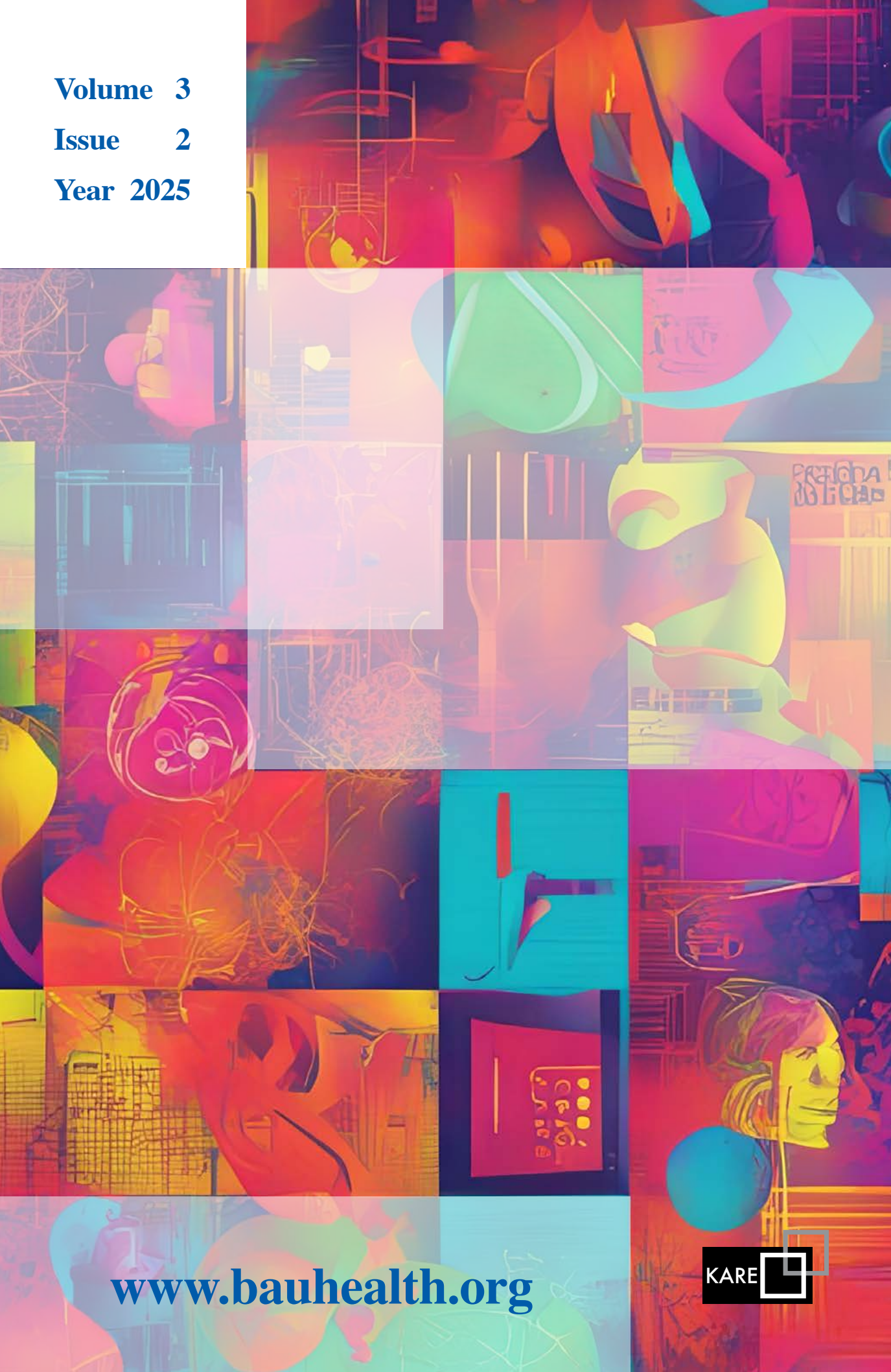


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ABOUT THE JOURNAL

Current Name: The BAU Health and Innovation Journal

Abbreviation: BAU Health Innov

Publication Type: Periodical

Editor-in-Chief: Prof. Gökay Görmeli (e-mail: gokay.gormeli@bau.edu.tr)

Publisher: Bahçeşehir University Faculty of Health Sciences

Journal Description: The BAU Health and Innovation is supported by Bahçeşehir University Faculty of Health Sciences officially and is a blind peer-reviewed free open-access journal and three issues are released every year in April, August, and December.

Abstracting and Indexing: BAU Health and Innovation is indexed in Open Ukrainian Citation Index, Scilit, İdealOnline, Asian Science Citation Index and Gale Cengage.

Start Year: 2023

Average Duration of the First Review Round: 2 months

Type of Publications: Original Article, Case Report, Review, Brief Report, Editorial Comments, Letter to the Editor.

Language of Publication: English

Frequency: Three issues per year.

Fee or Charges: This journal assesses NO submission fees, publication fees (article processing charges), or page charges.

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AIM AND SCOPE

Aim

The BAU Health and Innovation is an international, scientific, open access periodical published in accordance with independent, unbiased, and double-blinded peer-review principles. The journal publishes original articles, reviews, case reports, and other commentary in accordance with recognized ethical guidelines (<https://bauhealth.org/policies>) The journal is published every four months and three issues per year (April, August and December). The publication language of the journal is English.

The primary goal of the The BAU Health and Innovation journal is to contribute high-quality manuscripts from the field of to the international literature. We are committed to fostering the global advancement of medical science, facilitating interdisciplinary dialogue, and promoting evidence-based clinical practices to improve patient care.

The editorial and publication processes of the journal are shaped in accordance with the guidelines of the International Committee of Medical Journal Editors (ICMJE), World Association of Medical Editors (WAME), Council of Science Editors (CSE), Committee on Publication Ethics (COPE), European Association of Science Editors (EASE), and National Information Standards Organization (NISO). The journal is in conformity with the Principles of Transparency and Best Practice in Scholarly Publishing (doaj.org/bestpractice).

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Scope

The BAU Health and Innovation welcomes submissions in the following areas, but not limited to:

Clinical Research: Original research articles that contribute new knowledge to various medical specialties and sub-specialties.

Case Reports: Detailed reports of clinical cases that present unique or rare manifestations, challenges, or treatment approaches.

Review Articles: Comprehensive reviews on current topics, innovative treatments, or emerging technologies in the field of medicine.

Medical Education: Studies, reviews, and discussions concerning contemporary medical education practices, innovations, and challenges.

Medical Ethics and Medical Law: Articles addressing ethical dilemmas, discussions on medical law, and the integration of ethical practices in patient care.

Healthcare Management and Policies: Research and reviews on healthcare management, policies, system advancements, and patient safety protocols.

Interdisciplinary Medicine: Papers focusing on the intersection of different medical disciplines and the holistic approach to patient care.

Surgical and Medical Techniques: Detailed descriptions, evaluations, or innovations in surgical and medical procedures.

Technology in Medicine: Discussions, reviews, and original research on the impact, advancements, and challenges of technology in patient care, diagnosis, and treatment.

Global Health: Articles that address global health issues, international collaborations, and challenges in healthcare across different geographies.

Nutrition and Dietetics: Articles that address nutrition and dietetics issues, encompasses health, nutrition assessment, and dietary interventions.

Physiotherapy and Rehabilitation: Articles that address to enhance physical function, alleviate pain, and improve overall well-being through tailored therapeutic interventions and exercises.

Nursing: Articles that address Nursing encompasses the provision of holistic patient care, which includes health assessment, treatment planning, and compassionate support to promote well-being and recovery.

Language and Speech Therapy: Articles that address diagnosing and treating communication and speech disorders, helping individuals improve their communication skills.

Biomedical Engineering: Articles that application of engineering principles and techniques to solve problems in biology and medicine, such as designing medical devices, developing healthcare systems, and advancing medical imaging Technologies.

Manuscripts undergo a rigorous peer-review process to ensure that BAU Health and Innovation upholds the highest standards of medical scholarship and relevance. We value contributions from clinicians, researchers, educators, and medical professionals from around the world.

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Manuscript Preparation and Submission

Manuscripts should be prepared in accordance with the ICMJE-Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals (updated in December 2015 - <http://www.icmje.org/icmje-recommendations.pdf>). Authors are required to prepare manuscripts in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines for randomized research studies, the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines for observational original research studies, the Standards for Reporting Diagnostic Accuracy (STARD) guidelines, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, the Animal Research: Reporting of In Vivo Experiments (ARRIVE) guidelines for experimental animal studies, and the Transparent Reporting of Evaluations with Non-randomised Designs (TREND) guidelines for non-randomized behavioral and public health evaluations.

Manuscripts may only be submitted through the journal's online manuscript submission and evaluation system, <https://jag.journalagent.com/bauhi>. Manuscripts submitted via any other medium will not be evaluated. Manuscripts should be submitted by one of the authors of the manuscript. Submissions by anyone other than one of the authors will not be accepted.

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Manuscripts will first be submitted to a technical evaluation process in which the editorial staff will ensure that the manuscript has been prepared and submitted in accordance with the journal's guidelines. Submissions that do not conform to the journal's guidelines will be returned to the author with requests for technical correction.

The quality and clarity of the language used in a manuscript is very important. The editors may request that authors have the manuscript professionally edited if the language of the submission does not conform to the journal standards. BAU Health and Innovation uses American English. Please submit text of a quality ready for publication. Information about language editing and copyediting services

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

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

** The BAU Health and Innovation encourages the registration of all clinical trials (randomized and non-randomized) via ClinicalTrials.gov (www.clinicaltrials.gov) or one of the registries of the WHO's International Clinical Trials Registry Platform (ICTRP: <http://www.who.int/ictcp/network/primary/en/index.html>). The name of the trial registry and the registration number together should be provided at the end of the abstract.

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The manuscript should be typed in a Microsoft Word™ file, single-column format, double-spaced with 2.5 cm margins on each side, and 12-point type in Times New Roman font.

All abbreviations in the text must be defined the first time they are used (both in the abstract and the main text), and the abbreviations should be displayed in parentheses after the definition. Authors should avoid abbreviations in the title. Measurements should be reported using the metric system according to the International System of Units (SI). When a drug, product, hardware, or software mentioned within the main text product information, including the name of the product, producer of the product, city of the company and the country of the company should be provided in parenthesis.

Original article: It provides new information based on an original and novel research. It should contain a structured abstract of a maximum of 350 words with the following subheadings: Objective, Materials and Methods, Results, Conclusion. The main text of an original article should be structured with Introduction, Materials and Methods, Results, Discussion and Conclusion, References, Tables, and Figure Legends subheadings. Original articles are limited to 3500 words and 50 references.

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Review article: Reviews prepared by authors who have extensive knowledge on a particular field and whose scientific background has been translated into a high volume of publications with a high citation potential are welcomed. These authors may even be invited by the journal. Reviews should describe, discuss, and evaluate the current level of knowledge of a topic in clinical practice and should guide future studies. The subheadings of the review articles should be planned by the authors. However, each review article should include an "Introduction" and a "Conclusion" section. Please check Table 1 for the limitations for Review Articles.

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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.

Type of manuscript	Word limit	Abstract word limit	Reference limit	Table limit	Figure limit
Original article	3500	350 (Structured)	50	6	6
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Review	5000	250	60	6	6
Brief report	1500	150	15	1	3
Editorial comments	1200	No abstract	15	No tables	No figures
Letter to the editor	500	No abstract	5	No tables	No figures

The submission should not include an abstract, keywords, tables, figures, and images.

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Keywords: Each submission must be accompanied by a minimum of three and a maximum of six keywords for subject indexing included at the end of the abstract. The keywords should be selected from the National Library of Medicine, Medical Subject Headings database (<https://www.nlm.nih.gov/mesh/MBrowser.html>).

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- Statistical analysis should be conducted in accordance with the guidelines on reporting statistical data in medical journals [Altman DG, Gore SM, Gardner MJ, Pocock SJ. Statistical guidelines for contributors to medical journals. *Br Med J* 1983; 7; 1489-93 and Lang T, Altman D. Basic statistical reporting for articles published in clinical medical journals: the SAMPL Guidelines. In: Smart P, Maisonneuve H, Polderman A (editors). *Science Editors' Handbook*, European Association of Science Editors, 2013.]. The software used for statistical analysis must be described.
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Figures and figure legends: Figures, graphics, and photographs should be submitted as separate files in TIFF or JPEG format through the article submission system. The files should not be embedded in a Word document or the main document. Thick and thin arrows, arrowheads, stars, asterisks, and similar marks can be used on the images to support figure legend. Any information within the images that may identify an individual or institution should be blinded. The minimum resolution of each submitted figure should be 300 DPI. Figure legends should be listed at the end of the main document.

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(more than six authors): Dahmann-Noor AH, Comyn O, Kostakis V, Misra A, Gupta N, Heath J, et al. Plusoptix Vision Screener: the accuracy and repeatability of refractive measurements using a new autorefractor. *Br J Ophthalmol* 2009;93(1):346-9.

Epub ahead-of-print article: Miao Y, Wang X, Yin H, Han R. Effects of cavitation from extracorporeal shock wave combined with sulfur hexafluoride microbubble on myocardial ultrastructure in rats. *Anatol J Cardiol* 2023 Jun 7. doi: 10.14744/AnatolJCardiol.2023.2946. [Epub ahead of print].

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

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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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Uncorrected publication: Accepted, The abstract will appear in journal web page under the "Accepted Articles" section. A DOI will be assigned to the article at this stage.

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Final publication: The final, corrected version will appear in an issue of the journal and will be added to the journal website. To ensure rapid publication, we ask authors to provide their publication approval during the proofreading process as quickly as possible, and return corrections within 48 hours of receiving the proof.

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 - Ethics approval and/or patient consent for publication,
 - The funding information,
 - The data availability a statement that the manuscript has not been previously published or accepted for publication and is not submitted or under simultaneous review for publication elsewhere.
2. A title page including;
 - The full title of the manuscript no more than 150 characters and a short title (running head) of no more than 50 characters,

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 - The statement of conflict of interest and funding information,
 - Name, address, phone number(s), and email address of the corresponding author,
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Authorship Policy

Each individual listed as an author should fulfill the authorship criteria recommended by the International Committee of Medical Journal Editors (ICMJE). The ICMJE recommends that authorship should be based on the following 4 criteria:

Substantial contributions to the conception or design of the work, or the acquisition, analysis, or interpretation of data for the work; AND

Drafting the work or revising it critically for important intellectual content; AND

Final approval of the version to be published; AND

Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

In addition to being accountable for their own work, authors should have confidence in the integrity of the contributions of their co-authors and each author should be able to identify which co-authors are responsible for other parts of the work.

All of those designated as authors should meet all four criteria for authorship, and all who meet the four criteria should be identified as authors. Those who provided a contribution but do not meet all four criteria should be recognized separately on the title page and in the Acknowledgements section at the conclusion of the manuscript.

The BAU Health and Innovation requires that corresponding authors submit a signed and scanned version of the authorship contribution form available for download through during the initial submission process in order to appropriately indicate and observe authorship rights and to prevent ghost or honorary authorship. Please note that the list of authors on the final manuscript will be presented in the order provided on this form. If the editorial board suspects a case of "gift authorship," the submission will be rejected without further review. As part of the submission of the manuscript, the corresponding author should also send a short statement declaring that they accept all responsibility for authorship during the submission and review stages of the manuscript.

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In accordance with the journal's policy, an approval of research protocols by an ethics committee in accordance with international agreements "WMA Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects (last updated: October 2013, Fortaleza, Brazil)", "Guide for the care and use of laboratory animals (8th edition, 2011)" and/or "International Guiding Principles for Biomedical Research Involving Animals (2012)" is required for all research studies. If the submitted manuscript does not include ethics committee approval, it will be reviewed according to COPE's guideline (Guidance for Editors: Research, Audit and Service Evalu-

ations). If the study should have ethical approval, authors will be asked to provide ethical approval in order to proceed the review process. If they cannot provide ethical approval, their manuscript will be rejected and also their institutions and when needed, the related bodies in their country will be informed that such studies must have ethics committee approval. If they provide approval, review of the manuscript will continue.

For articles concerning experimental research on humans, a statement should be included that shows informed consent of patients and volunteers was obtained following a detailed explanation of the procedures that they may undergo. The journal may request a copy of the Ethics Committee Approval received from the relevant authority. Informed consent must also be obtained for case reports and clinical images.

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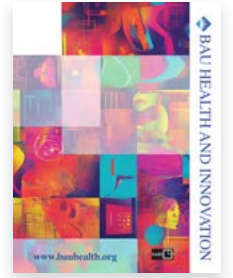
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Relationship Between Microbiota Awareness Probiotic Food Consumption Frequency and Orthorexia Nervosa in Health Professional Candidates

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Abstract

Objectives: This study aims to evaluate the relationship between microbiota awareness, frequency of probiotic food consumption, and orthorexia nervosa (ON) tendencies among university students studying health-related fields.

Methods: The study was cross-sectional and descriptive research with 275 voluntary participants from the faculties of Health Sciences, Medicine, Pharmacy, and Dentistry. The data were collected through an online survey. The analysis was performed using the Statistical Package for the Social Sciences 22.0 software.

Results: After analysing, the mean ORTO-11 score was 24.68 ± 6.3 and the mean microbiota awareness scale score was 70.6 ± 18.03 . No significant relationship was found between the frequency of probiotic consumption and ON tendencies ($p > 0.05$). However, a significant positive correlation was found between microbiota awareness and ORTO-11 scores ($p < 0.05$). Regression analysis showed that microbiota awareness accounted for 16.4% of the variance in ORTO-11 scores. Each one-point increase in microbiota awareness score was associated with a 0.057-point increase in ORTO-11 score.

