identify further relevant studies.

As this was a narrative review, no quantitative synthesis or meta-analysis was performed; instead, selected studies were qualitatively analyzed and organized into key thematic areas, including material composition, mechanical performance, and clinical applications.

History of Dental Fiber Posts

The history of dental fiber posts dates back to 1989 with the clinical introduction of the first carbon fiber post, the Composi Post (RTD, Meylan, France). The first published article on fiber posts was written by Duret et al.^[9] in 1990. The early incorporation of fiber posts into clinical dentistry provided an alternative to the metal post systems used at that time.^[5] The initial fiber post systems were fabricated from carbon or graphite fibers. They exhibited favorable mechanical properties, including high stiffness and tensile strength, as well as an elastic modulus comparable to that of dentin.^[9,10] However, first-generation carbon fiber posts had esthetic disadvantages due to their dark coloration and lack of radiopacity, making them difficult to mask under all-ceramic or composite restorations.^[9] To overcome this

limitation, radiopaque quartz and glass fiber posts (GFPs) were developed, offering more esthetic and clinically acceptable alternatives.

GFPs

The limitations of earlier post systems led to the development of glass fiber-reinforced post systems, first introduced in 1992. GFPs are composed of unidirectional glass fibers embedded in a resin matrix and are available in white, translucent, and opaque shades, offering superior esthetic outcomes. The resin-based composition of GFPs provides strong adhesion to resin cements.^[11] With a low modulus of elasticity and biomechanical behavior similar to that of dentin, these posts closely mimic the natural flexural properties of tooth structure. Translucent variants enable light transmission, further enhancing their esthetic potential.^[12] The dentin-like bending capacity allows for harmonious flexing under functional forces, thereby facilitating effective stress distribution over a broader surface area.^[12] In addition to high bonding capacity with tooth structures, composite resins, and resin cements, GFPs demonstrate excellent biocompatibility and corrosion resistance. Post length can be adjusted during clinical application, and removal from the canal can be performed using a rotary bur. However, the most significant drawback of GFPs is the reduced stability when exposed to moisture.^[13]

Clinical Determinants of Fiber Post Outcomes

The success and longevity of fiber post restorations depend on several key clinical factors:^[14]

- Remaining tooth structure and the presence of a ferrule,
- Tooth type and location (anterior/posterior; maxillary/mandibular),
- Anatomical variability of the root canal system,
- Type of luting cement,
- Type of final restoration (direct or indirect),
- Presence of proximal contacts.

Tooth type, location, and remaining tooth structure (i.e., the number of residual coronal walls) are key determinants of tooth longevity. Survival rates of ETT are higher in molars compared to pre-molars and anterior teeth, and teeth with one or fewer remaining coronal walls show increased failure rates.^[15]

Final restoration type also influences the long-term success of ETT. Direct restorations designed to protect occlusal cusps have been shown to improve survival rates. In addition,

sufficient remaining tooth structure and the presence of a ferrule have a greater impact on durability than the post type.^[16] Moreover, self-adhesive resin cements have demonstrated superior bond strength to conventional cements.^[17]

Studies have shown that horizontal occlusal loads increase stress concentration and that teeth without proximal contacts have a threefold higher failure rate. The presence of adjacent contacts helps distribute stress among teeth, thereby reducing stress concentration on a single tooth.^[18]

Types of Failure in Dental Fiber Post Systems

Post Retention Loss

Retention refers to the ability of a dental post to resist vertical displacing forces and represents the most frequently observed failure mode in post-restored teeth.^[19] Retention is influenced by multiple factors, including post diameter, taper, length, luting cement type, and whether the post design is active or passive. Increasing post length generally enhances retention, whereas parallel-sided posts provide superior retention to tapered designs. Active post designs demonstrate greater retention than passive posts due to their threaded or mechanically interlocking features.^[19] Post diameter has a relatively smaller impact on overall retention compared to other design and cementation factors.^[20] Although increasing diameter may slightly improve retention, excessive dentin removal compromises the structural integrity of the root; therefore, increasing post diameter solely to improve retention is not recommended.^[20] Marginal leakage between tooth structure and restoration contributes to post retention loss. Advancements in adhesive systems and posts with dentin-like elasticity have improved overall retention; however, cement systems are effective only when used with well-designed posts and cannot compensate for the deficiencies in poorly designed ones.^[21] Combining adhesive techniques is essential to maximize retention and preserve tooth structure.^[22]

Pre-cementation cleaning of the post surface improves retention and may involve ethanol rinsing, air abrasion, or phosphoric acid application. Applying cement simultaneously to both the post surface and root canal enhances retention more effectively than applying it to either alone.^[23]

Deformation of the Post

Post deformations primarily depend on the material properties and diameter. Posts with smaller diameters are prone to deformation under masticatory forces. The post

diameter should provide adequate resistance against deformation while minimizing unnecessary removal of remaining dental tissue.^[24] Pre-fabricated posts fracture more frequently than cast posts, although these failures are generally restorable.^[25,26]

Root Fractures

Root fractures represent irreversible failures that often necessitate tooth extraction.^[27] They occur most frequently in the maxillary anterior region, due to horizontal functional loads, making the presence of a ferrule particularly critical in this area.^[28]

Excessive removal of tooth structure during post space preparation weakens the tooth and increases fracture risk. The high modulus of elasticity of metal posts prevents uniform stress distribution within the root, whereas the widespread use of fiber posts whose modulus of elasticity is similar to that of dentin has been associated with a reduced incidence of fractures. Reported root fracture frequencies in teeth restored with posts range from 0% to 10%,^[18] with approximately 7% in tapered posts, 3% apically tapered posts, and 1% in parallel posts.^[4]

Root Perforation

Placement of posts with dimensions that do not correspond to the root canal anatomy may result in root perforation. This complication most frequently occurs during post space preparation but may also arise during endodontic treatment or when post removal becomes necessary. This type of failure may not be apparent during post placement. Therefore, radiographic control must be performed, and the anatomy of the root should be well understood.^[4] The use of parallel-sided posts may further increase the risk of perforation during root preparation.

Failure in Root Canal Treatment

Apical periodontitis presents with radiographic changes, percussion sensitivity, or a periapical abscess.^[29] Such failures result from inadequate asepsis or bacterial contamination, often due to prolonged temporary restorations or microleakage.^[22,30] In cases of reinfection, post removal and retreatment are indicated, whereas preserving at least 3 mm of apical gutta-percha to prevent apical leakage.^[31]

Crown Retention Loss

If a ferrule effect is not established in a tooth restored with a post core system, crown retention depends entirely on the retention of the post. Crown loss can be caused by cement

failure or caries developing in the dentin.^[31] Advances in dentin bonding have enabled integrated tooth–post–crown restorations, which tend to fail in a more repairable manner.^[31]

Secondary Caries

Secondary caries may develop due to inadequate oral hygiene or errors in the post core system. Stress generated at the post–crown interface, particularly with flexible posts, can cause microleakage and subsequent caries formation. Such lesions may remain clinically undetected, especially in bridge abutments where prosthetic support delays diagnosis.^[22]

Allergy

Allergic reactions are primarily associated with posts made from base metal alloys. Such reactions have been reported with modern post systems due to their biocompatibility.^[32]

Corrosion

Corrosion weakens the post–canal interface and may cause root and gingival discoloration; this issue, common with base metal alloys, has largely been eliminated with modern GFPs.

Esthetic Problems

Metal or carbon fiber posts placed under all-ceramic crowns can cause cervical discoloration and compromise esthetics, an issue largely resolved with the development of GFPs.^[24]

Sarkis-Onofre et al.^[30] classified post-related failures as absolute or relative. Absolute failures were defined as those requiring tooth extraction, whereas relative failures included cases of post decementation that could be managed by recementation or repair. Accordingly, success refers to the absence of both absolute and relative failures, whereas survival denotes the absence of absolute failures only.

Resin-Based Luting Cements

The adhesive system used for bonding fiber posts to dentin is critical for post retention and long-term clinical success. Total-etch systems provide strong micromechanical bonding and the highest retention; however, their effectiveness depends on acid concentration, application time, and proper rinsing and drying procedures, making them technique-sensitive and prone to operator errors.^[11] Self-etch systems combine the etching and priming steps into a single application, simplifying the procedure, reducing technique sensitivity, and yielding retention values comparable to those of total-etch systems.^[21] Clinically, self-etch adhesives demonstrate more consistent

results in the root canal environment, especially in deep regions where rinsing and drying control are difficult, thereby reducing post-operative sensitivity and improving marginal adaptation.^[21,29]

Self-adhesive resin cements eliminate the need for tooth surface pre-treatment, offering ease of use but demonstrating weaker chemical bonding to dentin and lower retention values. Although self-adhesive systems reduce chair time and the risk of contamination during cementation, *in vivo* and *ex vivo* studies report higher rates of post debonding and marginal leakage compared with total-etch and self-etch protocols.^[21,24]

Recent clinical evidence suggests that dual-cure and self-adhesive cements perform adequately for fiber post retention in the short term, but long-term performance may be compromised by hydrolytic degradation and incomplete polymerization in deeper canal areas.^[29,33] Therefore, adhesive selection should be based on post design, canal anatomy, and isolation control.

Retention values also vary by dentin regions, with higher retention generally observed apically than coronally, underscoring the influence of adhesive choice and clinical protocol on cementation outcomes.^[33]

What Should Be Considered in Post Applications?

Indication for post placement requires an assessment of the amount of remaining dentin and the overall clinical situation.^[29] Before post placement, the quality of endodontic treatment should be thoroughly evaluated. Periapical or lateral lesions must be examined radiographically, and retreatment of the root canal should be performed before post placement.^[29]

During post space preparation, preservation of coronal and radicular dentin is essential.^[32] Sound cervical dentin is critical for maintaining tooth structure and achieving a ferrule effect, thereby optimizing biomechanical performance.^[32] The ferrule effect – derived from the Latin words ferrum (iron) and viriola (bracelet) — was first introduced by Rosen in 1961 and refers to the crown's ability to encircle the underlying tooth structure in a ring-like manner.^[34]

The ferrule consists of a tooth structure extending coronally from the preparation margin and functions to distribute occlusal stresses, counteract wedging forces generated by posts, and reduce lateral functional loads.^[34] Although the ideal ferrule height remains debated, most authors recommend a continuous circumferential ferrule of 1–2 mm. Increasing ferrule height beyond 2 mm does not

appear to improve fracture resistance further.[3,34] When an adequate ferrule cannot be obtained, orthodontic or surgical extrusion or gingivectomy may be considered.

The diameter and length of a post influence both its retention and longevity. Optimal post length is as long as possible without compromising the apical seal or risking the integrity of the remaining root structure.^[4] Excessive post space preparation increases the risk of root perforation and reduces apical gutta-percha, potentially leading to periapical pathology, whereas insufficient post length results in inadequate retention.^[4,35]

The following criteria should be considered when determining post length:^[35]

- The post length should be equal to the length of the clinical crown
- The post length should be between one-half and two-thirds of the root length
- The post should extend to at least one-half of the portion of the root surrounded by bone.

Root length and morphology are the primary determinants of post length, followed by the quality of the apical seal.^[35] Periapical lesions are more frequent when apical gutta-percha is <3 mm. Optimal post length maximizes retention without compromising apical sealing or integrity of the remaining root structure, whereas excessive post preparation increases the risk of perforation and periapical pathology.^[4]

Increasing post diameter raises stress within the tooth, whereas smaller diameters may compromise retention.^[21] When a gap exists between the post, gutta-percha, and the root canal walls, a hermetic seal is not achieved, thereby increasing the likelihood of periapical lesion formation.^[29]

Post design also affects the retention and resistance of the restoration. Parallel-sided posts provide greater retention but require more dentin removal in thinner root regions, increasing fracture risk, whereas tapered posts preserve dentin but may concentrate stress apically due to a wedging effect.^[23,29]

According to surface retention mechanisms, posts are classified into two types: Active (screw-retained) and passive (cemented).^[36] Active posts generated stress concentrations that may lead to root fractures.^[36] Screw-retained posts are generally recommended for short roots requiring maximum retention.^[37] Another post design includes threaded posts with macro-retentive features that enhance mechanical retention between the post and cement. However, these features reduce flexural strength by decreasing post diameter.

Tooth's position within the arch is a key factor in restorative planning for ETT, as it influences occlusal force direction and magnitude. Research has shown that horizontal occlusal loads increase stress concentration.^[38] Furthermore, a prospective clinical study with a 39-month follow-up by Naumann et al.^[39] found that restorations on canines and incisors failed 3 times more frequently than those on premolars and molars. Adjacent teeth influence failure risk in teeth restored with intraradicular posts, with Naumann et al.^[39] reporting a threefold higher failure rate in the absence of proximal contacts. Proximal contacts help distribute stress among adjacent teeth, thereby reducing stress concentration on any single tooth.

Regardless of post space preparation, it is essential to avoid damaging the periodontal ligaments. Improper use of rotary instruments, including Peeso reamers, may significantly increase root surface temperature.^[22] Therefore, Peeso reamers or Gates–Glidden drills should be operated at low speeds and used intermittently under copious irrigation.

For optimal outcomes in fiber post applications, rubber dam isolation is recommended during both endodontic treatment and post placement to prevent bacterial contamination. Laboratory tests have demonstrated that water contact reduces the bending strength of fiber posts.^[32] Because temporary sealing of post spaces can compromise isolation, immediate post placement followed by core build-up is recommended.^[22]

A systematic review and meta-analysis by Dos Reis-Prado et al. (2021)^[38] demonstrated that delayed post space preparation compromises apical sealing, whereas immediate post placement is associated with reduced leakage. This study also recommends an ideal post space preparation interval between 24 h and 7 days after the completion of root canal filling, showing that preparation within this period minimizes apical leakage and preserves the sealing integrity of the filling.