Conclusion: These findings suggest that as microbiota awareness increases, ON tendencies decrease. While few studies have reported the relationship between ON and probiotic consumption, no research has directly examined the relationship with microbiota awareness. A multidisciplinary approach combining nutritional psychology and microbiota research is essential to advance understanding of this topic.

Keywords: Eating behavior, microbiota, microbiota awareness, orthorexia, probiotics.

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The role of probiotics and gut microbiota in human health has gained significant attention in recent years. Probiotics, defined as live microorganisms that provide health benefits when consumed in adequately, are crucial in maintaining gut health and modulating the immune system.^[1] Various probiotic food products have been classified based on their types and processing methods, with increasing interest in their applications in the food industry.^[2,3] Recent studies

highlight the impact of consuming foods rich in bacterial probiotics, postbiotics, and their metabolites on overall health.^[4] The gut microbiota, a complex ecosystem of microorganisms, has been linked to multiple physiological processes, including digestion, metabolism, and even mental health.^[5,6] Researchers emphasize the significance of gut microbiota in maintaining homeostasis and preventing various diseases.^[7]

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Moreover, emerging research has explored the psychological aspects of dietary habits, particularly orthorexia nervosa (ON), which is characterized by an excessive preoccupation with healthy eating by Steven Bratman in 1997.^[8] In 2016, Bratman and Dunn distinguished ON from the general desire to live a healthy lifestyle because of its negative consequences, such as malnutrition or impaired social functioning.^[9] Orthorexic individuals are primarily concerned with the quality and perceived purity of food rather than its quantity. They often examine the source, processing, and packaging of foods in detail, avoiding items they believe may be harmful to health, such as those exposed to pesticides or containing additives. This health-focused fixation, unrelated to religious or environmental motives, can lead to restrictive and time-consuming eating patterns based on strict personal rules.^[10] The diagnostic criteria and assessment tools for ON have been a subject of ongoing debate within the scientific community.^[11,12] Some researchers propose a strong correlation between obsessive-compulsive tendencies, dieting behaviors, and ON.^[13] In addition, the relationship between gut microbiota and mental health is an area of growing interest. The gut-brain axis, which refers to the bidirectional communication between the gut microbiome and the central nervous system, has been implicated in stress regulation and cognitive functions.^[14,15] This connection highlights the potential influence of dietary choices on both physical and mental well-being.

In the literature, studies examining the relationship between gut microbiota, nutrition psychology, and eating disorders have been increasingly emerging. However, comprehensive research integrating these variables remains limited. Most existing studies focus on the effects of gut microbiota on mental health (e.g., depression, anxiety) or the association between probiotic consumption and psychological well-being.^[5,16] Nevertheless, a clear framework has yet to be established regarding how microbiota awareness influences individuals dietary choices and how the balance between healthy eating and pathological eating behaviors is shaped in this process. In particular, the lack of studies directly investigating the relationship between ON and microbiota awareness is noteworthy. While it is known that orthorexic tendencies are often observed in individuals with a high awareness of healthy eating,^[17] the extent to which awareness of gut health and probiotic consumption habits influence these tendencies remains unclear. Among groups with greater nutritional knowledge, such as future healthcare professionals, it has not yet been adequately explored whether this awareness contributes to the development of ON.

In this study, the relationship between microbiota awareness, the frequency of consumption of probiotic-containing foods, and ON was examined to assess the tendencies of future healthcare professionals from the perspective of nutrition psychology. While many studies have looked at probiotic and microbiota effects on mental health, few have directly examined how microbiota-related health consciousness influences pathological eating patterns, ON, especially among future health workers. The findings obtained may contribute to understanding the boundaries of healthy eating behaviors from a nutrition psychology perspective and to adopting more balanced nutritional approaches in the educational processes of healthcare professionals.

Materials and Methods

Study Design

This study is a cross-sectional and descriptive research examining the relationship between probiotic food consumption frequency and microbiota awareness levels with ON among university students. The study was conducted by the principles of the Helsinki Declaration, and ethical approval was obtained from the Bahçeşehir University Scientific Research and Publication Ethics Committee on 04.04.23 with the approval number E-20021704-604.02.02-56224.

The study was conducted between April 2023 and February 2024 with students aged 18 and older studying at Bahçeşehir University. The study population consisted of students from the Faculty of Health Sciences, Faculty of Medicine, Faculty of Dentistry, and Faculty of Pharmacy at Bahçeşehir University. A simple random sampling method was used for sample selection. The sample size of the study was calculated using the G*Power 3.1.9.4 power analysis program. Sample size calculations indicated that at least 266 individuals needed to be included at a 95% confidence level ($\alpha = 0.05$) and 95% power. Participants took part in the study through an online survey form. The survey form was shared in WhatsApp groups of participants from the relevant departments. Before starting the survey, participants were asked to fill out an informed consent form and indicate whether they agreed to participate in the study.

Questionnaire

The "Sociodemographic Form," consisting of 10 questions, was used to determine individuals' sociodemographic characteristics, including gender, age, undergraduate class, marital status, employment status, presence of chronic diseases, smoking, and alcohol consumption status, and

anthropometric measurements such as height and weight. Participants body mass index (BMI) was calculated according to the classification of the World Health Organization.^[18]

The "Probiotic food Consumption Frequency Form," developed by the researcher, was used to assess individuals' consumption of probiotic-containing foods or dietary supplements. This form consists of 14 categories, including "Probiotic Food Supplements (Sachet-Capsule)," "Probiotic-Enriched Milk," "Yogurt," "Types of Cheese," "Ayran," "Kefir," "Boza," "Brined Olives," "Turnip Juice," "Pickles," "Pomegranate Molasses," "Vinegar," "Beer," and "Red Wine," all of which are probiotic food options accessible to students.

The microbiota awareness scale (MAS) was developed by Külcü and Önal^[19] to assess microbiota awareness levels in adults. This scale consists of 20 questions and is structured into four sub-dimensions: "General Information," "Product Knowledge," "Chronic Disease," and "Probiotics and Prebiotics". It is a five-point Likert-type scale ("1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree"). Questions 17 and 18 consist of multiple-choice knowledge questions, where each correct answer earns 1 point, and each incorrect answer that is not marked is also scored 1 point. Questions 19 and 20 are open-ended, and scoring is based on the number of responses: 1 point for no response, 2 points for one response, 3 points for two responses, 4 points for three responses, and 5 points for four or more responses. The total possible score on the scale ranges from a minimum of 18 to a maximum of 100. Since there is no cut-off point, higher scores indicate higher levels of microbiota awareness. The Cronbach's Alpha coefficient of MAS is 0.852, while in this study, it was found to be 0.952. Necessary permissions were obtained from the original researchers before conducting the study.

ORTO-11 was developed by Donini and Marsili,^[20] and its Turkish adaptation was carried out by Arusoglu.^[21] ORTO-11 is a four-point Likert-type scale, ranging from "always"^[1] to "never."^[4] Only question 8 is reverse-coded. The total score on this scale ranges from 11 to 44, with higher scores indicating lower orthorexic tendencies. The Cronbach's Alpha coefficient for scale is 0.62 Donini and Marsili^[20] while in this study, it was found to be 0.687. Necessary permissions were obtained from the original researcher before conducting the research.

Statistical Analysis

The data obtained in the study were analyzed in a computer environment using the statistical program Statistical Package for the Social Sciences (SPSS) for Windows, Version 22 (IBM SPSS Statistics for Windows, Version 22. Armonk, IBM Corp., NY, USA). A normality analysis (Shapiro-Wilk

and Kolmogorov-Smirnov tests) determined that the data followed a normal distribution; therefore, parametric tests were used for the analyses. Categorical variables were analyzed using frequency and percentage values. Quantitative variables were analyzed using minimum, maximum, mean, and standard deviation. Comparisons between the two groups were conducted using the chi-square test for categorical variables, and Student's t-test for quantitative variables. Comparisons among more than two groups were conducted using one-way analysis of variance (ANOVA). Spearman's correlation test was used for relational analyses, while Linear Regression was applied for effect analysis. A $p < 0.05$ was considered statistically significant.

Results

This study was conducted between April 2023 and February 2024 with a total of 275 participants, of whom 76.7% were female and 23.7% were male. The participants ages ranged from 18 to 30 years, with a mean age of 21.2 ± 2.18 years. The general characteristics of the participants are presented in Table 1.

The ORTO-11 scale scores of individuals were compared according to the frequency of consumption of various probiotic-containing foods and supplements. No statistically significant differences were observed between groups for any of the foods analyzed ($p > 0.05$ for all). Although the mean scores showed slight variations across consumption frequencies, these differences were not statistically significant. For instance, individuals consuming probiotic supplements (sachet or capsule) $< 1-2$ times/week had a mean ortho-11 score of 24.63 ± 6.71 , whereas those consuming them $1-2$ times/week or more had a mean score of 22.71 ± 7.44 , and those who never consumed had a score of 25.13 ± 5.85 ($p = 0.718$). Similarly, for probiotic-enriched milk, mean scores were 25.41 ± 6.21 ($< 1-2$ times/week), 22.59 ± 5.92 ($\geq 1-2$ times/week), and 24.74 ± 6.34 (never), with no significant difference between groups ($p = 0.146$). Among all the foods, turnip juice approached statistical significance ($p = 0.052$), suggesting a potential trend toward differences depending on consumption frequency, although it did not reach the conventional threshold of statistical significance ($p < 0.05$). Overall, the consumption frequency of probiotic foods and supplements did not significantly affect ORTO-11 scores in this sample (Table 2).

It is observed that the mean score of the general information sub-dimension is 24.21 ± 7.26 , the product knowledge sub-dimension is 9.41 ± 2.03 , the chronic disease sub-dimension is 17.78 ± 5.43 , the probiotic and prebiotic sub-dimension is 18.82 ± 5.76 , the MAS score is 70.23 ± 18.2 , and the ORTO-11 scale score is 24.68 ± 6.3 (Table 3).

Table 1. Distribution of general information about participants

Characteristics	Min-max	Mean±SD	Characteristics	n (275)	%
Age (year)	18–30	21.2±2.18	Marital status		
Characteristics	n (275)	%	Single	271	98.5
Gender			Married	4	1.5
Female	211	76.7	Working status		
Male	64	23.3	Working	35	12.7
Undergraduate department			Not working	240	87.3
Nutrition and dietetics	104	37.8	Chronic disease		
Speech and language therapy	6	2.2	Yes	24	8.7
Dentistry	12	4.4	No	251	91.3
Pharmacy	11	4	Smoking		
Physiotherapy and rehabilitation	20	7.3	Yes	66	24
Nursing	60	21.8	No	209	76
Medicine	62	22.5	Alcohol use status		
Class			Yes	123	44.7
1 st	61	22.2	No	152	55.3
2 nd	89	32.4	BMI		
3 th	59	21.5	Underweight (<18.5 kg/m ²)	29	10.5
4 th	56	20.4	Normal weight (18.5–24.9 kg/m ²)	189	68.7
5–6 th	10	3.6	Overweight (25–29.9 kg/m ²)	46	16.7
			Obese (≥30 kg/m ²)	11	4

SD: Standard deviation, BMI: Body mass index.

Table 2. Evaluation of ORTO-11 scores of individuals according to frequency of use of probiotic-containing foods and food supplements

Variables	ORTO-11 scores according to frequency of use				
	<1–2 times/week	≥1–2 times/week	Never	F	p
Foods					
Probiotic supplements (sachet-capsule)	24.63±6.71	22.71±7.44	25.13±5.85	2.521	0.718
Probiotic-enriched milk	25.41±6.21	22.59±5.92	24.74±6.34	1.934	0.146
Yogurt	25.46±5.99	24.43±6.26	24.37±7.67	0.708	0.494
Cheese varieties	25.82±5.75	24.48±6.32	23.83±6.99	1.288	0.278
Ayran (Turkish Yogurt drink)	25.25±5.87	24.04±6.53	25.09±6.74	1.192	0.305
Kefir	24.87±6.07	23.59±6.41	24.84±6.41	0.640	0.528
Boza (fermented beverage)	25.00±6.51	24.17±9.09	24.64±6.20	0.074	0.929
Pickled olives	25.43±6.46	24.51±6.49	24.28±5.97	0.782	0.459
Turnip juice	24.10±6.189	21.21±7.475	25.15±6.173	2.986	0.052
Pickles	25.13±5.89	24.37±6.63	24.18±6.63	0.612	0.543
Pomegranate molasses	24.96±5.50	24.56±7.08	24.38±6.77	0.232	0.793
Vinegar	24.69±5.83	24.15±6.65	24.89±6.62	0.233	0.792
Beer	24.28±6.10	24.87±7.71	24.86±6.04	0.247	0.781
Red wine	25.10±6.52	25.24±8.14	24.42±5.94	0.414	0.661

ORTO-11: Orthorexia Nervosa Scale-11, F: Analysis of variance (ANOVA) test statistic.

In the comparison of the scale and sub-dimensions by gender, a statistically significant difference was found between gender and the chronic disease, probiotic, and prebiotic sub-dimensions, as well as MAS ($p<0.05$). The

mean scores of female participants were found to be higher in the sub-dimensions and MAS where a significant difference was observed. No significant differences were found between BMI categories and class level. The ANOVA

Table 3. Score distributions of the scale and its subdimensions

	Min	Max	Mean±SD
General information	6	30	24.21±7.26
Product knowledge	4	16	9.78±2.14
Chronic disease	5	25	17.78±5.43
Probiotic and prebiotic	5	25	18.82±5.76
MAS score	22	95	70.6±18.03
ORTO-11 score	11	44	24.68±6.3

SD: Standard deviation, MAS: Microbiota awareness scale.

analyses for general information, product knowledge, chronic disease awareness, probiotic and prebiotic knowledge, MAS score, and ORTO-11 score showed no significant differences for BMI categories ($p>0.05$) and class level ($p>0.05$). The analysis revealed no significant

relationship between BMI categories and MAS scale scores or its sub-dimensions ($p>0.05$) (Table 4).

In the relational analysis between participant age and the scale and its sub-dimensions, a low-level positive and statistically significant relationship was found between age and the ORTO-11 scale ($p<0.05$) (Table 5).

In the relational analysis of the ORTO-11 scale with MAS and its sub-dimensions, a positive, low-level, and statistically significant relationship was found between the ORTO-11 score and the general information, chronic disease, probiotic and prebiotic sub-dimensions, as well as MAS ($p<0.05$). In the impact analysis conducted between MAS and the ORTO-11 scale, it was determined that MAS affected ORTO-11 by 16.4% ($R=0.164$), that a 1-unit increase in the MAS score increased ORTO-11 by 0.057 points ($B=0.057$), and that this effect was statistically significant ($p<0.05$) (Table 6).

Table 4. Comparison of gender, grade level and BMI categories with scales and sub-dimensions

Scale	Female (n=211)	Male (n=64)	t	p	Class-level F	p	BMI F	p
General information	24.73±6.73	22.50±8.62	1.900	0.061	1.228	0.299	0.210	0.889
Product knowledge	9.81±2.18	9.70±2.00	0.351	0.726	0.712	0.584	0.847	0.469
Chronic disease	18.23±5.12	16.31±6.16	2.266	0.026*	1.631	0.167	0.540	0.655
Probiotic and prebiotic knowledge	19.36±5.51	17.04±6.25	2.847	0.005*	1.149	0.334	0.237	0.870
MAS score	72.13±16.91	65.56±20.68	2.320	0.011*	1.046	0.384	0.175	0.913
ORTO-11 score	24.63±6.10	24.86±7.04	0.255	0.799	1.491	0.205	0.473	0.701

Independent-samples t-tests were used for gender comparisons; one-way ANOVA for class-level and BMI-category comparisons. *: $p<0.05$. BMI: Body mass index, F: Analysis of variance (ANOVA) test statistic, MAS: Microbiota awareness scale, ORTO-11: Orthorexia Nervosa Scale-11, ANOVA: Analysis of variance.

Table 5. Relational analysis of age with scales and subdimensions pearson correlation test

Variable	General information	Product information	Chronic disease	Probiotic and prebiotic	MAS score	ORTO-11 score
Age (r^*)	-0.058	-0.069	0.005	-0.039	-0.034	0.127
Age (p^*)	0.340	0.253	0.930	0.523	0.575	0.035

*: Spearman's correlation analysis. MAS: Microbiota awareness scale

Table 6. Results of the relational analysis (spearman correlation) and linear regression analysis of ORTO-11 scale and mas and its sub-dimensions

	General information	Product information	Chronic disease	Probiotic and prebiotic	MAS score
ORTO-11					
r	0.158	0.072	0.179	0.120	0.164
p**	0.009	0.231	0.003	0.047	0.006
	B	R	t	p*	
(Constant)	20.639	0.164	13.604	<0.001	
MAS	0.057		2.752	0.006	

** : Spearman's correlation analysis (r), * : Linear regression analysis (B, R). MAS: Microbiota awareness scale, B: Unstandardized regression coefficient, R: Correlation coefficient in regression analysis.