Based on these findings, a simplified decision-making framework was developed to guide clinicians in selecting the most appropriate post system for different clinical scenarios. The main characteristics, clinical indications, and common failure modes of currently available post systems are summarized in Table 1. This framework is based on four key clinical criteria:

- Remaining coronal dentin (presence of a ferrule)
- Root canal anatomy (narrow, flared, or irregular canal morphology)
- Esthetic requirements and tooth position (anterior or posterior region)
- Functional load and occlusal stress.

Table 1. Comparative summary of different post systems (fiber, metal, CAD/CAM, and 3D-printed)

Post type	Composition	Elastic modulus	Clinical indications	Common failure modes
Fiber (Glass/Quartz)	Glass/quartz fibers in resin matrix	Similar to dentin (low-to-moderate)	Esthetic zones; moderate coronal loss; desire to reduce root fractures	Loss of retention/debonding; post-dislodgement
Metal (Pre-fabricate-CAST)	Stainless steel, titanium, cast alloys	High (>>dentin)	Extensive coronal loss; posterior teeth	Root fracture; corrosion; esthetic issues
Ceramic	Zirconia or alumina-based ceramics	Very high (rigid)	High esthetic demand with ceramic crowns	Root fracture; loss of retention (adhesion challenges)
CAD/CAM (Customized)	Milled Fiber-reinforced composite blocks (customized post core)	Low-to-moderate	Flared/weakened canals; need for thin, uniform cement layer	Debonding if bonding suboptimal; marginal gap
3D-Printed	Photopolymer/resin-based reinforced composites (custom)	Closer to dentin (material-dependent)	Personalized design; complex anatomies	Surface defects; adhesion/printing accuracy limits

CAD: Computer-aided design; CAM: Computer-aided manufacturing.

Table 2. Post design types

Design type	Mechanical behavior	Advantages	Disadvantages	Clinical recommendations
Parallel-sided	More uniform stress distribution; high cemented retention	High retention	More dentin removal apical/middle third; potential perforation risk if anatomy is not respected	Prefer when root length and dentin bulk are adequate
Tapered	Mimics root anatomy but may increase apical stress concentration (wedging effect)	Conserves dentin; better for narrow/tapered canals	Lower retention versus parallel; stress concentration apically (wedging effect)	Use in thin/narrow roots to preserve dentin; maintain optimal post length to avoid excessive apical stress
Active (screw-retained)	Threads engage dentin mechanically	High primary retention (especially in short roots)	Higher risk of root fracture due to stress concentration	Use cautiously; generally avoid in thin roots; consider only when maximum retention is needed
Passive (cemented, smooth)	Relies on adhesive cementation; lower mechanical interlock	Lower stress on the root; compatible with adhesive strategies	Lower primary retention than active designs	Preferred with fiber posts and adhesive cements; prioritize ferrule and isolation

Fiber posts are preferred in cases with an adequate ferrule and esthetic demands. Metal posts may be considered for posterior teeth with high occlusal stress and low esthetic demand. For teeth with flared or irregular root canals, customized fiber posts or CAD/CAM- or 3D-printed post systems are recommended to achieve optimal adaptation. Post placement is unnecessary when three or more sound coronal walls and a sufficient ferrule can be achieved with direct or indirect restorations. The characteristics, advantages, disadvantages, and clinical recommendations of different post designs are summarized in Table 2.

Restorations of ETT

Restoration of ETT aims to:

1. Preserve the remaining tooth structure and prevent fracture,
2. Prevent reinfection of the root canal system,
3. Replace lost tooth structure.^[30]

ETT differ structurally and in restorative treatment requirements compared with vital teeth.^[35] Loss of structural integrity, reduced moisture, increased brittleness, cavity preparation procedures, and dentin removal during caries

excavation contribute to the higher fractures incidence in ETT.^[35] Access cavities preparation weakens teeth and increases the risk of cusp fractures. The amount of remaining hard tissue is critical for tooth stability. Access cavity and root canal procedures reduce durability and rigidity by about 5%, whereas a three-surface mesio-occluso-distal preparation reduces them by about 63%.^[37] Insufficient remaining tooth structure predisposes weakened cusps to fracture under normal functional loads. Such fractures may occur at the enamel-dentin junction or extend into the root.^[39] Therefore, the restorative approach should ensure both esthetic appearance and structural reinforcement. Restoration of ETT is a challenging phase of dental treatment with multiple therapeutic options.^[22] Post placement is primarily indicated by the amount of remaining tooth structure and functional requirements.^[22]

Clinical Studies on Fiber Posts

Sarkis-Onofre et al. compared the clinical performance of GFPs and cast metal posts placed in ETT without ferrules.^[30] The annual failure rate for both types of posts was reported as 1.5% after 5 years. When evaluated individually, the annual failure rate was 1.2% for cast metal posts and 1.7% for GFPs. Most failures (16/23) occurred in posterior teeth, including 10 root fractures and 5 post dislodgement.

In their first long-term randomized controlled trial (2017), Naumann et al.^[39] compared GFPs systems with rigid titanium post (TP) systems in ETT with two or fewer remaining walls. After 132 months, survival rates were 58.7% for GFP and 74.2% for TPs. Failures in the GFP group included root fractures (n=4), crown fractures (n=1), secondary caries (n=1), failed endodontic treatment (n=2), and extraction due to mobility (n=1). In the TP group, failures were mainly due to failed endodontic treatment (n=5) and root fracture (n=1), and survival rates decreased markedly after 8 years in both groups.

Bruhnke et al.^[40] conducted a prospective clinical study to investigate the survival of ETT restored with GFPs and TPs. The primary outcome for the 128 included patients was restoration survival. Clinical and radiographic assessments were performed at 6, 12, and 24 months, with continued follow-up to 178 months. After 178 months, cumulative survival was 57.1% for GFP I, 56.5% for GFP II, and 71.8% for TP, with no significant effect of post system on tooth survival.

Van Landuyt et al.^[20] conducted a 15-year randomized controlled trial comparing GFP and metal posts in single-crowned ETT. Among 182 restorations, survival rates were 68.5% for pre-fabricated GFPs and 53.6% for metal posts,

whereas success rates were 59.2% and 48.0%, respectively. Metal posts failed more frequently due to root fractures, whereas GFPs showed fewer catastrophic failures, although the difference was not statistically significant.

Linnemann et al.^[25] conducted a multicenter prospective study evaluating the success and survival of post-restored ETT during a 3–15-year follow-up. A total of 195 teeth restored with posts were evaluated. The study defined success as cases where the post and initially placed final restoration remained intact during follow-up, including restoration replacement or re-cementation, post or crown dislodgement, root fracture, or post fracture. If the post was still functioning at the final follow-up without any clinical or radiographic signs of technical failure, even after re-cementation of the post or crown, the restoration was considered to have survived. Conversely, post replacement or tooth extraction was considered a survival failure. The annual failure rates were 6.0% for success and 3.3% for survival.