Discussion

A literature review reveals a limited number of studies on microbiota awareness, and no study examining the relationship between microbiota awareness and ON has been found. In our study, the total score of the MAS was found to be 70.6 ± 18.03 . In the validity and reliability study of the MAS conducted by Külcü and Önal,^[19] the total MAS score was found to be 64.74 for women and 62.42 for men. In a study involving students from various faculties, the average MAS score was found to be 68.4, while the score for Health Sciences Faculty students was 69.9, which was significantly higher.^[22]

It has been the subject of various studies that probiotics modulate gut health, improve immune response, reduce intestinal inflammation, have cholesterol-lowering effects, and have positive effects on mental health through the brain-gut axis.^[23,24] Probiotics, which are known to have these health effects, may increase their consumption in orthorexic individuals in the context of the etiology of orthorexia. Therefore, individuals with higher ON tendencies may consume probiotic foods more frequently to optimize their general health, thus, a positive relationship between ORTO-11 scores and probiotic consumption may be expected. Nevertheless, no relationship was found between the total ORTO-11 score and probiotic food consumption in our study. In a study evaluating the frequency of food consumption and ON tendency using a form consisting of 116 food groups, a significant difference was found between the consumption of full-fat yogurt and ON tendency. Individuals who consumed yogurt "5–6 times a week" had a higher ON tendency compared to those who consumed it "2–3 times a week".^[25] The number of studies in the literature between ON and probiotic food consumption is quite limited. The lack of a significant relationship between probiotic consumption frequency and ON in our study may be because the frequency categories we assessed reflect foods easily accessible and commonly consumed in daily diets in the Turkish sample. Importantly, health sciences students generally have above-average knowledge about what probiotic foods are, what they do, and from which sources they can be obtained. This may indicate that their food preferences are more informed, but based on knowledge rather than orthorectic motivations. In other words, their probiotic consumption may not reflect their orthorectic behavior.

A high ORTO-11 score means there is a low tendency for ON. In this study, a positive correlation was found between ORTO-11 and age, meaning that as age increases, ON tendency decreases. Similarly, in Arusoğlu's^[21] study, it was reported that ON tendency decreases with age. This may be related to the fact that as individuals age, their knowledge and experience regarding nutrition increase. In

their study examining the effect of age on ON, Dunn et al.^[26] found that younger individuals exhibited stricter attitudes toward healthy eating, but this tendency declined with age. Similarly, a meta-analysis conducted by Strahler,^[27] showed that women are more prone to ON compared to men, but this tendency decreases with age in both genders. Considering that the participants in our study are prospective health professionals, it is expected that as they age, their knowledge base will expand, and they will develop a more balanced approach to nutrition.

In our study, a significant relationship was found between gender and the total MAS score, as well as the "probiotic and prebiotic" and "chronic disease" subdimensions. Women had higher scores in the significant subdimensions and the total MAS score. Similar studies have also found higher scores among female participants.^[19,22,28]

The lack of a significant association between BMI categories and scale scores in the present study. In a study examining MAS scores in nutrition and dietetics students, it was reported that students categorized as slightly overweight had significantly lower microbiota awareness compared to other BMI groups.^[29] However, similar studies investigating adults have not found a significant relationship between microbiota awareness and BMI.^[22,30]

There are conflicting results in the literature regarding the relationship between BMI and ON. One study found a very weak negative correlation between BMI and ON, although it was not statistically significant.^[31] Arusoğlu et al.^[21] stated that BMI had no significant effect on ON tendencies. Similarly, a study conducted with university students reported no relationship between BMI and ON.^[32] A study conducted with 465 participants among undergraduate students found that although there was no relation between BMI and ON symptomatology, individuals who perceived themselves as relatively muscular and lean were more likely to exhibit ON symptoms.^[33] The results of a systematic review of the risk of ON in healthcare workers and students offer mixed results. The relationship between BMI and ON remains inconsistent.^[34] Overall, while some associations exist, they tend to be weak and inconsistent, with limited clinical significance.

Additionally, class level was not found to be a significant predictor of the measured scale variables in this study. Similarly, some studies have reported no difference between orthorexia scores and grade level in their studies of nutrition and dietetics students.^[35–37] In our study, there was no significant relationship between undergraduate class and MAS scores, but the group with the lowest average in the MAS total score was composed of 1st-year students. A study shows In a study, it was reported that the level of microbiota awareness increased significantly

with increasing age in nutrition and dietetics students and awareness was significantly higher in 4th grade students compared to other grades.^[29] Although it is an expected result that the groups with lower undergraduate grade levels have lower MAS scores, the reason for the lack of a significant relationship can be explained by the fact that the score gap between the grade groups is not very wide.

Results of the relational analysis of the ORTO-11 scale and MAS it was observed that MAS influenced ORTO-11 and that an increase in MAS scores led to an increase in ORTO-11 scores. The increase in MAS scores may be associated with a decrease in orthorexic tendencies. Our study suggests that as individuals' microbiota awareness increases, their ON tendencies decrease. The observed relationship between MAS and ORTO-11 in our study can be explained by the fact that individuals with high microbiota awareness may act more consciously regarding nutrition, leading to a lower tendency for ON.

Limitations of the Study

- The gender distribution of our participants is not equal and they completed the survey online, their responses were accepted without external validation which may limit the generalizability of impacts and outcomes to other demographic groups.
- In addition, a detailed dietary assessment method such as a 24-h food consumption record or a several-day diet diary was not used. This may have resulted in the actual consumption levels of individuals not being fully reflected and the association between the ORTO-11 score and probiotic consumption not being detected.

Strengths of the Study

- The study explores the novel intersection of microbiota awareness, probiotic food consumption, and ON, contributing to emerging research in health and nutrition.
- The study integrates concepts from microbiology, nutrition, psychology, and public health, providing a comprehensive perspective on the topic.

Conclusion

In recent years, interest in health and healthy eating habits has been increasing across various scientific disciplines. ON is a controversial eating disorder characterized by an excessive preoccupation with the purity of food. It is important for healthcare professionals/candidates to be well-informed about healthy nutrition and to understand what constitutes a healthy diet. This knowledge is essential for them to provide beneficial guidance to their patients or clients in their professional practice.

The findings of this study indicate that participants with higher levels of microbiota awareness exhibit lower tendencies toward ON. This suggests that as awareness increases, the risk of ON decreases. This outcome may be explained by the fact that participants perceive healthy eating not as an obsession but as an integral part of a healthy lifestyle. Given the limited number of studies investigating microbiota awareness, future research in this area is of significant importance.

The study shows no significant relationship was found between the frequency of probiotic consumption and ON. The number of studies exploring the link between probiotic consumption and ON in the literature is quite limited. Considering the growing interest in probiotics in recent research, future studies could investigate this relationship in a broader sample, incorporating various food categories beyond probiotics. In this context, the findings of our study provide valuable insights into the influence of microbiota awareness on ON tendencies.

The present findings suggest that the relationship between microbiota awareness, consumption of probiotic foods, and orthorexic tendencies among future healthcare professionals should be carefully evaluated. In this context, incorporating more content into healthcare education curricula that promote balanced and flexible eating behaviors may help students develop a knowledge-based, yet non-obsessive, approach to healthy eating. Future research should be conducted with larger and more homogeneous samples from different age groups and professional backgrounds to establish stronger correlations and better understand causal relationships. A multidisciplinary approach, integrating nutritional psychology and microbiota research, is essential for advancing knowledge in this field.

Disclosures

Ethics Committee Approval: The study was approved by the Bahçeşehir University Scientific Research and Publication Ethics Committee (no: E-20021704-604.02.02-56224, date: 04/04/2023).

Informed Consent: Informed consent was obtained from all participants.

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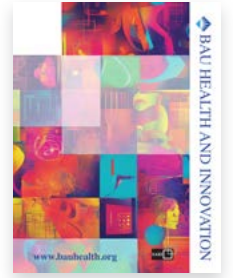
Author Contributions: Concept – A.Y., B.M.K.; Design – A.Y., B.M.K.; Supervision – A.Y., B.M.K.; Resource – A.Y.; Materials – A.Y.; Data collection and/or processing – A.Y.; Data analysis and/or interpretation – A.Y.; Literature search – A.Y.; Writing – A.Y.; Critical review – A.Y., B.M.K.

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Dentists' Awareness of the Role of Physiotherapists in the Treatment of Temporomandibular Disorders

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Abstract

Objectives: Temporomandibular disorders (TMDs) are frequently encountered conditions with complex, multifactorial causes that often necessitate a multidisciplinary and collaborative treatment approach.

Methods: This cross-sectional study assessed TMDs management practices among Turkish dentists through a 22-item online questionnaire. The tool, based on standardized TMDs criteria, included an educational infographic. Data were collected from dentists through social media/email, focusing on referral patterns, interdisciplinary awareness, and treatment preferences. The data are presented as the total number of participants and frequency percentages.

Results: The questionnaire was completed by 106 dentists. The participating dentists had a mean age of 32 ± 9.58 years. The majority were general dental practitioners with bachelor's degrees and 0–5 years of clinical experience. It was observed that 26.4% of dentists refer TMDs patients to physiotherapist (PT). Most of the dentists prefer occlusal splints, occlusal adjustments, and pharmacotherapy in the TMDs treatment. TMDs patients were predominantly referred to PT for neck pain and postural problems. Before participating in this survey, the majority of dentists were unaware that PT could play a role in the treatment of TMDs patients. After the questionnaire, 67% of dentists indicated an increased likelihood of referring TMDs patients to a PT when deemed necessary. 87.7% of participants expressed an interest in gaining further knowledge about the benefits of interdisciplinary collaboration with PT in the management of TMDs.

Conclusion: This study showed that dentists had limited awareness of the role of PTs in the treatment of TMDs. The results highlight significant gaps in both knowledge and awareness about the TMDs treatment.

Keywords: Dentists, physical therapists, temporomandibular dysfunction.

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The temporomandibular joint (TMJ) is one of the most frequently utilized and highly mobile joints in the human body, playing a crucial role in functions, such as mastication, swallowing, and speech.^[1] Temporomandibular disorders (TMDs) refer to a group of conditions that affect the structure and function of the TMJ and its associated components.^[2] The common clinical manifestations of TMDs

include TMJ pain, restricted mandibular movement, joint sounds during function, widespread myofascial pain in the surrounding muscles and jaw fascia, and headaches.^[3] TMDs are relatively common, with a prevalence ranging from 5% to 12% across different populations. The condition is more frequently observed in women than in men and typically affects individuals between the ages of 20 and 50.^[4]

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TMDs, as classified by the Diagnostic Criteria for TMDs, encompass a broad spectrum of conditions, ranging from acute to chronic and from simple to complex forms.

^[5] These disorders are often influenced by cognitive, psychosocial, and behavioral factors. TMDs are considered multifactorial in origin, with risk factors, including trauma, bruxism, malocclusion, psychological stress, poor posture, and connective tissue disorders. In chronic cases, a multidisciplinary approach is particularly essential, involving collaboration among primary care physicians, dentists, physiotherapists (PTs), psychologists, and speech-language therapists. The knowledge, training, and coordinated efforts of these professionals play a pivotal role in achieving effective treatment outcomes.^[6]

A variety of treatment modalities have been proposed for TMDs, including interocclusal appliances, occlusal adjustment, physiotherapy, jaw exercises, acupuncture, transcutaneous electrical nerve stimulation, cognitive behavioral therapy, and pharmacological interventions.

^[7] Physiotherapy is recognized as the most cost-effective and non-invasive treatment modality for TMDs.^[8] Recent evidence further underscores the pivotal role of PT in restoring jaw function by increasing mouth opening and mobility, and alleviating TMJ-related pain and inflammation. Moreover, interdisciplinary collaboration – particularly between dentists and PTs – has been associated with superior clinical outcomes.^[9]

Several studies have investigated the knowledge, attitudes, and awareness of dentists and PTs regarding their respective roles in the treatment of TMDs across various geographical regions.^[1,7,9–12] These studies consistently report a lack of interprofessional collaboration in TMDs management and indicate that many dentists are unaware of the importance of referring patients to PTs.^[1,8] However, a review of the existing literature reveals a lack of studies evaluating dentists' awareness of the role of physical therapists in Türkiye.

The primary objective of the present study is to assess the present level of awareness among dentists in Türkiye concerning the role of PTs in TMDs treatment, as well as the extent of interdisciplinary collaboration between these professional groups. A secondary aim is to enhance understanding of the critical contributions of PTs in TMDs management and to emphasize the benefits of a multidisciplinary approach through collaborative practice. This study hypothesizes that emphasizing the role of physiotherapy and rehabilitation in TMDs treatment will strengthen interdisciplinary collaboration between dentists and PTs and increase dentists' awareness of PTs' contributions to TMD management.

Materials and Methods

Study Design

This cross-sectional observational study was conducted online through the Google Forms platform between May 27, 2023, and January 10, 2025. The study was approved by the Ethics Committee of Istanbul Medipol University (Decision No: E-10840098-772.02-3061, dated May 26, 2022). The study was conducted in accordance with the Declaration of Helsinki, and electronic informed consent was obtained from all participants through an online consent form.

Participants

Participants in this study were dentists actively practicing in public and/or private clinics across Türkiye. They were contacted through social networks and email. The inclusion criteria were as follows: (a) Completion of dental training (undergraduate or post-graduate) in Türkiye; and (b) active clinical practice at the time of data collection. Exclusion criteria comprised dentists who were not working in Türkiye or were still pursuing their education. All participants were informed about the purpose of the survey and the confidentiality of their responses.

Questionnaire

An online survey was prepared based on the studies by Gadotti et al.^[1] and the Turkish version of the Diagnostic Criteria for TMDs.^[13] A structured online survey consisting of 22 items was created using Google Forms ([Appendix 1](#)). The questionnaire form included 5 questions about demographic information and education, 1 question about dentists' education about TMD, 11 questions about TMD diagnosis and treatment, and 5 questions about TMD awareness. At the end of the questionnaire, to inform dentists about physiotherapy approaches and the role of the PT in the treatment of TMD and to increase their awareness, a diagram was produced based on,^[14] there is a diagram named "Approach to the Treatment of the Patient with TMD Symptoms." The questionnaire was sent to dentists working in Türkiye through social media and e-mail. It was stated that the average time taken by participants to complete the survey was between 7 and 8 min.

The categories of questions in the questionnaire;

- Demographic and educational background (4 questions: Age, gender, level of education, and clinical experience),
- Education related to TMDs (1 question)
- Clinical assessment and treatment approaches for TMD (6 questions)
- Patient referral practices (5 questions)

- Awareness of interdisciplinary collaboration with PT (2 questions)
- Perceptions of the role of physiotherapy in TMD treatment (2 questions)
- Interest in interdisciplinary collaboration with PT (2 questions).

Data Analysis

Descriptive statistics were used to analyze the responses. The data are presented as the total number of participants (n) and frequency percentages (%). Written responses provided by the dentists were also taken into account in the analysis. The results are visually represented through tables and bar charts to illustrate the participants' demographic information, referral patterns related to TMDs, and referral criteria for physiotherapy. Since no inferential statistical methods were employed due to the descriptive nature of the study, a formal power analysis (sample size calculation) was not conducted; however, a minimum of 100 participants was targeted to ensure adequate representativeness.

Results

106 dentists completed the questionnaire. Demographic information of the groups is shown in Table 1. The health care providers TMDs patients are referred to are shown in Figure 1. Conditions in which dentists refer patients with TMDs to PTs is shown in Figure 2. The age of the participants ranged from 23 to 67 (mean 32 ± 9.58). 68 participants (64.1%) were with a bachelor's degree, 18 participants (16.9%) had a master's degree, and 20 participants (18.8%) had a doctoral degree. 72 participants (67.3%) were general dentists and followed

Table 1. Demographic information of the participants

Demographics	n	%
Age (years)		
23–29	42	39.6
30–39	25	23.5
40–49	32	30.1
50–59	6	5.6
60+	1	0.9
Years of practicing dentistry		
0–5	45	42.5
6–10	12	11.3
11–15	9	8.5
16–20	14	13.2
21–25	19	17.9
26–30	4	3.8
31–35	2	1.9
41–45	1	0.9
Specialities of the dentists		
General practicing dentist	72	67.9
Periodontologist	9	8.5
Prosthodontist	6	5.7
Orthodontist	4	3.8
Oral, dental, and maxillofacial surgeon	5	4.7
Other specialties	8	9.4
Education level		
Bachelor's degree	68	64.2
Master's degree	18	17
Doctor of philosophy	20	18.9

n: number.

by other specialties (32.7%). The majority (42.1%) had 0–5 years of experience. 30.8% of participants had taken courses related to TMDs.

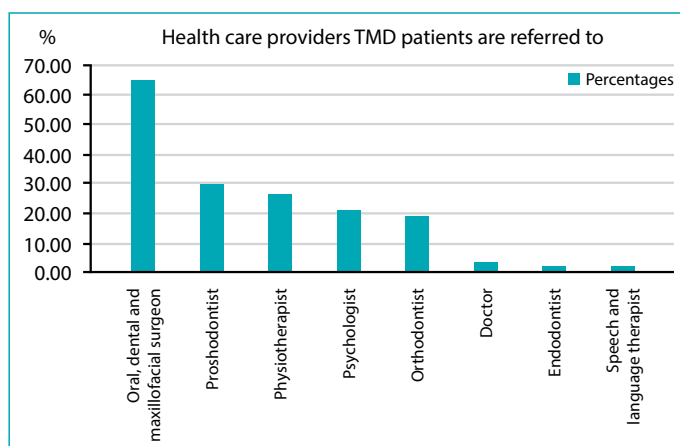


Figure 1. Healthcare providers temporomandibular disorder patients are referred to.

TMD: Temporomandibular disorders.

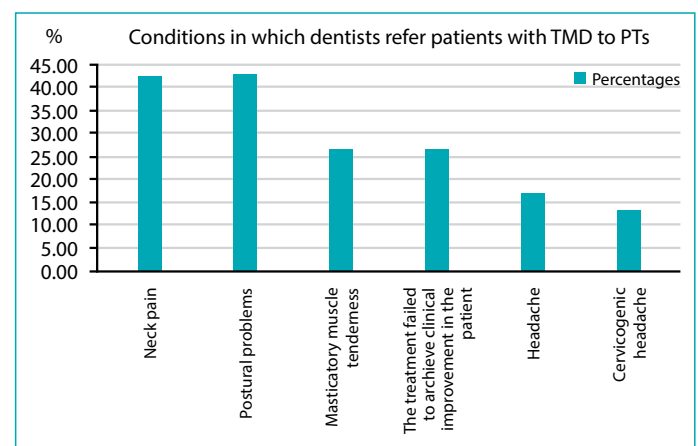


Figure 2. Conditions in which dentists refer patients with temporomandibular disorders to physiotherapists.

PTs: Physiotherapists.

21.7% of dentists reported that between 1% and 10% of their patients have TMDs symptoms. 21.6% of dentists reported that more than half of their patients have TMDs symptoms. Dentists reported diagnosing TMDs in their patients at a rate of 31.1% in the acute stage, 16% in the subacute stage, and 66% in the chronic stage.

Parafunction habits (55.7%) and TMJ disc displacement (25.5%) were the most common TMDs symptoms assessed. Occlusal alterations (16%), muscle tightness/tender points (14.2%), and headaches (10.4%) were the least seen TMDs symptoms. TMJ degeneration, TMJ hypermobility, and hypomobility were among the other TMDs symptoms handled. 3.6% of the dentists reported that all symptoms were assessed. Furthermore, it was found that dentists observed neck pain in 60.3%, postural problems in 31.1%, and cervicogenic headaches in 50.9% of their patients with TMDs during the assessment. 26.4% of dentists did not evaluate neck pain, 49% did not assess postural problems, and 38.6% did not evaluate cervicogenic headaches.

Jaw movements while opening/closing the mouth (92.5%), TMJ click sounds (92.5%), TMJ palpation (82.1%), signs of parafunctional habits (82.1%), dental occlusion assessment (78.3%), and palpation of chewing muscles (77.4%) were the most commonly used assessment methods for TMDs by dentists. They reported that palpation of neck muscles (0.9%), maximum mouth opening (0.9%), joint vibration sounds (0.9%), digital occlusion analysis (0.9%), and mouth open/closed MRI (0.9%) were used at low rates by dentists for the assessment of TMDs.

In the treatment of TMDs, 67% of dentists were found to prefer splint therapy and occlusal adjustment, 12.3% preferred botulinum toxin therapy, and 12.3% chose pharmacological treatment. 0.9% of the participants reported that they used dry needling and massage. 84.9% of the participants stated that they referred their patients to another health professional. It was found that 23.8% of dentists refer 0–5% of TMDs patients, while 21% refer 75–100% to a healthcare professional. It was observed that 65.1% of dentists referred TMDs patients to an oral and maxillofacial surgeon, 30.2% to a prosthodontist, 26.4% to a PT, and 20.8% to a psychologist. TMDs patients were predominantly referred to PT for neck pain and postural problems. Referrals were less common for masticatory muscle tenderness and persistent symptoms following treatment. Furthermore, dentists reported infrequent referrals for headaches, including cervicogenic headaches. The primary reason 70.5% of dentists never referred their patients to a PT was a lack of awareness regarding its benefits, while 19.2% believed the patient did not require physiotherapy.

Before participating in this survey, the majority of dentists were unaware that PT could play a role in the treatment of TMDs patients. However, 52.8% of dentists reported having prior knowledge that cervical spine pain could contribute to jaw pain. In addition, 55.7% of participants acknowledged being aware of scientific evidence suggesting that physiotherapy interventions, including oral exercises, manual therapy, and postural re-education exercises, can be effective in alleviating TMDs symptoms.

Most dentists indicated an increased likelihood of referring TMDs patients to a PT when deemed necessary. Moreover, 87.7% of participants expressed an interest in gaining further knowledge about the benefits of interdisciplinary collaboration with PT in the management of TMDs.

Discussion

To the best of the authors' knowledge, this study is among the first to evaluate dentists' awareness of the role of physical therapy in the management of TMDs in Türkiye and to explore the potential for interdisciplinary collaboration. In addition, the study aimed to raise awareness among dentists regarding the importance of physiotherapy in the treatment of TMDs and to highlight the potential benefits of collaborative practice between dentists and PT.

The questionnaire was completed by 106 dentists living in Türkiye. In the present questionnaire study, the age, education level, and specialization of dentists were consistent with previous studies.^[9,15]

There is a well-established neuroanatomical and neurophysiological connection between the TMJ and the cervical spine, influencing both posture and the masticatory system.^[10] Previous studies have demonstrated associations between TMDs and conditions, such as neck pain, cervicogenic headache, and postural dysfunction.^[15–19] A comprehensive understanding of this interrelationship may enable both PTs and dentists to manage TMDs-related pathologies more effectively. However, findings from the present study revealed that 26.4% of dentists did not assess neck pain in patients with TMDs, 49% did not evaluate postural abnormalities, and 38.6% failed to consider cervicogenic headaches during clinical examinations. These results highlight the need for dentists to incorporate the evaluation of these associated symptoms into their clinical practice and to refer patients to PT when necessary. Conversely, it is also important for PT to be capable of identifying dental issues linked to TMDs – such as occlusal abnormalities – during their assessments and to refer patients to dentists when appropriate. This underscores the importance of bidirectional interdisciplinary collaboration to ensure comprehensive and effective management of TMDs.^[20]

Dentists and PT address different aspects of patient well-being, working collaboratively to provide comprehensive care that improves TMDs symptoms, oral health, and physical function.^[21] Studies have demonstrated that a multidisciplinary approach can enhance treatment outcomes.^[22,23] This interprofessional collaboration between dentists and PT has been shown to improve patients' oral health, alleviate TMDs symptoms, enhance functional recovery, and elevate overall quality of life.^[23,24] Present evidence suggests that physiotherapy should be attempted, where appropriate, before considering surgical options in TMDs management.^[1] The results indicated that although 42.5% of dentists were aware of the role of PT in the treatment of TMDs patients before this study, the majority demonstrated a lack of awareness in this regard. Moreover, similar to Shaheen's study, the referral rate of TMDs patients to PT was found to be low.^[9] In our study, less than half of dentists were unaware of the evidence that physiotherapy can improve TMDs symptoms with oral exercises, manual therapy, and postural corrective training. Recent studies have shown that most dentists are unaware of the benefits of collaborating with PT, in accordance with our results.^[12,25,26] On the other hand, in both our study and previous researches, dentists have expressed a strong desire to gain further knowledge about the benefits of physiotherapy after participating in this questionnaire.^[16,27] The results demonstrated that dentists require further education on the multidisciplinary approach to treating TMDs, particularly regarding the role of PT.

In line with previous literature, the present study found that the most frequently employed treatment modalities among participating dentists were pharmacotherapy, occlusal splints, and occlusal adjustments.^[1,7] However, overlooking the potential contribution of physiotherapy in the management of TMDs may compromise the overall treatment outcomes and negatively impact patients' oral health. To address this gap, it is recommended that the role of physiotherapy and PTs in TMDs treatment be integrated into undergraduate and post-graduate dental education curricula, thereby promoting greater awareness of the importance of multidisciplinary care.

The first limitation of this study is the relatively small sample size, which may limit the generalizability of the findings. Future research should aim to include larger and more diverse samples, incorporating both national and international dental practitioners. In addition, alternative strategies should be considered to increase participation rates and enhance dentists' awareness regarding interdisciplinary approaches to TMDs management.

A second limitation is the one-time administration of the survey. Longitudinal follow-up assessments are recommended to evaluate changes over time in dentists' understanding of the role of PT in the treatment of TMDs.

Conclusion

This study demonstrated that dentists have limited awareness regarding the role of PT in the management of TMDs. The findings highlight significant gaps in both knowledge and awareness related to TMDs treatment. It is anticipated that this study will contribute to increasing awareness of the critical role of physiotherapy within the multidisciplinary management of TMDs. Future research should investigate whether collaboration between dentists and PT has improved over time and assess its therapeutic impact using larger sample sizes and longitudinal follow-up assessments.

Disclosures

Ethics Committee Approval: The study was approved by the Istanbul Medipol University Non-interventional Clinical Research Ethics Committee (no: E-10840098-772.02-3061, date: 26/05/2022).

Informed Consent: Informed consent was obtained from all participants.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: Concept – B.N.Y.; Design – B.N.Y., S.Ö.G.; Supervision – B.N.Y., S.Ö.G.; Resource – B.N.Y., S.Ö.G.; Materials – B.N.Y., S.Ö.G.; Data collection and/or processing – B.N.Y., S.Ö.G.; Data analysis and/or interpretation – B.N.Y., S.Ö.G.; Literature search – B.N.Y., S.Ö.G.; Writing – B.N.Y.; Critical review – B.N.Y., S.Ö.G.

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Peer-review: Externally peer-reviewed.

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Appendix 1

Dear Participant,

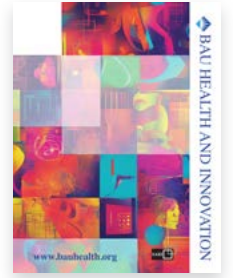
This survey has been prepared to provide data for a scientific research study being conducted by Physiotherapist Beyza Nur Yumak within the scope of the Master's Program in Physiotherapy and Rehabilitation at Medipol University Health Sciences Institute. The aim of the study is to investigate the awareness levels of dentists regarding the role of physiotherapy in the treatment of temporomandibular joint dysfunction. Your responses will be used solely for scientific research purposes, and your personal information and answers will not be shared with anyone. The survey consists of 22 questions. It will take approximately 10 minutes to complete the survey questions. At the end of the survey, there is an informative diagram about the treatment of temporomandibular dysfunction symptoms. Thank you in advance for your valuable contributions and assistance.

1. Do you agree to participate in this study? (Mark only one option)
☐ Yes ☐ No
 2. How old are you?years
 3. Which city do you live in?
 4. What is the highest level of education you have completed in your field? (Mark only one option)
☐ Bachelor's Degree ☐ Doctorate ☐ Specialization
 5. Which field do you work in? (Mark only one option)
☐ Dentist ☐ Pedodontics ☐ Periodontology ☐ Oral and Maxillofacial Surgery ☐ Orthodontics ☐ Prosthodontics ☐ Other
 6. How many years have you been practicing dentistry? (Mark only one option)
☐ 0–5 ☐ 6–10 ☐ 11–15 ☐ 16–20 ☐ 21–25 ☐ 26–30 ☐ 31–35 ☐ 36–40 ☐ 41–45
 7. Have you previously attended any training/courses on temporomandibular dysfunction? (Mark only one option)
☐ Yes ☐ No
 8. What percentage of your patients have symptoms of temporomandibular dysfunction? (pain in the jaw joint, sounds (crepitation or clicking), and irregular jaw movements) (Mark only one option)
☐ 0% ☐ 1–10% ☐ 11–20% ☐ 21–30% ☐ 31–40% ☐ 41–50% ☐ 51–60% ☐ 61–70% ☐ 71–80% ☐ 81–90% ☐ 91–100%
 9. What type of temporomandibular dysfunction have you diagnosed and/or treated in your patients? Mark only one option.
☐ TMJ (temporomandibular joint) disc displacement ☐ TMJ degeneration ☐ TMJ hypermobility ☐ TMJ hypomobility
☐ Muscle tension/trigger points ☐ Parafunctional habits (bruxism, etc.) ☐ Headaches ☐ Occlusal changes
☐ I have never diagnosed or treated TMD before ☐ Other
 10. Which of the following do you apply when evaluating patients with temporomandibular dysfunction? (You can select one or more options). Mark all that apply.
☐ TMJ palpation ☐ Masticatory muscle palpation ☐ Jaw movements during opening/closing ☐ TMJ sounds
☐ Signs of parafunctional habits ☐ Dental occlusion ☐ None ☐ Other:
 11. At what stage of the disease did you diagnose temporomandibular disorder in your patients? Mark only one option.
☐ Acute ☐ Subacute ☐ Chronic
 12. During the evaluation, did your patients with temporomandibular dysfunction have any of the following symptoms? (Mark only one option in each row)
- | | Yes | No | Not evaluated |
|-----------------------|--------------------------|--------------------------|--------------------------|
| Neck pain | ☐ | ☐ | ☐ |
| Posture disorder | ☐ | ☐ | ☐ |
| Cervicogenic headache | ☐ | ☐ | ☐ |
13. Which method do you prefer most when treating your patients with temporomandibular dysfunction? (Mark only one option)
☐ Splint therapy and occlusal adjustment ☐ Pharmacological treatment ☐ Botox ☐ Intra-articular injection ☐ Other:
 14. Do you refer your patients with temporomandibular dysfunction to another healthcare professional? (Mark only one option)
☐ Yes ☐ No
 15. What percentage of your patients with temporomandibular disorder do you refer to another healthcare professional? Mark only one option.
☐ 0–5% ☐ 5–25% ☐ 25–50% ☐ 50–75% ☐ 75–100%
 16. If you refer your patients with temporomandibular dysfunction to another healthcare professional, which of the following do you prefer to refer them to? (Mark all that apply)
☐ Orthodontist ☐ Pedodontist ☐ Oral and maxillofacial surgeon ☐ Endodontist ☐ Physiotherapist ☐ Psychologist
☐ Speech and language therapist ☐ Doctor ☐ Prosthodontist ☐ Other:

Appendix 1. Cont.

17. If you refer your patient with temporomandibular dysfunction to a physiotherapist, which of the following reasons do you refer them for? (Mark all that apply)
- ☐ Neck pain ☐ Postural changes (forward head posture, etc.) ☐ Masticatory muscle tenderness ☐ Headache
☐ Cervicogenic headache ☐ Because the patient did not improve after treatment
18. If you have never referred your patient with temporomandibular dysfunction to a physiotherapist, what is the reason? (Mark only one option)
- ☐ The patient does not need physiotherapy ☐ Not knowing the benefits of physiotherapy ☐ Other:.....
19. Before this survey, were you aware that a physiotherapist could treat TMD patients? (e.g., retraining jaw movements and restoring masticatory muscle function). (Mark only one option)
- ☐ Yes ☐ No
20. Before this survey, did you know that cervical spine pain could be the cause of jaw pain? (Mark only one option)
- ☐ Yes ☐ No
21. Were you aware that scientific research suggests that physical therapy can improve TMD symptoms with oral exercises, manual therapy, and postural corrective training? (Mark only one option)
- ☐ Yes ☐ No
22. After participating in the survey, are you more likely to refer a patient with temporomandibular dysfunction to a physiotherapist when necessary? (Mark only one option)
- ☐ Yes ☐ Maybe ☐ No
23. Would you like to learn more about the benefits of collaborating with physiotherapists to treat temporomandibular dysfunction patients? (Mark only one option)
- ☐ Yes ☐ No

Original Article



The Effect of Vagus Nerve Stimulation on Cognitive Performance

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Abstract

Objectives: This study aims to investigate the effect of transcutaneous auricular vagus nerve stimulation (taVNS) on working memory (WM) performance. The primary goal of the study is to comprehend the interindividual variations in taVNS responses and examine the factors underlying these differences. The fundamental hypothesis of the thesis is that taVNS enhances WM performance (WMP). The research anticipates that this effect will be particularly observed in the group receiving actual taVNS.

Methods: An equal number of female (n=15) and male (n=15) participants were selected from a cognitively healthy group aged between 18 and 45 years. Participants underwent a WM test (n-back) initially, followed by the sham taVNS. After receiving sham session participants completed the same WM task again. Followed by the real taVNS session and the WM task is given for the last time. Participants also filled out scales for the Big Five personality traits (BFS), Experiences in Close Relationships Scale-Revised, and the Symptom Checklist-90-Revised during the same period.

Results: The findings demonstrated a notable increase in WMP in the actual taVNS group. In addition, the results suggest that individuals exhibiting avoidant attachment, displaying phobic anxiety symptoms, and having high interpersonal sensitivity tend to benefit more from taVNS.

Conclusion: These outcomes imply that taVNS has the potential to enhance WMP and reflects the influence of individual factors.

Keywords: Autonomic nervous system, behavior, memory, neuropsychological tests, object attachment, personality, vagus nerve stimulation.