Cloet et al.^[2] conducted a prospective study comparing 5-year outcomes of 203 ETT restored with GFPs and cast posts. The mean follow-up period was 5.8 years, and failures were classified as absolute or relative. Irreparable fractures requiring tooth extraction were classified as absolute failures. Failures manageable by re-cementing of the post and crown were classified as relative failures. Success required the absence of both absolute and relative failures, whereas survival required the absence of absolute failure. After 5 years, success and survival probabilities were 85.2% and 91.5%, respectively, with no significant difference between groups.

New Approaches: Customized Fiber Post Systems

In flared root canals, where extensive tissue loss makes post adaptation difficult, pre-fabricated GFPs often fail to conform to the canal shape and size, requiring a thicker cement layer for luting.^[27] A thick cement layer is associated with inadequate polymerization, reduced mechanical strength, and void formation.^[28] To overcome these limitations, CAD/CAM and 3D printing technologies enable the fabrication of anatomically customized, monolithic GFPs that allow placement with a thin, uniform cement layer.^[28] These approaches improve adaptation and mechanical performance, reducing fracture risk, particularly in flared or weakened root canals.^[29] 3D printing offers design flexibility and rapid production, enabling highly individualized solutions.^[27] These digital techniques provide precise adaptation and potentially enhanced long-term outcomes; however, further clinical validation is required.

Conclusion

Fiber posts are essential for restoring teeth with extensive coronal damage and should be placed based on thorough clinical and radiographic evaluation of the remaining dentin. This review outlines current principles of fiber post application and common cases of failure. Future research should establish standardized clinical protocols for CAD/CAM and 3D-printed customized post systems to ensure predictable outcomes. Long-term prospective randomized clinical studies are needed to evaluate their survival rates, mechanical performance, and failure patterns under functional conditions. The development of novel biomaterials with enhanced bonding potential, biomechanical compatibility, and resistance to hydrolytic degradation should be encouraged. Integrating digital design tools, AI-assisted analysis, and patient-specific risk assessment may further reduce failures and enhance treatment durability.

Ethics Committee Approval: Ethical approval was not required for this study since this is a review article.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: Not declared.

Peer-review: Double blind peer-reviewed.

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REVIEW

Microtensile Bond Strength of Restorative Materials to Enamel and Dentin: A Narrative Review

Özge Ünlü,  Jale Görücü

Department of Restorative Dentistry, Lokman Hekim University Faculty of Medicine, Ankara, Türkiye

Abstract

The foundation of modern adhesive dentistry was laid by Buonocore's introduction of the acid-etch technique in 1955 and Bowen's development of composite resins in 1962. Today, adhesive restorative materials are widely used, offering reliable bonding to enamel. Achieving long-lasting adhesion to dentin is still challenging because of its variable structure and the presence of the smear layer. The constant evolution of adhesive systems introduces numerous products with varying compositions and clinical protocols, necessitating thorough performance evaluation. *In vivo* studies are limited by ethical and technical constraints, making *in vitro* bond strength tests a more practical alternative. While laboratory studies cannot fully replicate the oral environment, they allow for rapid, cost-effective comparisons. Various testing techniques – macroshear, macro push-out, microtensile, microshear, micro push-out, and microtensile – are employed to assess adhesive performance, with outcomes influenced by specimen preparation, substrate variability, and environmental conditions such as thermocycling. Among these, microtensile bond strength (μ TBS) has gained prominence due to its high sensitivity and ability to evaluate small bonding interfaces. It also facilitates the study of bonding behavior at different dentin depths and under localized conditions. However, translating laboratory findings into clinical success remains challenging. This review critically discusses the methodology, limitations, and clinical relevance of μ TBS in adhesive dentistry.

Keywords: Adhesive systems; Enamel and dentin adhesion; Microtensile bond strength; Resin–dentin interface

Modern adhesive dentistry began in 1955 with Buonocore's acid etching technique, followed by Bowen's development of composite resins in 1962.^[1] Buonocore, Gwinnett, and Matsui showed that acid etching created microporosities in enamel, allowing resin infiltration and micromechanical bonding via resin tags.^[2] However, dentin bonding presents greater challenges due to its heterogeneous structure, hydrophilic properties, and smear layer. In addition, adhesion strength differs across superficial, middle, and deep dentin zones. An effective

adhesive should reliably bond to both enamel and dentin, even though they differ markedly in composition.^[3]

The success of esthetic and functional restorations depends on selecting suitable adhesive systems. As minimally invasive techniques gain popularity, the clinical use of direct composite restorations has expanded in parallel with advances in adhesion technology.

This review first outlines the development and classification of adhesive systems, then focuses on the μ TBS. μ TBS is a widely accepted technique for evaluating bond strength,

Cite this article as: Ünlü Ö, Görücü J. Microtensile Bond Strength of Restorative Materials to Enamel and Dentin: A Narrative Review. Lokman Hekim Health Sci 2026;6(3):554–562.

Correspondence: Özge Ünlü. Lokman Hekim Üniversitesi Tıp Fakültesi, Restoratif Diş Hekimliği Anabilim Dalı, Ankara, Türkiye

E-mail: ozge.unlu@lokmanhekim.edu.tr **Submitted:** 27.08.2025 **Revised:** 16.01.2026 **Accepted:** 22.01.2026 **Available Online:** 06.08.2026



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offering benefits such as multiple specimen retrieval from one tooth and regional strength analysis.^[4] The review details the application, advantages, limitations, and influencing variables of this test based on current literature. The aim of this study was to identify and analyze the key methodological factors influencing μ TBS outcomes. Despite numerous laboratory investigations, the lack of standardized methodologies limits comparability across μ TBS studies.

A non-systematic literature search was conducted in PubMed, Scopus, and Web of Science using the keywords “microtensile bond strength,” “adhesive systems,” and “enamel-dentin bonding.”

Development and Classification of Adhesive Systems

Long-term clinical success depends heavily on the adhesive technology used. Over decades of research, improvements in adhesive performance have significantly promoted minimally invasive resin-based restorations. Adhesive systems are classified by generation, as summarized in Table 1.