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Why we can not learn, improve, remember, or recover at the same pace? Why do we have different systems that allow or prevent us from succeeding equally, why do some of us try harder to remember the same phone number, whereas others memorize it immediately, why all individuals do not benefit from cognitive therapies equally? The primary aim of the research is to investigate the effect of transcutaneous auricular vagus nerve stimulation (taVNS) on working memory (WM) performance by comparing

participants who receive active taVNS with those who receive sham stimulation. The secondary aim is to examine how individual differences, including attachment styles, personality traits, and psychological symptoms, influence the relationship between taVNS and WM performance (WMP), and to identify the psychosocial factors that contribute to differential responsiveness to taVNS. The existing literature suggests that acute psychological stress can reduce activity in the dorsolateral prefrontal cortex, a brain region crucial

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for WM functioning.^[1] Neurobiological evidence supports this notion, showing reduced theta activity in the frontal area under acute stress, which is associated with WM.^[2] In addition, stress-induced cold pressor tasks hinder executive functions required for WMP.^[3,4] indicating an inhibiting effect of acute stress on WM. In contrast, individual differences in WM capacity (WMC) have been attributed to both inherent traits and current states that affect information management and the contents of WM.^[5] Successful self-regulation and self-regulatory lapses are linked to WMC, highlighting the importance of assessing the big five personality traits and psychological symptoms that could influence WMC.^[5] Furthermore, the development of self-regulation is influenced by early parent-child relationships, and innate temperament differences passed down through generations, as suggested by attachment theory.^[6] Attachment styles have been found to impact WM by influencing one's self-regulation capabilities.^[7] Therefore, this study explores the effect of attachment styles, trait personalities, and psychological symptoms on the relationship between stress and WM. Various methods to facilitate WM, such as training or deep-brain stimulation, have limitations, such as high costs or lack of immediate effects.^[8-10] Hence, the investigation of novel methods, such as taVNS, to enhance WMP is crucial for expanding the existing literature on WM facilitation.^[11]

Existing literature indicates that taVNS can potentially enhance WMP.^[12,13] However, it remains unclear why some individuals benefit more from taVNS while others show less improvement after receiving taVNS. To address this gap, the current research integrates measures of psychological symptoms (Symptom Checklist-90 [SCL-90]), adult attachment styles (Experiences in Close Relationships Scale-Revised), and personality traits (Big Five Scale) to explore the underlying factors contributing to differential responses to taVNS. The primary hypothesis of this study is that WMP scores will increase after receiving taVNS, and there will not be a significant difference between the baseline and sham sessions. Secondly, securely attached individuals will benefit more from taVNS, showing a more significant increase in WMP after stimulation. Participants with a lower general symptom index on the SCL-90, indicative of lower psychological distress, are also expected to exhibit more significant improvements in WM following taVNS. Moreover, individuals scoring high on neuroticism and openness but low on conscientiousness and extraversion are anticipated to show more significant benefits from taVNS due to their potential for increased neuroplasticity,^[14,15] and more robust information retrieval mechanisms in the prefrontal cortex.^[16] Furthermore, it is hypothesized that participants who undergo actual taVNS

sessions will demonstrate a significant increase in WMP compared to those who undergo sham sessions, indicating the specific efficacy of taVNS in enhancing WM. The contribution of this research to science lies in its novelty as it aims to be the pioneering investigation exploring the individual differences behind the varying effects of taVNS on WMP, providing valuable insights into individualized cognitive enhancement techniques.

Vagus Nerve Stimulation (VNS)

VNS originated as a treatment method for refractory epilepsy.^[17] However, its application expanded beyond epilepsy when researchers discovered that VNS ameliorates seizure activity and enhances cognitive performance in epileptic patients, making it a promising tool for various clinical demands.^[18] The vagus nerve, the 10th cranial nerve, is pivotal in the parasympathetic nervous system (PNS). While the precise neurophysiological impact of VNS is not fully elucidated, current understanding suggests that VNS stimulates the tractus solitarius, which subsequently activates the locus coeruleus (LC). This chain of events ultimately leads to the secretion of norepinephrine, a neurotransmitter known to enhance cognitive performance.^[18,19] The nucleus tractus solitarius in the medulla emerges as a critical player in this process, as it sends information to several vital brain regions, including the hypothalamus, LC, dorsal raphe nucleus, and parabrachial nucleus.^[20,21] Due to its multiple impacts on different brain regions, VNS can potentially manipulate diverse neural signals for various therapeutic purposes. As a result, VNS finds applications in treating conditions such as fibromyalgia, migraine, depression, epilepsy, and post-traumatic stress disorder.^[22] Moreover, solid theoretical evidence supports the enhancing effect of VNS on cognitive abilities. The activation of the nucleus of the solitary tract through VNS is particularly critical, as it houses several junctions of afferent vagal nerve fibers. Consequently, VNS is thought to induce metabolic changes in specific brain regions, impacting cognitive functioning.^[23]

Attachment Style and taVNS

Attachment theory, proposed by Bowlby and Ainsworth, posits that attachment is an innate and biologically driven behavioral system that develops in early childhood and continues to influence individuals throughout their lives.^[24,25] This theory suggests that the quality of early attachments to primary caregivers forms an internal working model that shapes individuals' perceptions, emotions, behaviors, and social interactions. Attachment styles are classified into three categories: secure, insecure-avoidant, and insecure-anxious/ambivalent. Securely attached individuals tend

to have positive views of themselves and others, feel comfortable with intimacy, and exhibit effective emotion regulation. In contrast, insecure-avoidant individuals are more self-reliant, suppress their emotions, and avoid intimacy, while insecure anxious/ambivalent individuals are preoccupied with relationships, fear abandonment, and have difficulty regulating their emotions.^[26]

Materials and Methods

The Place Where the Study Takes Place

The study took place on the North Campus of Bahçeşehir University.

Duration of the Study

The data collection for the study lasted for 3 months but took place 8 months, including preparing the manuscript and receiving ethics approval.

Ethics Approval

The ethics approval was received from İstanbul Medipol University Non-interventional Clinical Research Ethics Committee Presidency on April 17, 2023 with the number of E-10840098-772.02-2574. The study was conducted in accordance with the Declaration of Helsinki.

Participant

According to the G power analysis, we aimed to make the study with 30 participants. T-tests and mean differences between two independent variables were set for the statistical test. The type of power analysis was set to compute the required sample size, given alpha, power, and effect size. With a 0.5 effect size and 0.05 error probability, output parameters indicated that 27 participants must have a 0.81 actual power with 26 degrees of freedom. In demographics questions, participants are asked to report if they have any chronic illness, whether they are on any psychiatric drug or alcohol, any caffeine intake frequency, marital status, and romantic relationship status. The informed consent forms were handed to the participants beforehand in the experiment.

Instruments

Big Five Personality Traits Scale

The Big Five Personality Traits Scale is a 5-point Likert-type scale comprising ten items that assess the five major dimensions of personality: extraversion, agreeableness, conscientiousness, neuroticism, and openness. The scale is handy for investigating the relationship between personality traits and various cognitive, emotional, and

social outcomes.^[27] In the current research, the Turkish adaptation of the Big Five Personality Traits Scale, adapted by^[27] was utilized because the participants were Turkish-speaking. According to the linguistic equivalence study, the correlation coefficients between the Turkish and original English form scores were found to be 0.81 for the overall scale, 0.85 for extraversion, 0.87 for agreeableness, 0.85 for conscientiousness, 0.71 for neuroticism, and 0.86 for openness to experience dimensions. All correlations are significant at the 0.01 significance level.^[27] It took participants 10 minutes to complete the scale.

Experiences in Close Relationships–relationship Structures Questionnaire

The attachment style was assessed using the Turkish adaptation of the Experiences In Close Relationships–Relationship Structures Questionnaire.^[28,29] The attachment scale measures two dimensions: anxiety and avoidance. Participants responded to items on an insert Likert scale ranging from 1=“Strongly disagree” to 7=“Strongly agree.” The Cronbach’s alpha was 0.86 for anxiety and 0.90 for avoidance, indicating strong internal consistency. Administration took approximately 7 minutes per participant.

The SCL-90-Revised (SCL-90-R)

The SCL-90-R is a self-report 5-point Likert scale questionnaire ranging from “not at all” to “extremely that assesses various psychological symptoms and distress.”^[30] It consists of 90 questions that measure nine symptom dimensions, including depression, anxiety, phobic anxiety, hostility, obsessive–compulsive tendencies, interpersonal sensitivity, somatization, paranoid ideation, and psychoticism. The Turkish version of the SCL-90-R was used in the current research, providing valuable insights into participants’ mental health status.^[29] The scale’s reliability analysis in the Turkish adaptation yielded a high Cronbach’s alpha coefficient of 0.97, indicating excellent internal consistency.^[30]

The application of the scale took approximately 15 minutes per participant.

The Montreal Cognitive Assessment (MOCA)

The MOCA is a widely used cognitive screening tool designed to assess various cognitive domains, including attention, memory, language, and visuospatial abilities.^[31] In the current research, the Turkish-validated version of the MOCA, known as the “Montreal Bilişsel Değerlendirme Ölçeği (MOBİD),” as developed by Selekler et al.^[31] in 2010, was utilized. According to the results of the receiver operating characteristic analysis, a cutoff score of 21 points was determined for the total score of MOBİD.

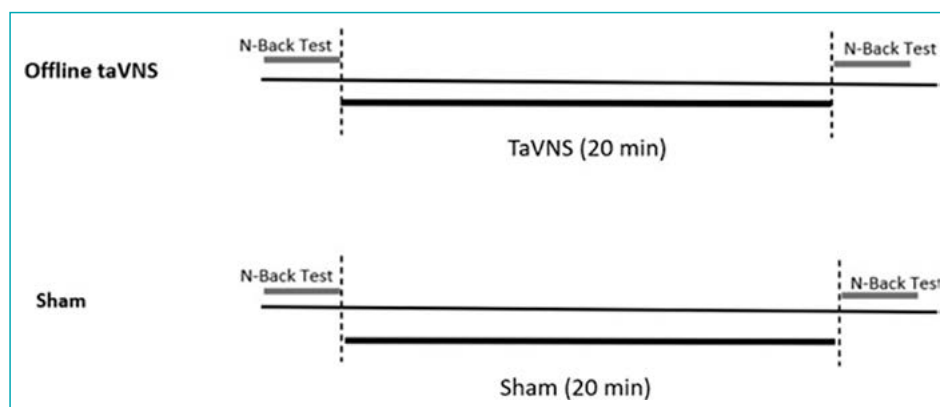


Figure 1. Research design.

taVNS: Transcutaneous auricular vagus nerve stimulation; min: Minute.

Therefore, participants who scored below 21 on MOBID were planned to be excluded from the analysis in the study.^[32] The application of the scale took approximately 15 minutes per participant.

Working Memory Assessment

The n-back test presents participants with a sequence of stimuli one by one. In the current study, a 2-back task will be used, where participants must respond if the current letter matches the letter from two trials ago. The stimulus set will consist of 15 letters (A, B, C, D, E, H, I, K, L, M, O, P, R, S, and T), and each letter will be presented for 500 ms with a 2500-ms black period following. Participants will have 3 s to respond to each trial, and a new stimulus will be presented every 3000 ms. The n-back test will consist of three blocks, each containing 25 trials, and participants will receive detailed feedback on their responses.^[33] The application of the scale took approximately 10 minutes per participant.

Vagustim

2×AA batteries power the device. With the help of Vagustim, we non-invasively stimulated both sides of the Vagus nerve through the auricular canal transcutaneously. The conductive gel was used on both ears, followed by the placement of electrodes. Participants were asked about their satisfaction with the electrodes and if they felt any discomfort. The stimulation threshold intensity was measured separately for each participant. We used the modulation mode and set the width to 300 ms, rate to 10 Hz, and the duration to 20 minutes.

Research Protocol

Design

After an eligibility screening, participants are invited to the Medipol University. First, participants are asked to complete

a WM test called the n-back test. This first session of the n-back test is named “Baseline.” Later, participants received 20 minutes of sham taVNS and were asked to sit still and avoid walking or standing up to prevent any sympathetic nervous system activation. They were told that there would be no feelings or irritation in their ear since the currency is set to a minimum for attenuation. After 20 minutes of the sham taVNS session, named “Sham,” participants were asked to complete the n-back test again. The n-back test is represented online and randomly differs each time it is presented. Participants complete the n-back test before and after the Sham session to compare each session’s score and investigate if there is any significant difference between the two. There should not be any significant difference since there is no actual taVNS administration on the participants. After participants complete the second round of the n-back test, the actual taVNS administration is given for 20 minutes. This time, participants are asked to raise their hands whenever they feel a slight titillating sensation in their ears to set an individual threshold for them. Hence, each participant received a different mV of currency according to their level in starting to feel the stimulation. This session is called taVNS. After receiving taVNS for 20 minutes, participants were asked to complete the n-back task for the last time. Therefore, we collected three WM data from each participant: Baseline, Sham, taVNS. We used these three data sets to compare each participant’s increase rate from baseline to taVNS. The research design and protocol are illustrated in Figures 1 and 2 below.

Statistical Analysis

Descriptive statistics were calculated, and then the assumption of normality for the n-back test scores was assessed using the Shapiro–Wilk test, which indicated a non-normal distribution. Therefore, the Wilcoxon signed-rank

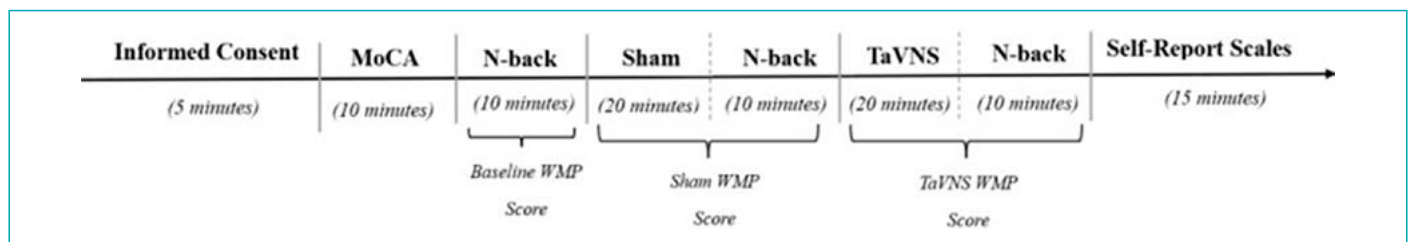


Figure 2. Research protocol.

MoCA: Montreal cognitive assessment, taVNS :Transcutaneous auricular vagus nerve stimulation, WMP: Working memory performance.

test was employed to assess the difference in n-back scores before and after the taVNS administration ($Md=64$, $n=30$), $z=-4.789$, $p<0.05$ compared to baseline ($Md=57$, $n=30$), $z=-4.602$, $p<0.05$ and sham ($Md=57$, $n=30$), $z=-0.48$, $p<0.05$. According to Wilcoxon signed-rank test, there is a significant difference between taVNS and baseline ($z=-4.789$, $p<0.001$); taVNS and sham ($z=-4.602$, $p<0.001$). Therefore, results indicate that participants' WMP is higher in taVNS sessions compared to baseline and sham sessions. However, there is no significant difference between baseline and sham ($z=-0.048$, $p>0.001$). Therefore, this supports that there is no placebo effect of taVNS; hence, its effect on WMP is accurate. Test statistics of Wilcoxon signed-rank test as shown in Table 1.

Results

Descriptive Analysis

Thirty participants, 50% were female, 50% were male. 67% were in the 18–24 year range, 63% were in the 24–34 year range, and 30% were in 35–45 year range. Most of the participants, 40% were postgraduates, 13.3% had high school degrees, 33.3% had an undergraduate degree, and 13.3% were Ph.D. students. 3.3% of the participants reported low socioeconomic status (SES), 60.9% reported medium SES and 36.7% of them reported low SES. 63.3% of the participants to use up to 20 mg of alcohol weekly whereas 36.7% of them use 20–40 alcohol weekly. 80% of the participants drink up to 2 cups of coffee daily, whereas 20% of them drink 3–5 cups daily.

Pre taVNS and Post taVNS Evaluation Scores of the Participants

The difference in n-back scores across conditions that refers to H1 was assessed using the Wilcoxon signed-rank test. Participants completed the n-back task at 3 time points: baseline, after sham stimulation, and after taVNS administration.

H1: There is a significant effect of taVNS on WM.

The results indicated a statistically significant increase in WMP following taVNS ($Md=64$, $n=30$), as compared

to both baseline ($Md=57$, $z=-4.789$, $p<0.001$) and sham stimulation ($Md=57$, $z=-4.602$, $p<0.001$). However, no significant difference was found between baseline and sham conditions ($z=-0.048$, $p=0.962$).

These results support the hypothesis that taVNS has a significant effect on WM, and the absence of a significant difference between sham and baseline further suggests that the observed effects are not due to placebo, but rather to the neuromodulatory influence of taVNS. Wilcoxon signed-rank test statistics are presented in Table 1.

Backward Multiple Linear Regression Analysis

By using the backward linear regression, it is aimed to see the relationship between sociodemographic and psychological factors with the taVNS effect. SES (Low, Mid, High), gender (female and male), age (18–24; 25–34; 35–45), SCL-90 (GSI and sub-dimensions: hostility, anxiety, phobic anxiety, paranoid ideation, interpersonal sensitivity, depression, somatization, psychoticism, obsessive-compulsive and other), attachment (avoidant and anxious), big five personalities (extraversion, openness, agreeableness, conscientiousness, and neuroticism) are included into the model. SPSS generated 14 models, among which Model 14 was selected for the evaluation of our hypothesis. The results derived from this model are presented in detail in Table 2.

In the 14th model, the dependent variable (taVNS effect) was regressed on predicting variables of attachment psychological symptoms (interpersonal sensitivity, anxiety,

Table 1. Pairwise comparison between taVNS, sham, and baseline conditions

	taVNS-baseline	taVNS-sham	Sham-baseline
Z	-4.789 ^b	-4.602 ^b	-0.048 ^c
p	0.000*	0.000*	0.962

* $p<0.001$: Wilcoxon Signed Ranks, taVNS: Transcutaneous Auricular Vagus Nerve Stimulation, Sham: The taVNS session in which the participant had received a sham treatment. Baseline: Before taVNS implementation, ^b: Based on negative ranks, ^c: Based on positive ranks.

Table 2. Backward multiple linear regression analysis predicting working memory performance (Model 14)

	Unstandardized Coefficients		Standardized Coefficients		
	B	SE	Beta	t	p
(Constant)	12.681	1.059	–	11.979	<0.001
Avoidant attachment	-1.273	0.290	-0.801	-4.393	0.00*
Anxious attachment	0.880	0.334	0.461	2.636	0.015*
Interpersonal sensitivity	0.820	0.275	0.403	2.979	0.007*
Hostility	-1.353	0.513	-0.349	-2.634	0.015*
Phobic anxiety	-1.109	0.392	-0.444	-2.831	0.010*

*: $p < 0.001$: Backward multiple linear regression analysis, B: Unstandardized regression coefficient, SE: Standard error of the coefficient, Beta: Standardized regression coefficient, t: t-value.

Table 3. ANOVA table for Model 14: Predicting the effect of taVNS

	SS	df	MS	F	p
Regression	251.781	7	35.969	11.465	<0.001*
Residual	69.019	22	3.137		
Total	320.800	29			

*: $p < 0.05$: ANOVA. ANOVA: Analysis of variance, Model 14: Final step of the backward linear regression analysis, taVNS: Transcutaneous auricular vagus nerve stimulation, SS: Sum of squares, df: Degrees of freedom, MS: Mean square (SS/df), F: F-ratio (ANOVA test statistics).

hostility, and phobic anxiety). As shown in Table 3, the independent variables apart from anxiety and depression significantly predict the taVNS effect, $F(7,22) = 11.464$, $p < 0.001$ in the 14th model. $R^2 = 0.785$ depicts that the model explains 78.5% of the variance in the taVNS effect.

In addition, coefficients were further assessed to ascertain the influence of each factor on the criterion variable (taVNS effect). The following hypothesis was proposed: H2: There is a significant negative impact of psychological symptoms (somatization, hostility, interpersonal sensitivity, phobic anxiety, depression, anxiety, paranoid ideation, psychoticism, and obsessive-compulsive) on the effect of taVNS. H3: There is a significant impact of Big Five personality on the taVNS effect. H4: There is a significant negative impact of attachment styles on the taVNS effect.

H2 evaluates whether dimensions in SCL-90 that is used to assess the psychological symptoms, significantly and negatively influence the taVNS effect. The results revealed that people with high interpersonal sensitivity ($B = 0.820$, $t = 2.979$, $p < 0.05$), lower hostility ($B = 1.353$, $t = -2.634$, $p < 0.05$), and lower levels of phobic anxiety ($B = -1.109$, $t = -2.831$, $p < 0.05$) had a greater effect of taVNS. Hence, H1 is partially supported since two dimensions in SCL-90 negatively influence the taVNS effect. In addition, H3 evaluates whether

the big five personalities significantly influence the taVNS effect. According to the fourteenth model, personality has no significant effect on the taVNS effect. Finally, H4 evaluates whether avoidant and anxious attachment styles significantly influence the impact of taVNS. According to the results, people with lower levels of avoidant attachment ($B = -1.273$, $t = -4.393$, $p < 0.05$) and higher levels of anxious attachment ($B = 0.880$, $t = 2.636$, $p < 0.05$) had a greater effect of taVNS. H3 is partially supported since avoidant attachment negatively influences the taVNS effect.

Discussion

This study investigated the acute and offline effects of taVNS on WMP, along with the role of psychological symptoms, attachment styles, and personality traits. The results demonstrated that taVNS significantly improved WMP, while no significant difference was found between baseline and sham sessions. This suggests that a 20-minutes offline taVNS session can effectively activate the PNS and enhance cognitive performance. Moreover, individuals with avoidant attachment, higher hostility, and phobic anxiety, as well as lower anxious attachment and interpersonal sensitivity, benefited less from taVNS.

Our findings partially supported the hypothesis that psychological symptoms negatively influence the taVNS effect. Among the nine SCL-90-R dimensions, hostility and phobic anxiety showed significant negative associations. Previous research has linked hostility to reduced parasympathetic activity and autonomic imbalance due to chronic stress.^[34,35] This could explain the diminished responsiveness to taVNS in individuals with high hostility.

The study found contrasting effects of attachment styles on taVNS responsiveness. Anxious attachment was positively associated with taVNS effects, while avoidant attachment showed a negative association. These results align with

psychobiological models indicating that anxiously attached individuals exhibit heightened emotional reactivity and interoceptive sensitivity,^[36] potentially enhancing their responsiveness to vagal modulation. In contrast, avoidantly attached individuals tend to suppress emotional needs and display reduced vagal tone and interoceptive awareness making them less receptive to taVNS stimulation.^[37,38]

Although we hypothesized that Big Five personality traits would influence taVNS effects, no significant associations were found. Prior studies suggest traits like conscientiousness and low neuroticism are linked to better health outcomes and ANS function.^[37,38] However, uneven trait distribution among participants may have limited our ability to detect effects, as statistical power is sensitive to sample balance.^[37,38]

Conclusion

This study highlights the intricate interplay between taVNS, WMP, and individual psychological factors. This research offers a comprehensive perspective by examining acute and offline taVNS effects while considering psychological symptoms, attachment styles, and personality traits.

The findings reveal taVNS's potential to enhance cognitive performance, especially in individuals with distinct psychological profiles, and contribute to a nuanced understanding of these effects. Despite complexities, the study's holistic approach and alignment with existing literature bolster its significance.

Disclosures

Ethics Committee Approval: The study was approved by the İstanbul Medipol University Non-interventional Clinical Research Ethics Committee (no: E-10840098-772.02-2574, date: 17/04/2023).

Informed Consent: Informed consent was obtained from all participants.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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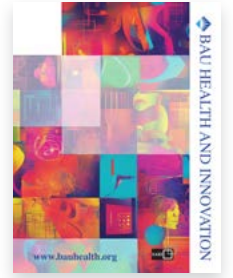
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Original Article



Hygiene Attitudes, Behaviors, and Health Perception Among Students of Home Patient and Elderly Care Programs

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Abstract

Objectives: This study aims to examine the relationship between health perception and hygiene-related attitudes and behaviors among university students enrolled in associate degree programs in Elderly Care and Home Patient Care.

Methods: This study employed a correlational and descriptive research design. The study population consisted of all students enrolled in Home Patient Care or Elderly Care programs at universities during the 2020–2021 academic year. A total of 847 students from 12 different universities participated in the study. Data were collected online between February and June 2021. The data collection tools included the “Descriptive Characteristics Information Form,” the “Hygiene Behavior Scale (HBS),” and the “Health Perception Scale (HPS).”

Results: The mean age of the participants was 19.95±2.44 years. Of the participants, 68% were female and 58% were 1st-year students. The mean total score on the HBS was 37.7±6.75, whereas the mean total score on the HPS was 53.57±7.60. A statistically significant difference was found between students’ mean HBS scores and their gender, place of residence, and economic status. In addition, a significant difference was observed between their mean HPS scores and their economic status.

Conclusion: The findings of the study revealed a statistically significant relationship between students’ hygiene behaviors and their health perceptions. It was observed that as students’ health perception decreased, negative hygiene behaviors increased.

Keywords: Health perception, health services for aged, hygiene, patient care, public health.

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Understanding hygiene-related attitudes, behaviors, and health perceptions among students enrolled in home care and elderly care programs is of great importance, especially considering the vulnerable populations they are being trained to serve.

Hygiene-related practices are not only essential for infection prevention and patient safety, but also reflect individuals’ broader health beliefs and subjective perceptions of well-being.^[1,2]

Research shows that while health behaviors directly affect physical well-being, the beliefs, attitudes, and perceptions underlying these behaviors are equally influential. The health belief model (HBM) provides a long-established theoretical framework that explains the cognitive factors influencing individuals’ decisions to engage in preventive or health-promoting behaviors.^[3,4] Health perception – which includes an individual’s thoughts, feelings, biases, and expectations regarding health – is recognized as a key

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determinant; individuals with a positive health perception ("good health perception") are more likely to adopt healthier lifestyles and develop a strong belief in their ability to control their own health.^[5] Conversely, individuals with a negative perception of their health are less likely to engage in behaviors that maintain or improve their health. Empirical evidence indicates that the quality of an individual's health perception directly affects the adoption and maintenance of health behaviors. For example, studies using the HBM have shown that perceived susceptibility, severity, benefits, barriers, and self-efficacy interact dynamically to predict whether an individual will adopt preventive behaviors.^[4] Students with positive health perceptions are more likely to develop strategic approaches to managing their health, and this has been associated with improved health literacy and better health outcomes.^[5] These positive perceptions, in turn, strengthen individuals' intentions to adopt and sustain health-enhancing behaviors over the long term.^[4,5]

Integrating the cognitive determinants described by the HBM with empirical measures of health behavior underscores the importance of promoting positive health perceptions. Such an approach plays a critical role in enabling individuals to adopt and sustain health-promoting behaviors, thereby contributing to improved health outcomes at both individual and community levels.^[3-5]

There is a complex and bidirectional relationship between hygiene behaviors and health perception. On the one hand, consistent and positive hygiene practices can strengthen individuals' sense of control over their health and enhance their overall well-being.^[6] On the other hand, a strong and positive health perception may lead to greater adherence to hygiene standards and self-care routines.^[7] This bidirectional relationship is particularly important for students preparing for careers in home care, where personal responsibility and direct patient interaction demand heightened awareness of hygiene practices and holistic health concepts.^[8] Investigating this relationship offers critical insight into how the education and mindset of future caregivers may influence the quality and safety of the care they provide. A review of the literature revealed no previous studies examining the relationship between students' hygiene behaviors and their health perception.

This study examined the relationship between hygiene-related attitudes and behaviors and health perception among associate degree students enrolled in university programs in Home Care and Elderly Care.

Moreover, this study seeks to address the following research questions:

1. What are the hygiene-related attitudes and behaviors of students enrolled in Home Care and Elderly Care programs?
2. What is the level of health perception among these students?
3. Is there a relationship between hygiene-related attitudes and behaviors and health perception in this population?

Materials and Methods

Purpose and Design of the Study

This study aimed to examine the relationship between health perception and hygiene-related attitudes and behaviors among students enrolled in associate degree programs in Elderly Care and Home Care at universities. The study employed a descriptive and correlational research design.

Study Population and Sample

The population of the study consisted of 1257 students enrolled in Elderly Care or Home Care programs at universities across Türkiye during the 2020–2021 academic year. The study was conducted with the entire accessible population, and no sampling method was employed. The final sample included 847 students from 12 different universities who were 18 years of age or older, open to communication and cooperation, willing to participate, and who had completed the questionnaire in full. A total of 67.4% of the target population was reached.

Data were collected using the Descriptive Characteristics Information Form, the hygiene behavior scale (HBS), and the health perception scale (HPS).

Descriptive Characteristics Information Form

This form was developed by the researchers based on a review of the relevant literature^[9-11] and includes 19 items designed to collect sociodemographic information about the students. It covers variables such as gender, university, year of study, place of residence, presence of chronic illness, number of siblings, type of family, perceived economic status, and parents' educational and occupational backgrounds.

Hygiene Behaviors Scale

Developed by Çoban and Bilgin in 2015,^[12] this socially oriented scale measures individuals' hygiene-related behaviors. It consists of 25 items and is structured using a 4-point Likert-type format. The scale includes three sub-dimensions: personal hygiene (items 1–13), hand

washing (items 14–19), and food hygiene (items 20–25). Higher scores indicate poorer hygiene behaviors, with total scores ranging from 25 to 100. A total score of 38 or above is interpreted as poor hygiene behavior and serves as the cutoff point. Subscale score ranges are 13–52 for personal hygiene and 6–24 for both hand washing and food hygiene. For these sub-dimensions, scores of 20 and above (personal hygiene) or 9 and above (hand washing and food hygiene) indicate poor hygiene behaviors. The original Cronbach's alpha coefficient for the scale was reported as 0.90.^[12] In the present study, the Cronbach's alpha was found to be 0.76, indicating a high level of internal consistency (as values between 0.60 and 0.80 are considered to reflect acceptable reliability).

HPS

This scale was originally developed by Diamond et al.^[13] to assess individuals' perception of health. The Turkish adaptation and reliability study was conducted by Kadioğlu and Yildiz.^[14] The scale consists of 15 items and employs a 5-point Likert-type format. It includes four subdimensions: locus of control, self-awareness, certainty, and importance of health. Total scores range from 15 to 75. Six items (1, 5, 9, 10, 11, and 14) are positively worded, whereas nine items (2, 3, 4, 6, 7, 8, 12, 13, and 15) are negatively worded and reverse-scored. Positively worded items are scored as follows: "Strongly Agree = 5," "Agree = 4," "Neutral = 3," "Disagree = 2," and "Strongly Disagree = 1." The negatively worded items are reverse-coded. The original Cronbach's alpha for the overall scale was 0.77, with subscale reliability coefficients of 0.76 (locus of control), 0.63 (self-awareness), 0.71 (certainty), and 0.60 (importance of health).^[14] In the current study, the Cronbach's alpha for the overall scale was 0.75, and for the subdimensions: 0.71 (locus of control), 0.56 (self-awareness), 0.74 (certainty), and 0.57 (importance of health). A higher score indicates a more positive perception of health, whereas a lower score reflects a more negative perception.

Data Collection

Data were collected online between February and June 2021 from 847 students enrolled in associate degree programs in Elderly Care and Home Care at various universities who agreed to participate voluntarily. Informed consent was obtained electronically at the beginning of the survey. Participants were provided with detailed information about the purpose, scope, and confidentiality of the study, and their consent to proceed with the questionnaire confirmed their voluntary participation.

Statistical Analysis

Data Analysis

Quantitative data analysis was conducted using IBM Statistical Package for Social Sciences Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Statistical significance was set at $p < 0.05$, corresponding to a 95% confidence interval. Descriptive statistics – including frequency (n), percentage (%), arithmetic mean ($\bar{X}$), and standard deviation – were used to summarize the data. The assumption of normality was assessed using skewness and kurtosis coefficients, and further evaluated through appropriate normality tests based on sample size. Since the sample size exceeded 50 participants, the Kolmogorov–Smirnov test was employed to determine the distribution of the data.^[15] To assess group differences, one-way analysis of variance was used for comparisons involving more than two groups, whereas the independent samples t-test was applied for comparisons between two groups. Pearson correlation analysis was conducted to examine relationships between variables, and frequency analysis was also used where appropriate.

Ethical Considerations of the Study

Ethical approval for this study was obtained from the Scientific Research and Publication Ethics Committee of Gümüşhane University, with the decision dated September 24, 2020, and numbered 2020/9. In addition, written permission was granted by the original authors for the use of the data collection instruments. All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and complied with relevant legal and regulatory guidelines.

Results

A total of 847 students enrolled in Home Care and Elderly Care programs from 12 different universities participated in the study. The mean age of the participants was 19.95 ± 2.44 years. Among the participants, 67.9% were female and 58.3% were 1st-year students. In addition, 44.6% reported living in a provincial center, 92.8% stated that they did not have a chronic illness, and 85.1% reported not being employed.

In terms of students' family backgrounds, 76.5% reported living in nuclear families. Regarding parental education, 52.1% of mothers and 45.5% of fathers were primary school graduates. In addition, 63.3% of the participants described their income level as moderate, whereas 55.6% reported a household income of <2500 TL (Table 1).

Table 1. Descriptive characteristics of participants (n=847)

Descriptive data	n	%
Age, mean±SD	847	19.95±2.44
Gender		
Female	272	32.1
Male	575	67.9
Class		
1 st year	494	58.3
2 nd year	353	41.7
Place of residence		
Province	378	44.6
District	336	39.7
Other	133	15.7
Employment status		
Yes	126	14.9
No	721	85.1
Chronic disease		
Yes	61	7.2
No	786	92.8
Family type		
Nuclear	648	76.5
Extended	199	23.5
Mother's education level		
Illiterate	122	14.4
Literate	38	4.5
Primary school	441	52.1
Middle school	131	15.5
High school	97	11.5
University	18	2.1
Father's education level		
Illiterate	17	2.0
Literate	38	4.5
Primary school	385	45.5
Middle school	184	21.7
High school	171	20.2
University	52	6.1
Economic status		
Poor	195	23
Moderate	536	63.3
Good	116	13.7
Income status		
1–2.500 TL	471	55.6
2.500–5000 TL	302	35.7
5.000 TL and above	74	8.7
Total	847	100

n: Number, SD: Standard deviation

According to the total scores on the HBS, 54.3% of the students demonstrated positive hygiene behaviors, whereas 45.7% exhibited negative hygiene behaviors.

Table 2. Distribution of students' positive and negative hygiene behaviors according to the subdimensions and total score of the hygiene behaviors scale

Hygiene behaviors scale subdimensions	n	%
Personal hygiene		
Positive hygiene behavior	359	42.9
Negative hygiene behavior	488	57.6
Hand washing		
Positive hygiene behavior	465	54.9
Negative hygiene behavior	382	45.1
Food hygiene		
Positive hygiene behavior	585	69.1
Negative hygiene behavior	262	30.9
Total		
Positive hygiene behavior	460	54.3
Negative hygiene behavior	387	45.7

Table 3. Mean scores of the hygiene behaviors scale and health perception scale

Scales and subdimensions	Mean±SD	Min–max values	Cronbach alfa
Hygiene behaviors scale	37.78±6.75	25.00–72.00	0.762
Personal hygiene	21.11±4.54	13.00–38.00	0.674
Hand washing	8.58±2.09	6.00–17.00	0.533
Food hygiene	8.09±2.06	6.00–20.00	0.627
Health perception scale	53.57±7.60	31.00–75.00	0.750
Internal control	16.92±3.96	5.00–25.00	0.715
Self-awareness	11.83±2.04	3.00–15.00	0.568
Certainty	12.70±3.54	4.00–20.00	0.744
Importance of health	12.13±2.02	3.00–15.00	0.579

When examining the subscale scores, 57.6% of the participants displayed negative hygiene behaviors in the personal hygiene subscale, whereas 54.9% and 69.1% exhibited positive hygiene behaviors in the handwashing and food hygiene subscales, respectively (Table 2).