Fourth Generation

Developed in the 1980s–1990s, these systems employ a total-etch (TE) technique, removing the smear layer completely. They involve three steps: Acid etching, primer, and adhesive application. A hydrophilic primer applied to moist dentin forms a hybrid layer, yielding high bond strength. Although still considered a gold standard, the multi-step protocol has led to the pursuit of simpler alternatives.^[5]

Fifth Generation

Introduced in the 1990s, these simplified systems combine primer and adhesive in a single bottle but maintain the TE approach. While they achieve high bond strength through a hybrid layer and resin tag formation, they are more sensitive to moisture and may be incompatible with some dual-/self-cure composites.^[5]

Sixth Generation

Emerging in the late 1990s, these self-etch (SE) adhesives incorporate an acidic primer, eliminating separate etching. They are less moisture-sensitive but show weaker enamel adhesion, requiring selective-etch (SEE). Over-demineralization of dentin can reduce bond strength.^[5]

Seventh Generation

These all-in-one systems combine etchant, primer, and adhesive in a single solution.^[5] Although user-friendly, they are highly hydrophilic. This makes them prone to moisture uptake, hydrolytic degradation, and limited resin infiltration.^[5,6] Their inability to achieve hydrophobicity after polymerization and the risk of phase separation can compromise bonding, particularly to dentin. Consequently, bond strengths are generally lower than those of previous generations.^[7]

Universal (Multimode) Adhesives

Designed to overcome previous limitations, universal adhesives (UA) can be used in TE, SE, or SEE modes. The TE approach is technique-sensitive; over-drying can collapse the collagen matrix and hinder monomer infiltration,^[8,9] increasing the risk of post-operative sensitivity.^[10] SE techniques reduce technique sensitivity but often underperform on enamel due to low pH.^[8,11] SEE offers a balance but demands precise isolation to prevent dentin over-etching.^[12]

UAs are designed to work in diverse clinical situations and can be used in both direct and indirect restorations. They are compatible with self-, light-, and dual-cure composites and a variety of substrates, including zirconia, porcelain, and metal.^[13] Properly applied, they deliver adequate bonding to enamel and dentin.^[14]

Table 1. Summary of adhesive generations and corresponding bond strength ranges

Generation	Clinical application techniques	Steps	Bond strength (MPa)
First	Resin	Two	1–3
Second	Phosphate ester+ Resin	Two	4–6
Third	Acid+Primer+ Adhesive	Three	3–8
Fourth	ER	Three	18–30
Fifth	ER	Two	17–25
Sixth	SE	Two	13–25
Seventh	SE	One	12–30
Eighth (Universal)	SE		
SEE			
ER	One		
Two			
Two	22–37		

SE: Self-etch; ER: Etch-and-rinse; SEE: Selective-etch.

While adhesive efficacy is evaluated through clinical and *in vitro* studies, the latter are more common due to time, cost, and ethical concerns. However, *in vitro* results may not fully replicate oral conditions.^[15] Thus, both study types should be used complementarily, with laboratory data supporting clinical validation. Importantly, success criteria differ between these two approaches.

Clinical Evaluation and Success Criteria

Cvar and Ryge introduced the United States Public Health Service (USPHS) criteria in 1971 to assess restorations clinically.^[16] These include color match, marginal discoloration, anatomical form, marginal adaptation, and secondary caries. Outcomes are classified as Alpha (ideal), Bravo (clinically acceptable), Charlie (needs replacement), or Delta (requires immediate replacement).^[17]

As these criteria were not designed to detect minor changes in marginal adaptation or discoloration, the Modified USPHS system was later developed. It includes additional parameters such as surface roughness, tooth integrity, retention, and post-operative sensitivity.^[17]

Laboratory Evaluation of Bond Strength

In vitro bond strength tests are widely utilized in laboratory evaluations due to several advantages over clinical studies. These advantages include rapid data collection, control over isolated variables, and ease of implementation. They also allow comparisons between standard and experimental materials, the inclusion of multiple test groups in a single study, and lower costs.^[18,19]

For reliable outcomes, careful equipment selection, proper calibration, and minimization of confounding variables are essential. In addition, repeatability, consistency within acceptable variability limits, and procedures that simulate oral conditions enhance the validity of laboratory results.^[19] In clinical conditions, multiple aging factors act simultaneously. Laboratory studies should mimic this complexity through combined protocols such as enzymatic degradation, thermal cycling, and mechanical loading. Without such simulations, *in vitro* bond strength data may not reflect clinical reality.

Bond strength tests measure the resistance of tooth-material interfaces to shear, tensile, or push-out forces. Based on bonding area, tests are categorized as macro (4–28 mm²) or micro (approximately 1 mm²). The most commonly used device for these evaluations is the Instron universal testing machine (UTM) (Norwood, MA, USA).^[19]

Macroshear Bond Strength

This test evaluates the shear resistance of dental materials on hard tissues using a bonded surface area >3 mm². A composite resin is applied via a cylindrical mold (2.5–3 mm diameter) and polymerized. A shear force is then applied using a chisel blade in a UTM.

Its advantages include ease of setup, minimal equipment, and frequent use. However, uneven stress distribution and concentration at the margins compromise test reliability.^[20]

Macro Push-Out Bond Strength

It is used to assess resistance to dislodgement under axial loading, especially in root canals with posts or resin cements. It better simulates clinical conditions in endodontic treatments, but requires a more complex protocol.^[20]

Macrotensile Bond Strength

This test measures tensile strength using larger adhesive surfaces (>3 mm²), typically with cone-shaped specimens. While it replicates tensile loading well, the difficulty in achieving uniform adhesive interfaces undermines reproducibility and reliability.^[20]

Microshear Bond Strength

Small composite cylinders are bonded to enamel or dentin, and shear force is applied using a thin wire loop. The small bonding area ensures a more homogeneous stress distribution and allows multiple specimens from one tooth. Nevertheless, slippage of the wire can lead to inaccurate measurements, necessitating a precise technique.^[20]

Micro Push-Out Bond Strength

This test involves bonding micro-sized posts in 0.7–1 mm-thick root slices, followed by axial loading to evaluate push-out resistance. It also allows analysis of dentinal tubule orientation, enhancing understanding of the bond mechanism.^[20]

Microtensile Bond Strength

The μ TBS applies tensile stress on bonded interfaces. A composite block is built on the tooth surface, from which multiple stick-shaped specimens (~1 mm²) are sectioned. Each is mounted and subjected to tensile force via UTM.^[21]

μ TBS offers high precision due to homogeneous stress distribution and the ability to assess multiple regions of a single specimen. It also evaluates localized

Table 2. Comparison of different bond strength test techniques

Test type	Surface area	Application type	Stress type	Sensitivity	Bond strength (MPa)	Reliability	Area of use
Macroshear	>3 mm ²	Cutting	Heterogeneous	Medium	Low	Medium	It is used in general restorative materials and is easier to apply.
Macro push-out	>3 mm ²	Pushing	Heterogeneous	Medium	High	Very high	It is used in post and endodontic applications with different test geometries.
Macrotensile	>3 mm ²	Pulling	Heterogeneous	Medium	Low	Low	It is the test technique used to measure the bond strength of restorative materials to tooth surfaces.
Microshear	<1 mm ²	Cutting	Homogeneous	High	High	Medium	It is used more frequently in adhesive research and is a more sensitive test technique.
Micro push-out	<1 mm ²	Pushing	Homogeneous	High	Medium	High	It is generally used to determine the bond strength of root dentin.
Microtensile	<1 mm ²	Pulling	Homogeneous	Very high	Very high	Very high	It is the most reliable bond strength test used to measure the bond strength of restorative materials to tooth surfaces.

adhesion strength. However, specimen preparation is technique-sensitive; and chipping during sectioning may impair results.^[20] A detailed comparison of different test techniques is presented in Table 2.

Specimen Preparation for Testing

For μ TBS, restorative materials are applied to prepared tooth surfaces. Using an Isomet cutting machine with water-cooled diamond discs, the bonded specimens are sectioned to yield a 1 mm² bonding area. The number of sticks per tooth depends on tooth size. Specimens typically range from 10 to 24 mm in length, half composed of tooth substrate and half of restorative material.^[21]

Various geometries can be used in μ TBS – stick, dumbbell, or hourglass shapes (Fig. 1). Correct alignment during tensile loading is crucial to avoid shear force interference. Special jigs or customized holders are often employed to achieve precise orientation (Fig. 2).^[4,22]

Advantages of the Microtensile Bond Strength

In contrast to macroscale tests, microtensile methods allow multiple specimens to be prepared from a single tooth, enabling the assessment of tooth-related variables and the calculation of an average bond strength value for each individual tooth. The μ TBS permits assessment on rough surfaces and enables better stress distribution across the

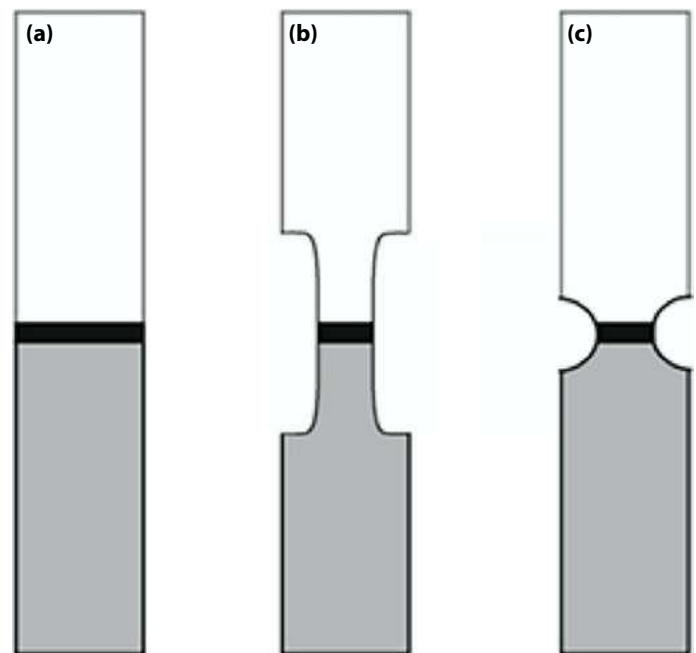


Figure 1. Shapes used in the μ TBS test: (a) bar, (b) dumbbell, and (c) hourglass.

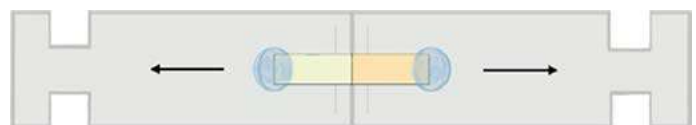


Figure 2. Schematic drawing of the holder apparatus used to measure μ TBS (Drawn by the authors).

bonded interface. Structural variations within the same tooth can be examined, and testing can be performed in very small areas such as caries-affected dentin.

The influence of remaining dentin thickness on bond strength can be analyzed, as can the effects of different cavity preparations and restorative techniques on μ TBS. The bond strength of root dentin can also be assessed. The bonding performance of each restorative material under investigation can be systematically evaluated. Compared to conventional tensile testing, μ TBS provides a more uniform force distribution.

This technique is more suitable for artificial aging procedures and, in contrast to macroscale tests, its shorter intraspecimen diffusion path enables accelerated aging protocols to be implemented more efficiently. Shear forces are minimized, and differences between adhesive systems can be detected more clearly than with other bond strength tests.

Because smaller specimens are used, the test yields more sensitive and consistent results, exhibiting less variability. Compared to other techniques, μ TBS typically demonstrates higher bond strength values in statistical analyses. The mode of failure can be easily identified using a stereomicroscope, and mechanical, morphological, and chemical analyses can be performed on the same specimen. As such, μ TBS is considered a reliable technique for evaluating adhesive performance.^[23]

Disadvantages of the Microtensile Bond Strength

Despite its numerous advantages, the μ TBS is more labor-intensive and requires greater technical precision than other bond strength tests. Specimen geometry, adhesive layer thickness, and operator handling can significantly affect stress distribution and measurement accuracy. Preparation requires specialized equipment to produce consistent specimen shapes. Internal defects, dehydration, or damage during sectioning and testing are common, and the unpredictable location of fracture initiation further complicates data interpretation. Measuring very low bond strengths (<5 MPa) remains challenging, as interface stress during handling may artificially alter results.^[24]

Roulet and Van Meerbeek^[25] proposed three approaches for managing pretest failures in μ TBS data:

1. Exclusion of all pretest failures, leading to overestimated bond strength values.
2. Assignment of 0 MPa to failures, resulting in underestimation.

3. Substitution with the lowest value from the relevant adhesive group – a compromise increasingly favored in recent studies for its balanced accuracy and reduced bias.^[25]

Importantly, the limitations of μ TBS arise not only from technical issues but also from biological variability and material-dependent factors. These aspects must be carefully considered when interpreting results or comparing data across studies.

When the advantages and limitations of μ TBS are considered together, it becomes evident that the test should not be relied upon as the sole diagnostic tool. Its high sensitivity means that even minor methodological deviations can substantially influence the results, and the way pretest failures are reported can also alter the outcome directly. While some authors in the literature have argued that μ TBS is a reliable method,^[23] others have reported that its highly sensitive nature limits its ability to predict clinical performance.^[24] These inconsistencies indicate that μ TBS findings should be interpreted alongside clinically relevant aging protocols and long-term clinical evidence.

Key Factors Influencing Microtensile Bond Strength Results

Type of Substrate

Studies have shown that the μ TBS values and SEM images obtained from human and bovine teeth are quite similar. This suggests that bovine teeth may serve as a practical and ethically acceptable alternative. However, it must be noted that microstructural differences between human and bovine dentin do exist, and these differences may lead to statistical deviations in bond strength outcomes.^[26]

Storage Duration and Conditions of Extracted Teeth

According to ISO 11450 standards, μ TBS should ideally be performed immediately after tooth extraction to ensure reliable and standardized results. However, this is often impractical in clinical and laboratory settings. As a result, extracted teeth are commonly stored under controlled conditions for later use. Prolonged storage can induce various alterations in dentin structure – particularly degenerative changes in dentin proteins – which can modify the bonding surface.

Some studies report that when appropriate storage media are used (e.g., chloramine-T or formalin), teeth can be stored for up to 2 years without a significant negative impact on μ TBS values. In contrast, other studies have

found that storage in 0.05% thymol solution for 3–6 months, or in sodium hypochlorite (NaOCl) solution for 2 months, significantly decreases μ TBS.^[27,28]

To minimize inconsistencies in bond strength data, it is generally recommended that teeth not be stored for longer than 6 months and that all storage conditions be reported in detail within the methodology.