The mean scores for the subscales of the HBS and the HPS are presented in Table 3.

The mean total score on the HBS was 37.7±6.75. The mean subscale scores were 21.11±4.54 for personal hygiene, 8.58±2.09 for handwashing, and 8.09±2.06 for food hygiene.

The mean total score on the HPS was 53.57±7.60. The mean subscale scores were 16.92±3.96 for locus of control, 11.83±2.04 for self-awareness, 12.70±3.54 for certainty, and 12.13±2.02 for importance of health.

The comparison of students' descriptive characteristics with their HBS and HPS scores is presented in Table 4.

Table 4. Comparison of descriptive variables with hygiene behaviors scale (HBS) and health perception scale (HPS) mean scores (significance level: $p < 0.05$)

Features	HBS	Test and p	HPS	Test and p
Gender				
Female	38.44±7.29	t=1.967	53.11±7.14	t=-1.208
Male	37.46±6.45	p=0.049	53.78±7.80	p=0.227
Class				
1 st year	37.73±6.78	t=-0.234	53.53±7.46	t=-0.139
2 nd year	37.84±6.70	p=0.815	53.61±7.79	p=0.890
Place of residence				
Province	36.92±5.67	F=8.034	53.45±7.79	F=1.673
District	38.03±6.88	p=0.000	54.05±7.51	p=0.188
Other	39.56±8.60		52.66±7.22	
Employment status				
Yes	38.66±6.85	t=1.595	53.64±7.20	t=0.118
No	37.62±6.72	p=0.111	53.55±7.67	p=0.906
Chronic disease				
Yes	38.01±7.36	t=0.281	51.91±9.12	t=-1.763
No	37.76±6.70	p=0.779	53.69±7.46	p=0.078
Family type				
Nuclear	37.79±6.50	t=0.081	53.57±7.68	t=0.013
Extended	37.74±7.50	p=0.935	53.56±7.34	p=0.989
Economic status				
Poor	39.09±6.95	F=4.814	51.75±7.59	F=7.752
Moderate	37.38±6.59	p=0.008	53.98±7.49	p=0.000
Good	37.42±6.88		54.68±7.68	
Income status				
1–2.500 TL	37.86±6.65	F=2.568	53.54±7.37	F=1.708
2.500–5.000	37.29±6.92	p=0.077	53.23±7.68	p=0.182
5.000 and above	39.24±6.43		55.05±8.60	

A statistically significant difference was found in students' HBS scores based on gender ($t[98]=1.967$; $p < 0.05$), place of residence ($F[2, 844]=8.034$; $p < 0.05$), and economic status ($F[2, 844]=4.814$; $p < 0.05$), at the 95% confidence level. In this context, male students, those living outside city centers, and students with lower economic status had higher HBS scores, indicating more negative hygiene behaviors.

A statistically significant difference was also observed between students' HPS scores and their economic status ($F[2, 844]=7.752$; $p < 0.05$), at the 95% confidence level. Students with higher economic status had significantly higher HPS scores compared to those with moderate or lower economic conditions.

The relationship between the HBS and HPS was examined, revealing a low-level negative correlation at the 95% confidence level ($r=-0.151$; $p=0.015$). This finding indicates that as students' health perception decreases, their negative hygiene behaviors tend to increase (Table 5).

Table 5. Correlation values between the hygiene behaviors scale (HBS) and health perception scale (HPS)

Scales and subdimensions	Personal hygiene	Hand washing	Food hygiene	Hygiene behaviors scale
Internal control				
r	0.014	-0.048	-0.087	-0.032
p	0.682	0.159	0.011	0.350
Self-awareness				
r	-0.057	-0.175	-0.118	-0.129
p	0.095	0.000	0.001	0.000
Importance of health				
r	-0.089	-0.285	-0.275	-0.232
p	0.010	0.000	0.000	0.000
Certainty				
r	0.009	-0.142	-0.143	-0.081
p	0.788	0.000	0.000	0.018
Health perception scale				
r	-0.027	-0.214	-0.217	-0.151
p	0.426	0.000	0.000	0.000

Discussion

Personal hygiene practices undertaken by individuals to maintain health are a key factor in protecting and promoting overall well-being. Moreover, health-care personnel involved in patient care play a critical role in preventing the spread of infectious diseases through appropriate hygiene behaviors. Given that individuals' health perceptions are closely linked to their health-promoting behaviors, it is essential to assess the hygiene behaviors and health perceptions of future health-care professionals who will be actively engaged in patient care.

The total HBS scores obtained by the students were consistent with findings from previous studies examining hygiene behaviors among university students.^[16–18]

In contrast to previous research, the current study found that male students exhibited more positive hygiene behaviors compared to female students. However, existing literature presents differing results. Several studies have reported that female students generally demonstrate better hygiene behaviors than their male counterparts.^[17,19,20] This trend is often interpreted as a reflection of behavior patterns shaped by traditional gender roles, which influence individual personal hygiene habits.^[20]

Nevertheless, recent literature suggests that male students may outperform their female counterparts in specific aspects of hygiene, particularly in adherence to hand hygiene practices. For example, Piriñçi (2021) reported that male students exhibited more consistent hand hygiene behaviors in certain contexts.^[16] Similarly, a study by Şeker and Gürgül (2018) on the hygiene-related knowledge, attitudes, and behaviors of medical students found that male participants reported more favorable practices in areas such as regularly changing toothbrushes, using separate towels for hands and feet, and carrying personal grooming items such as combs.^[21]

Moreover, Cruz and Bashtawi (2016) found that being male was a positive predictor of hand hygiene compliance among nursing students.^[22] This challenges the commonly held assumption that female students are inherently more hygienic, highlighting that, under certain educational conditions, male students are equally capable of demonstrating exemplary hygiene practices. Similarly, research by Kadi and Salati (2012) showed that male medical students adhered more consistently to hand hygiene protocols, particularly when explicit hygiene training was included in the curriculum.^[23] Collectively, these findings challenge the prevailing narrative that females universally maintain superior hygiene practices

and emphasize the importance of targeted educational interventions in shaping student behavior.

In addition, a recent study by Malik et al.^[24] found that male students reported better sleep hygiene practices, which were positively associated with mental well-being. This indicates that male students engage in hygiene-related behaviors not only to support physical health but also as part of their psychological self-care. These findings contribute to a broader and more nuanced understanding of hygiene behaviors among male students.

Therefore, although traditional perspectives have typically associated female students with higher hygiene standards, emerging evidence suggests a shift in hygiene-related behaviors among male students. These changes may be influenced by factors such as curriculum content, behavioral role modeling, and evolving gender norms within academic settings.

In conclusion, although the prevailing view in the literature suggests that female students are generally more conscientious about hygiene, growing evidence indicates that male students – particularly those in structured educational environments – can also exhibit high levels of hygiene compliance.^[22–24] These findings highlight the need for further research to identify the factors that promote positive hygiene behaviors among male students, with the goal of informing inclusive and effective health education interventions across genders.

When hygiene behaviors were examined in relation to students' place of residence, it was found that those living in districts and villages exhibited more positive hygiene behaviors compared to students residing in city centers. This finding aligns with literature suggesting that the social, cultural, and educational dynamics of a locality can significantly influence individual health behaviors.^[25,26] It may be that in smaller settlements, local community norms, family structures, and school-based health education programs exert a stronger influence on personal hygiene practices.

It was found that students with lower economic status had higher HBS scores compared to those with moderate economic status, indicating more negative hygiene behaviors. While many studies suggest that individuals with higher income and education levels tend to have greater access to hygiene products and engage in more deliberate hygiene practices,^[27–29] there is also evidence showing that individuals with lower economic status may adopt positive hygiene behaviors despite limited resources.^[30,31] These conflicting findings highlight the complex relationship between socioeconomic status and hygiene-related behaviors.

It can be suggested that intensive health education initiatives implemented by public institutions, along with local health policies targeting economically disadvantaged populations, may have contributed to the higher hygiene behavior scores observed in this group. In addition, emotional factors – such as fear of illness, which are known to be significant determinants of hygiene behavior – may lead individuals with limited access to health-care services and resources to pay greater attention to hygiene practices. This, in turn, could result in higher self-reported hygiene behavior scores among economically disadvantaged students.

The study found no statistically significant differences in students' hygiene behaviors based on class year, employment status, presence of chronic illness, family type, or parental education and income levels. However, existing literature emphasizes the role of parental education in shaping individuals' hygiene behaviors. Several studies have reported that children of more highly educated parents tend to exhibit better hygiene practices, suggesting that family educational attainment can significantly influence personal hygiene habits.^[14]

This discrepancy may be attributed to the influence of educational settings. University students enrolled in health-care-related programs may have developed positive hygiene behaviors independently of their family background, as a result of the knowledge and skills gained through their education. Supporting this, a study by Taşkıran et al.^[32] found that students in health-related fields demonstrated more positive hygiene behaviors than those in non-health fields, highlighting the beneficial impact of health education on hygiene practices.

Although some studies have shown that family income significantly influences hygiene behaviors,^[33] other research suggests that such behaviors may be more strongly shaped by multidimensional social factors – such as education, awareness, and societal norms – rather than by economic status alone.^[34]

In this study, the mean HPS score among students was 53.57 ± 7.60 . Given that the scale ranges from 15 to 75, this result indicates a moderate level of health perception. Similar findings have been reported in previous studies.^[35–38]

The literature supports the view that university students' moderate levels of health perception are shaped by the interaction of multiple individual and environmental factors. Health-related course content, seminars, health screenings, and digital interventions provided during university education play a key role in enhancing students' health knowledge, thereby strengthening their health perceptions. In this context, interventions targeting health

behavior promotion among university students have been shown to produce positive psychological and behavioral outcomes, contributing to improved health perception.^[39]

Moreover, the university environment provides a social context that promotes healthy lifestyle behaviors, facilitates access to health-care services, and supports ongoing health awareness initiatives – factors that collectively contribute to the development of positive health attitudes and perceptions among students.

In addition, young adulthood is typically associated with good physical health, high energy levels, and physical fitness – factors that positively influence individuals' health perceptions.^[40]

An analysis of the relationship between students' health perception and sociodemographic characteristics revealed that those with better economic status had significantly higher health perception scores compared to peers with moderate or low economic status. This finding aligns with existing literature indicating a positive correlation between socioeconomic status and health perception, suggesting that economically advantaged individuals tend to report more favorable evaluations of their health.^[41–43]

A weak negative correlation was identified between HBS and HPS among students enrolled in Home Patient Care and Elderly Care programs. This finding indicates that lower levels of health perception are associated with an increase in negative hygiene behaviors.

The literature consistently emphasizes that health perception is a key determinant of health-related behaviors. Individuals with higher levels of health perception are more likely to engage in health-protective and health-promoting behaviors, whereas those with lower health perception tend to exhibit inadequate preventive health practices.^[44,45] In line with this, Ayyıldız and Aktaş^[46] reported that individuals with lower health perception scores also demonstrated lower levels of hygiene, healthy lifestyle behaviors, and self-care practices.

This finding demonstrates that health perception not only reflects individuals' self-assessment of health status but also plays a critical role in shaping their preventive and protective health behaviors.

Previous studies have demonstrated that health perception plays a critical role in shaping hygiene practices; lower health perception has been linked to factors such as low self-confidence, limited health education, and negative personal experiences, all of which may contribute to an increase in negative hygiene behaviors.^[47–49] The negative correlation observed among students in Home Patient Care and Elderly Care programs

suggests that interventions aimed at enhancing health perception could lead to improvements in both personal and professional hygiene behaviors.

Limitations and Strengths

This study has several limitations that should be acknowledged. First, its cross-sectional design limits the ability to draw causal inferences between the examined variables. Second, data were collected online, which may have introduced selection bias due to unequal access to digital resources or varying levels of digital literacy among participants. Third, the use of self-reported measures may have resulted in social desirability bias or inaccuracies in the responses provided by participants.

Despite these limitations, the study has several notable strengths. The inclusion of participants from a diverse range of universities enhances the generalizability of the findings. Moreover, the relatively large sample size increases the statistical power of the analyses. Finally, grounding the research in the HBM provides a strong theoretical foundation for interpreting the results and adds to the study's conceptual rigor.

Conclusion

The findings of this study revealed that more than half of the students exhibited positive hygiene behaviors and had a moderate level of health perception. A statistically significant relationship was identified between HBS and HPS, indicating that as students' health perception decreased, negative hygiene behaviors increased.

According to the HBM, health perception plays a critical role in shaping individuals' health behaviors and sense of health responsibility.^[50] In this context, it is essential that students preparing for future roles in patient care demonstrate positive hygiene behaviors and maintain a high level of health perception. The well-being of caregivers is particularly important, as it contributes to improving patients' quality of life and may indirectly reduce the overall health-care needs of patient populations.^[51]

Accordingly, it is recommended that educational interventions aimed at enhancing health perception and hygiene behaviors be systematically integrated into the curriculum. Priority should be given to the development of structured training programs focusing on personal hygiene, health awareness, and professional responsibility – particularly for students in caregiving-related disciplines. Such targeted initiatives are expected to improve not only students' individual health but also the overall quality of care they provide.

Disclosures

Ethics Committee Approval: The study was approved by the Gümüşhane University Scientific Research Ethics Committee (no: 2020/9, date: 24/09/2020).

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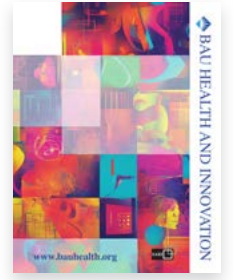
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Exploring the Impact of Caregiving on Musculoskeletal Health: Insights from Caregivers of Children with Cerebral Palsy

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Abstract

Objectives: This study aimed to evaluate the frequency, severity, and regional distribution of musculoskeletal pain in primary caregivers of children with cerebral palsy (CP) and to investigate its associations with caregiving-related factors, including the child's motor impairment level and demographic variables.

Methods: A cross-sectional observational study was conducted with 84 caregivers of children with CP. Musculoskeletal complaints were assessed using the Extended Nordic Musculoskeletal Questionnaire, and pain severity was measured by the Visual Analog Scale (VAS). The Gross Motor Function Classification System (GMFCS) was used to assess the motor impairment level of the children. Associations between caregiver pain and clinical variables were analyzed using appropriate statistical tests.

Results: The most frequently reported pain regions were the lower back (69.0%), neck (59.5%), and shoulders (58.3%). Pain in these areas significantly interfered with daily activities. Statistically significant associations were found between higher GMFCS levels and increased shoulder, wrist/hand, upper back, and lower back pain. Older child age and caregiver age were also associated with greater musculoskeletal burden. VAS scores showed a positive correlation with both GMFCS level and caregiver age ($P < 0.05$).

Conclusion: Musculoskeletal pain is common among caregivers of children with CP and is influenced by the severity of the child's motor disability and caregiver demographics. Preventive strategies, such as ergonomic education, regular screening, and multidisciplinary support should be integrated into pediatric rehabilitation services to protect caregiver health and ensure sustainable care.

Keywords: Caregiver burden, cerebral palsy, ergonomic risk, musculoskeletal pain.

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Cerebral palsy (CP) is a group of permanent, non-progressive motor disorders caused by disturbances in the developing fetal or infant brain, characterized primarily by impairments in movement and posture due to abnormalities in muscle tone, reflexes, motor control, and coordination.^[1] CP is not a uniform condition; rather, it comprises a spectrum of clinical manifestations that may

also involve sensory, perceptual, cognitive, communicative, and behavioral impairments, as well as epilepsy and secondary musculoskeletal problems.^[2,3] With an estimated prevalence of 4.4/1000 live births in Turkey, CP constitutes one of the most common causes of childhood physical disability and places a significant burden on both families and healthcare systems.^[4]

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Children with CP often experience limitations in gross and fine motor functions, which lead to difficulties in performing daily activities independently. As a result, they require continuous and intensive care, often provided by a primary caregiver, who is typically a family member. Caregiving responsibilities include a range of physical tasks, such as lifting and transferring the child, assisting with personal hygiene, supporting therapeutic exercises, and facilitating mobility, particularly in non-ambulatory cases.^[5,6] These tasks frequently require sustained physical effort and are often performed in ergonomically unfavorable positions, especially when the child grows older or gains weight, significantly increasing the physical workload on the caregiver.^[7]

Over time, this physical strain may lead to a variety of musculoskeletal complaints among caregivers. Previous studies have reported high rates of musculoskeletal symptoms – particularly in the neck, back, shoulders, and lower limbs – among caregivers of individuals with disabilities or chronic conditions.^[8,9] These symptoms can negatively impact caregivers' physical health, psychological well-being, and quality of life, potentially compromising the continuity and quality of care they provide.^[10] Furthermore, the cumulative burden on caregivers may contribute to increased healthcare utilization and indirect societal costs, highlighting the importance of early identification and prevention strategies.^[11]

Despite the considerable physical demands involved in caregiving for children with CP, limited research has specifically investigated the musculoskeletal health of their caregivers. Most available studies focus on caregiver stress or psychological burden, with relatively few addressing the prevalence, distribution, and severity of musculoskeletal symptoms in this population, as well as their relationship with caregiving demands.^[12] Moreover, the identification of risk factors, such as duration of caregiving, age of the child, gross motor function level, or caregiving posture may provide critical insight into targeted interventions for caregiver support.^[13]

In this context, the present study aims to evaluate the frequency and severity of musculoskeletal symptoms among primary caregivers of children diagnosed with CP, to examine the association between these symptoms and the caregiving process, and to identify potential risk factors contributing to musculoskeletal burden. To achieve this, we utilized the Extended Nordic Musculoskeletal Questionnaire (NMQ-E), a validated and widely used instrument for assessing musculoskeletal complaints, and incorporated data from the Gross Motor Function Measure-88 (GMFM-88) to account for the motor severity of the children under care.