Preparation Method and Surface Treatment

Preparation Method

μ TBS values are directly associated with the quality of the hybrid layer and resin tag formation on dentin surfaces. The preparation method significantly influences dentin morphology and, consequently, adhesive penetration. Studies comparing surfaces prepared with diamond burs, carbide burs, and 600-grit silicon carbide papers have found the highest μ TBS values in specimens prepared with 600-grit papers and the lowest with diamond burs. This indicates that sanding yields a smoother surface with minimal smear layer, which is more favorable for adhesive infiltration.^[5] Therefore, standardizing the preparation method is essential to ensure reliability and comparability of μ TBS results.

Etching Procedure

The type, concentration, duration, rinsing, and drying protocols of the acid used to remove the smear layer and demineralize dentin significantly affect μ TBS. Over-etching may cause excessive demineralization, reducing resin penetration; under-etching may leave smear debris, hindering hybrid layer formation.^[5] Thus, every stage of the etching process must be carefully controlled.

Primer Application

Primer plays a critical role in enabling adhesive monomer infiltration into demineralized dentin. Factors such as the amount of primer used, application time, evaporation method, surface moisture, and the bonding technique (wet vs. dry bonding) influence μ TBS. Insufficient application or rapid evaporation may hinder resin penetration and compromise adhesion quality.^[5] Therefore, primer application should follow manufacturer guidelines and standardized protocols.

Bond Application

Bonding performance at the adhesive interface is influenced by factors such as application amount, duration, agitation, film thickness, and polymerization. Applying a thin, uniform bonding layer and ensuring adequate light polymerization improves μ TBS, whereas thick, uneven, or

under-cured layers may reduce adhesive strength.^[5] Thus, controlled bond application is crucial.

Configuration Factor (C-Factor)

The C-factor refers to the ratio of bonded surfaces to unbonded, free surfaces and is a critical parameter influencing adhesion due to polymerization shrinkage stress. A study comparing flat dentin surfaces with low C-factors ($C=0$) to high C-factor cavities ($C=3/5$) found that while initial μ TBS values may be similar, long-term storage in water significantly reduces bond strength in high C-factor cavities.^[29] Particularly in Class-V preparations ($C=3$), polymerization-induced stresses negatively affect adhesion, resulting in considerably lower μ TBS values compared to flat surfaces. This adverse effect cannot be fully compensated for by alternative surface preparation methods and exerts a lasting weakening impact on adhesive durability.^[29] Therefore, consideration of the C-factor is critical for the accurate interpretation of μ TBS results.

Dentin Structure

Sclerotic Dentin

Sclerotic dentin contains two to three times more mineralized matrix compared to normal dentin. This increased mineralization, along with denatured collagen fibers, a hybridized inter-microbial matrix, and acid-resistant sclerotic plugs, significantly impedes resin tag formation, thereby reducing bond strength.^[30]

Caries-affected Dentin

The presence of a thick and irregular smear layer, acid-resistant surfaces, disrupted tubule structure, and bacterial or organic debris interferes with both hybrid layer formation and resin tag penetration. Due to decreased mineral content and partially denatured collagen, bond strength is significantly compromised.^[31]

Regional Variations in Dentin

Morphological characteristics such as dentin depth, tubule density, and the proportion of intertubular dentin have a direct influence on μ TBS. In root dentin, reduced tubule density and increased sclerotic tissue contribute to lower bond strength values.^[32]

*These findings show that differences in dentin morphology can substantially affect μ TBS outcomes. Therefore, dentin type, location, and structural characteristics should be standardized to ensure comparability and reliability of research outcomes.

Vital Bleaching Procedures

Hydrogen peroxide and carbamide peroxide are widely used in contemporary vital tooth bleaching protocols. Studies have demonstrated that increasing the peroxide concentration and application time correlates with a reduction in enamel μ TBS. This decrease is thought to result from peroxide-derived free oxygen, which interferes with resin polymerization by increasing polymerization shrinkage.^[33] To avoid this adverse effect on μ TBS in post-bleaching restorative procedures, it is recommended to allow sufficient time for the complete dissipation of residual oxygen or to delay bonding procedures accordingly.^[33] Moreover, to minimize the impact on μ TBS, the bleaching protocol – including peroxide concentration and exposure time – should be carefully planned and standardized.

Chlorhexidine Application

Chlorhexidine is used to enhance the long-term stability of adhesive systems by inhibiting dentin matrix metalloproteinases (MMPs), thus preventing enzymatic degradation of exposed collagen fibrils.^[14] Through this mechanism, it is believed to help preserve bond strength at the resin–dentin interface over time. Several studies have reported that application of chlorhexidine in 0.2% and 2% concentrations shows no significant short-term effect on μ TBS (e.g., after 24 h). However, after 6 months, the use of 2% chlorhexidine significantly slowed the reduction in μ TBS values.^[14] Therefore, whether or not a chemical agent (e.g., chlorhexidine) has been applied, and at what concentration, must be documented in detail, as these factors may affect μ TBS outcomes.

Thermal Cycling

This procedure involves subjecting specimens to alternating immersion in water baths at different temperatures to evaluate the resistance of restorative materials to intraoral thermal fluctuations. Due to differences in the coefficients of thermal expansion between dental tissues and restorative materials, this process induces repeated thermal stresses at the adhesive interface.^[34] Over time, such stresses may lead to microcracks or interfacial separation, resulting in reduced bond strength. While some studies have reported that thermal cycling significantly reduces μ TBS,^[23] others found the effect to be statistically insignificant.^[34] These discrepancies highlight the importance of protocol parameters such as temperature range, dwell time, and number of cycles. Therefore, detailed reporting of thermal

cycling conditions and standardized, clinically relevant simulation protocols are essential for improving the clinical validity of μ TBS results.^[34]

Specimen Geometry

The geometric shape of specimens used in μ TBS has a direct influence on the accuracy and reliability of the results. Commonly prepared shapes include straight sticks, dumbbell forms, and hourglass-shaped specimens, each differing in terms of stress distribution, test sensitivity, and ease of preparation.^[35] Straight stick and dumbbell shapes offer similar stress distribution and are easier to fabricate, providing an advantage in terms of standardization. In contrast, hourglass-shaped specimens are more difficult to prepare and carry risks such as microcrack formation. Therefore, the use of specialized equipment such as the Micro-Specimen Former is recommended to ensure consistent specimen preparation.^[35] In addition, because μ TBS values tend to be lower in hourglass-shaped specimens, the geometry of each specimen must be explicitly stated in studies, and its potential influence on the results should be carefully considered during data interpretation.^[35]

Test Protocol

For μ TBS results to be reliable and reproducible, the test protocol must be meticulously planned and standardized. Proper calibration of the testing machine, the use of a constant crosshead speed, and the preparation of specimens using a sharp blade, under water cooling, and at low speed, are all essential steps. Ideally, all specimens should be prepared by the same operator to eliminate operator-dependent variability. The materials and equipment used in the test – along with their brand, manufacturing lot number, expiration date, and storage conditions – must be thoroughly documented. Adhering to such technical reporting standards is crucial for ensuring cross-study comparability and scientific validity.^[21]

Future μ TBS research should adopt standardized reporting practices in accordance with ADM guidelines, including detailed documentation of specimen geometry, storage conditions, and crosshead speed. Such standardization will enhance reproducibility and facilitate meaningful comparisons across studies.

All of these factors significantly affect the reliability and reproducibility of μ TBS and should be carefully considered during result interpretation.^[24] Moreover, classification of failure modes during μ TBS provides valuable complementary information in evaluating the effectiveness of adhesive

systems. This is because numerical μ TBS values alone may not fully reflect the quality of adhesion. Failure mode analysis helps to identify weak areas within the bonded interface and provides insight into the nature of the bond.

Failure Modes Observed During Microtensile Bond Strength

The efficacy of μ TBS between two different substrates can be further evaluated by analyzing the types of failure observed following testing. These failure modes are typically classified as adhesive, cohesive, or mixed failures.

- **Adhesive failures:** These failures occur at the interface between the tooth substrate (enamel/dentin) and the restorative material. Adhesive failure is commonly observed in bonding systems with weak adhesion performance.^[36]
- **Cohesive failures:** These failures occur within one of the substrates – either within enamel, dentin, or the restorative material itself. Although cohesive failures are more frequent in strong bonding scenarios, a high rate of cohesive failure does not necessarily indicate optimal adhesion.^[36]
- **Mixed failures:** Mixed failures involve both adhesive and cohesive components, occurring simultaneously within the substrate and at the interface between different materials. The fracture patterns are typically examined either visually or under a stereomicroscope.^[36]

Conclusion

μ TBS remains the most sensitive laboratory method for assessing adhesive performance. However, methodological variability limits the clinical translation of laboratory results. Standardized testing protocols and integration with long-term clinical data are necessary to bridge this gap.

Ethics Committee Approval: Ethical approval was not required for this study since this is a review article.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

Use of AI for Writing Assistance: The author declared that artificial intelligence (AI) supported technologies was not used in the study.

Authorship Contributions: Concept: ÖÜ, JG; Design: ÖÜ, JG; Supervision: JG; Resource: ÖÜ, JG; Materials: ÖÜ, JG; Data Collection or Processing: ÖÜ, JG; Analysis or Interpretation: ÖÜ, JG; Literature Search: ÖÜ; Writing: ÖÜ; Critical Reviews: JG.

Peer-review: Double blind peer-reviewed.

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LETTER TO THE EDITOR

Metronidazole-Associated Delirium: A Case Report

 Azar Abiyev¹,  Nurten Ölmez²

¹Department of Gastroenterology, Lokman Hekim Akay Hospital, Ankara, Türkiye

²Department of Neurology, Lokman Hekim Akay Hospital, Ankara, Türkiye

Dear Editor,

Adverse drug reactions account for approximately 3–5% of all hospital admissions.^[1] Among antibiotics, neuropsychiatric side effects such as dizziness, tremor, and hallucinations have been reported in about 9–11% of patients treated with fluoroquinolones or nitroimidazoles. Although metronidazole is widely used and generally well tolerated, rare central nervous system adverse events – including encephalopathy, confusion, depression, and psychosis – have been described.^[2] Here, we present a case of acute delirium temporally associated with intravenous metronidazole administration.

A 45-year-old male was admitted to the emergency department with a 3-week history of diarrhea, lower abdominal pain, and syncope. His past medical history included coronary artery disease. On admission, his blood pressure was 70/40 mmHg, heart rate 120 bpm, body temperature 37°C, and oxygen saturation 95%. He reported watery, non-bloody, non-mucoid diarrhea occurring 5–6 times daily, along with nausea and vomiting, leading to reduced oral intake. Physical examination revealed mild diffuse abdominal tenderness without guarding or rebound. He denied recent travel or contact with individuals with gastroenteritis. Laboratory findings showed leukocytosis (white blood cell 21,000/ μ L), serum creatinine 2.2 mg/dL, sodium 131 mmol/L, potassium 3.8 mmol/L, and C-reactive protein 236 mg/L.

Parasite eggs were observed in stool sample. The patient was diagnosed with acute gastroenteritis and acute kidney injury, and hospitalized for intravenous hydration and empiric antimicrobial therapy with metronidazole 500 mg TID intravenously.

On the 2nd day of hospitalization, despite improvement in gastrointestinal symptoms, the patient developed confusion characterized by repetitive and incoherent speech, disorientation to place and time, and nocturnal agitation. Neurological examination revealed a confusional state with limited cooperation and apathy. The patient exhibited perseveration – repeating the same phrases in response to different questions – while cranial nerves and motor function were intact. There was mild truncal ataxia, but no focal deficits or cerebellar dysfunction. Metabolic, endocrine, and infectious causes of acute cognitive change were excluded through laboratory testing, and a non-contrast brain computed tomography was unremarkable. Given these findings, delirium was suspected, and low-dose haloperidol was initiated; however, no improvement was observed. Subsequently, metronidazole was discontinued, and within 24 h, the patient's neuropsychiatric symptoms completely resolved.

Metronidazole readily crosses the blood–brain barrier, and both the drug and its metabolites may reversibly bind to neuronal RNA, leading to direct or indirect neurotoxic effects.^[3] Metronidazole-related neuropsychiatric reactions

Cite this article as: Abiyev A, Ölmez N. Metronidazole-Associated Delirium: A Case Report. Lokman Hekim Health Sci 2026;6(3):563–564.

Correspondence: Azar Abiyev. Lokman Hekim Akay Hastanesi, Gastroenteroloji Kliniği, Ankara, Türkiye

E-mail: drazerabiyev@gmail.com **Submitted:** 29.10.2025 **Revised:** 23.11.2025 **Accepted:** 01.01.2026 **Available Online:** 06.08.2026



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are considered rare; however, to our knowledge, no precise incidence rate for metronidazole-associated delirium has been reported in the literature. The abrupt onset of delirium following drug initiation, in conjunction with rapid resolution after withdrawal, supports a probable causal relationship. In our case, the patient had taken a total of 2000 mg of metronidazole when delirium developed. Although delirium can occur at any age, it is more common in older adults. When delirium develops in younger patients, medication-induced toxicity or severe systemic illness should be strongly considered.^[4] Therefore, a detailed review of all current medications is essential when evaluating acute confusional states.

In conclusion, clinicians should remain vigilant for neuropsychiatric adverse reactions associated with metronidazole, particularly when new-onset delirium or cognitive changes arise during therapy. Early recognition and prompt drug discontinuation can prevent unnecessary diagnostic testing and facilitate rapid recovery.

Informed Consent: Written informed consent was obtained.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Use of AI for Writing Assistance: None declared.

Authorship Contributions: Concept: AA; Design: AA; Supervision: AA; Resource: AA; Materials: AA, NÖ; Data collection and/or processing: AA, NÖ; Analysis and/or interpretation: AA, NÖ; Literature review: AA; Writing: AA; Critical review: AA.

Peer-review: Double blind peer-reviewed.

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