Materials and Methods

Study Design and Setting

This cross-sectional observational study was conducted at the Physical Therapy and Rehabilitation Clinic of Beykent University Faculty of Medicine. The study aimed to assess the frequency and severity of musculoskeletal symptoms among primary caregivers of children diagnosed with CP, and to examine the relationship between these symptoms and caregiving-related physical burden. The study was approved by the Istanbul Beykent University Non-Interventional Clinical Research Ethics Committee (approval number: 2025/5; date: 26.06.2025), and all participants provided informed consent in accordance with the Declaration of Helsinki.

Participants

A total of 84 primary caregivers of children diagnosed with CP who were receiving routine physical therapy at our clinic were included in the study. Inclusion criteria were: (1) Being the primary caregiver of a child aged 4–18 years with a confirmed diagnosis of CP; (2) Providing direct physical care to the child (e.g., lifting, transferring, assisting with daily living activities); and (3) Voluntary consent to participate. Caregivers with known musculoskeletal disorders unrelated to caregiving, recent trauma or surgery, or those with systemic diseases that could affect musculoskeletal symptoms were excluded.

Data Collection and Measures

The gross motor function levels of the children were obtained retrospectively from medical records using the GMFM-88. The GMFM-88 is a standardized observational tool designed to evaluate changes in gross motor function over time in children with CP. It consists of 88 items divided into five dimensions: (1) Lying and rolling (17 items), (2) Sitting (20 items), (3) Crawling and kneeling (14 items), (4) Standing (13 items), and (5) Walking, running, and jumping (24 items). Each item is scored using a 4-point Likert scale (0 = Does not initiate, 1 = Initiates, 2 = Partially completes, 3 = Completes independently).^[14,15] This scale has been shown to have high reliability and validity for assessing gross motor function in children with CP.^[16]

Musculoskeletal complaints of caregivers were assessed using the NMQ-E. This validated instrument evaluates the presence of musculoskeletal symptoms in nine anatomical regions (neck, shoulders, upper back, elbows, wrists/hands, lower back, hips/thighs, knees, and ankles/feet) over three time frames: (1) During the past 12 months, (2) During the past 7 days, and (3) Whether the pain prevented the individual from performing normal activities.^[17] Responses were binary (yes/

Table 1. Frequency of musculoskeletal pain, pain-related activity limitation, and recent pain experience in caregivers according to body region

Body region	Pain in the past 12 months				Interfered with daily activities				Pain in the past 7 days			
	No		Yes		No		Yes		No		Yes	
	n	%	n	%	n	%	n	%	n	%	n	%
Neck	34	40.5	50	59.5	67	79.8	17	20.2	72	85.7	12	14.3
Shoulder	35	41.7	49	58.3	80	95.2	4	4.8	74	88.1	10	11.9
Elbow	68	81.0	16	19.0	84	100.0	0	0	80	95.2	4	4.8
Wrist/hand	54	64.3	30	35.7	80	95.2	4	4.8	78	92.9	6	7.1
Upper back	40	47.6	44	52.4	80	95.2	4	4.8	73	86.9	11	13.1
Lower back	26	31.0	58	69.0	72	85.7	12	14.3	67	79.8	17	20.2
Hip/thigh	66	78.6	18	21.4	82	97.6	2	2.4	80	95.2	4	4.8
Knee	63	75.0	21	25.0	82	97.6	2	2.4	80	95.2	4	4.8
Ankle/foot	61	72.6	23	27.4	79	94.0	5	6.0	78	92.9	6	7.1

no), and although the questionnaire allows for region-specific symptom mapping, it does not produce a total score. The Turkish version of the NMQ-E has been previously validated and widely used in occupational and clinical populations.^[18,19]

Based on previous studies that examined the relationship between caregiving burden or musculoskeletal pain and factors, such as Gross Motor Function Classification System (GMFCS) level or caregiving duration (e.g., Gokcin Eminel et al., 2021; Sharan et al., 2018),^[20,21] an expected effect size of $r=0.30$ was assumed. This value represents a medium effect size according to Cohen's classification and is consistent with reported associations in similar caregiver populations. Using G*Power 3.1.9.7 for a two-tailed Pearson correlation, with $\alpha=0.05$ and statistical power of 0.80, the minimum sample size required was calculated to be 84 participants.

Data Analysis

Statistical analyses were performed using the IBM Statistical Package for the Social Sciences Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize sociodemographic and clinical characteristics. For normally distributed continuous variables, mean and standard deviation values were reported; for non-normally distributed variables, medians along with minimum and maximum values were presented. The Kolmogorov-Smirnov test was used to evaluate the normality of continuous variables. Depending on the distribution, either the paired samples t-test (for normally distributed data) or the Wilcoxon signed-rank test (for non-normally distributed data) was applied to assess within-group differences. Categorical variables were compared using the Chi-square test or Fisher's exact test, where appropriate. For correlation analyses, Pearson or Spearman correlation coefficients were calculated

based on data distribution. If multiple comparisons were performed, P-values were adjusted using the Bonferroni correction method to control for the risk of Type I error. A $p<0.05$ was considered statistically significant.

Results

A total of 84 children with CP and their primary caregivers were included in this study. The mean level of the children on the GMFCS was 2.37 ± 0.74 , ranging from level 1 to level 4. The mean age of the children was 8.37 ± 3.80 years, with a range of 4–17 years. The mean age of the caregivers was 35.13 ± 5.55 years, ranging from 29 to 53 years. The caregivers' pain levels were assessed using the Visual Analog Scale (VAS), and the mean score was 5.30 ± 1.34 , with scores ranging from 2 to 8. Regarding the gender distribution of the children, 60.7% were female ($n=51$) and 39.3% were male ($n=33$). As for the occupational status of the caregivers, 94.0% ($n=79$) were housewives, while 6.0% ($n=5$) were employed.

Based on the Nordic Musculoskeletal Questionnaire, the most commonly reported pain regions over the past 12 months were the lower back (69.0%), neck (59.5%), and shoulders (58.3%). Pain in these regions also caused the greatest interference with daily activities, particularly in the neck (20.2%) and lower back (14.3%). In the past 7 days, the most frequent complaints were again in the lower back (20.2%), neck (14.3%), and upper back (13.1%). These findings highlight the physical burden of caregiving, especially on spinal and upper body regions (Table 1).

When musculoskeletal pain in caregivers was evaluated over the past 12 months, several statistically significant associations were identified. Shoulder pain was significantly associated with higher GMFCS levels ($p=0.013$) and older child age ($p=0.004$). Elbow pain was linked to higher GMFCS levels ($p=0.033$) and significantly younger caregiver age

Table 2. Distribution of musculoskeletal pain by body region and its associations with GMFCS level, child age, and caregiver age

Body region	Pain lasts 12 months	n	%	GMFCS (Mean±SD)	p	Patient age (Mean±SD)	p	Caregiver age (Mean±SD)	p
Neck	No	36	40.9	2.25±2.25	0.310	8.11±3.89	0.608	34.64±5.10	0.621
	Yes	52	59.1	2.40±2.40		8.44±3.81		35.50±5.94	
Shoulder	No	38	43.2	2.13±2.13	0.013	7.00±3.26	0.004	34.45±4.82	0.417
	Yes	50	56.8	2.50±2.50		9.30±3.95		35.68±6.12	
Elbow	No	72	81.8	2.28±2.28	0.033	8.60±4.12	0.427	35.87±5.91	0.013
	Yes	16	18.2	2.63±2.63		7.00±1.55		31.88±1.67	
Wrist/hand	No	58	65.9	2.19±2.19	0.004	7.86±3.96	0.031	34.36±5.26	0.039
	Yes	30	34.1	2.63±2.63		9.17±3.46		36.67±6.00	
Upper back	No	43	48.9	2.16±2.16	0.021	8.23±3.97	0.737	35.98±5.87	0.177
	Yes	45	51.1	2.52±2.52		8.39±3.72		34.32±5.25	
Lower back	No	27	30.7	2.11±2.11	0.040	7.04±3.12	0.032	34.48±3.67	0.960
	Yes	61	69.3	2.44±2.44		8.87±3.99		35.44±6.27	
Hip/thigh	No	70	79.5	2.29±2.29	0.134	8.46±3.84	0.441	35.09±5.67	0.739
	Yes	18	20.5	2.56±2.56		7.72±3.82		35.39±5.45	
Knee	No	65	73.9	2.34±2.34	0.844	7.83±3.60	0.069	35.11±5.11	0.603
	Yes	23	26.1	2.35±2.35		9.65±4.18		35.26±6.94	
Ankle/foot	No	64	72.7	2.30±2.20	0.259	8.03±3.88	0.155	34.73±5.10	0.429
	Yes	24	27.3	2.61±2.71		9.04±3.67		36.25±6.75	

GMFCS: Gross motor function classification system, SD: Standard deviation

($p=0.013$). Wrist/hand pain was related to higher GMFCS levels ($p=0.004$), older child age ($p=0.031$), and older caregiver age ($p=0.039$). Upper back pain was significantly associated with higher GMFCS levels ($p=0.021$). Lower back pain was associated with higher GMFCS levels ($p=0.040$) and older child age ($p=0.032$). No statistically significant associations were found between pain presence and study variables in the hip, knee, or ankle/foot regions (Table 2).

These findings suggest that musculoskeletal pain in caregivers, particularly in the shoulder, wrist, and lower back regions, is influenced by both the child's level of motor impairment and age, and in some areas, by the caregiver's age.

A correlation analysis was conducted to examine the relationship between pain severity (VAS scores) and clinical variables. VAS scores were found to be significantly and positively correlated with GMFCS level ($r=0.248$, $p=0.020$) and caregiver age ($r=0.215$, $p=0.044$). The correlation between VAS scores and child age did not reach statistical significance ($r=0.206$, $p=0.054$), although it approached the threshold. These findings suggest that caregivers of children with higher functional limitations and older caregivers tend to report higher levels of pain.

Discussion

This study revealed a high prevalence of musculoskeletal complaints among caregivers of children with CP, with the lower back, neck, and shoulders being the most frequently

affected regions. These findings are consistent with previous research highlighting the physical burden and ergonomic challenges associated with caregiving tasks, particularly in non-ambulatory or severely impaired children.^[22–24]

Our results demonstrated significant associations between musculoskeletal pain and both child- and caregiver-related factors. Specifically, higher GMFCS levels and older child age were consistently associated with pain in the shoulder, wrist/hand, and lower back regions. These findings are plausible considering that children with more severe motor limitations require full physical assistance with activities of daily living, including transfers, hygiene, and mobility support, which frequently involve repetitive lifting, pushing, and awkward postures. This mechanical overload is particularly concentrated in the upper body and spine. Our findings are in line with those of Gökcin Eminel et al.,^[20] who reported that lower levels of gross motor function in children with CP are significantly correlated with increased physical workload and pain complaints in caregivers, particularly in the back and upper extremities. Similarly, Sharan et al.^[25] emphasized that repetitive bending, twisting, and lifting without proper ergonomics were primary risk factors for the development of musculoskeletal disorders in caregivers of children with disabilities.

In addition to child-related characteristics, caregiver-related factors – especially age – also played a significant role in pain development. Our study revealed that older caregivers

reported higher levels of pain severity (VAS) and greater frequency of regional pain, particularly in the elbow and wrist/hand. This aligns with the findings of Ramezani et al.,^[26] who demonstrated that advanced age, increased body weight (body mass index), and the accumulation of physically demanding caregiving tasks were significant predictors of chronic low back pain among mothers of children with CP. It is likely that age-related musculoskeletal vulnerability, combined with long-term repetitive strain, reduces tissue resilience and heightens pain sensitivity over time. These data suggest that both the intensity and duration of caregiving are critical in shaping the physical health profile of caregivers. Interestingly, while neck pain was one of the most frequently reported symptoms, its statistical associations with measured clinical variables were weaker than for other body regions. This may reflect the contribution of unmeasured ergonomic factors, such as prolonged static postures, unsupported head/neck positioning during caregiving (e.g., feeding, dressing), or visual tracking while attending to the child's needs. These actions may not involve overt lifting or resistance, but they contribute to sustained muscle tension, particularly in the trapezius and cervical paraspinal regions. The accumulation of such micro-strain over time may explain the high prevalence yet weak statistical link to gross motor metrics.

Beyond anatomical localization and mechanical causes, emerging literature highlights the importance of pain mechanisms in understanding caregiver burden. In this context, Saraçoğlu et al.^[23] examined pain phenotypes in caregivers of children with CP and identified the presence of not only nociceptive pain due to mechanical strain but also nociplastic and neuropathic pain components, which may reflect central sensitization and chronicity-related changes in pain processing. Notably, caregivers with nociplastic or neuropathic pain phenotypes reported higher pain severity scores and poorer quality of life, even in the absence of corresponding increases in physical load. This suggests that long-term caregiving may trigger complex pain mechanisms, involving alterations in the central nervous system's response to pain stimuli.

These findings underscore the importance of adopting a biopsychosocial model when addressing caregiver pain. Interventions should not only target mechanical load reduction through ergonomic training, assistive devices, or physical therapy, but also include psychoeducation, stress management, and, where necessary, treatment for central sensitization syndromes. Regular screening for early pain symptoms, psychological distress, and functional limitations among caregivers should be integrated into pediatric rehabilitation follow-up protocols. Ultimately,

optimizing caregiver health is essential not only for their own well-being but also for ensuring the continuity and quality of care delivered to children with CP.

The emotional and psychological dimensions of caregiver burden, although not directly assessed in this study, should not be overlooked. Studies have shown that depression, stress, and perceived stigma significantly influence musculoskeletal symptoms and overall caregiver health.^[24-27] Therefore, any intervention strategy should be holistic and family-centered.

The cross-sectional nature of our study limits causal inference, and the self-reported nature of musculoskeletal complaints may be subject to recall bias. Pain severity was assessed only through VAS and not confirmed through clinical or imaging methods. Other important variables, such as body mass index, physical fitness, or psychosocial factors, were not included. In addition, the sample consisted primarily of female caregivers, which may limit the generalizability of the findings to broader caregiver populations.

Conclusion

Caregivers of children with CP face a high risk of musculoskeletal pain, particularly in the lower back, neck, and shoulders. These symptoms are significantly influenced by caregiving burden, especially in cases involving children with more severe motor impairments and older age. Preventive strategies, such as ergonomic training, physical therapy, and routine musculoskeletal screening should be integrated into pediatric rehabilitation programs. Supporting caregiver well-being is essential not only for their health but also for the sustainability and quality of care provided to children with CP.

Disclosures

Ethics Committee Approval: The study was approved by the Istanbul Beykent University Non-interventional Clinical Research Ethics Committee (no: 2025/5, date: 26/06/2025).

Informed Consent: Informed consent was obtained from all participants.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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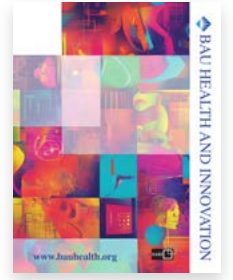
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Review



Operating Room Nursing and Malpractice

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Abstract

Operating rooms are places where advanced technological tools and equipment are used, various surgical techniques and methods are applied, and teamwork and making the right decisions quickly are important. Operating room nurses have important duties such as creating the necessary conditions for the environment where the operation will be performed, preparing the instruments and equipment before the operation, preparing the patient, performing and terminating the operation, and following the maintenance, cleaning, and sterilization of the instruments and equipment after the operation. Excessive workload, an insufficient number of staff, ambiguities in roles, long working hours, inadequate wages, working in a shift system, poor communication with health-care team members, and problems related to the management approach of managers reduce motivation and cause medical errors. The Joint Commission on Accreditation of Healthcare Organizations defines malpractice as damage to the patient as a result of inappropriate and unethical behavior of health-care professionals and inadequate and negligent behavior in professional practices. When we look at the undesirable events that operating room nurses may encounter: incomplete or incorrect transmission of information about the patient during patient transfer from the operating room to the clinic, cutting and piercing instrument injuries, wrong side surgery, forgetting a foreign body, surgical electrocautery burns, urinary catheter-related infections, transfusion errors, surgical site infections, drug administration errors, pressure wounds due to falls and immobility, pulmonary embolism, problems arising from medical devices, injuries, ventilator-associated pneumonia, and deep vein thrombosis. No studies evaluating the relationship between operating room nurses and malpractice were found in the literature. Further studies are needed to develop strategies to reduce/prevent malpractice rates, which have important consequences for patients and health professionals and are important markers of health-care quality, and to determine the attitudes and tendencies of health professionals toward malpractice.

Keywords: Malpractice, operating room nursing, safety, surgery.

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Operating rooms are places where advanced technological tools and equipment are used, various surgical techniques and methods are applied, and teamwork and making the right decisions rapidly are important.^[1,2] The operating room nurse works in an environment where basic life needs are determined according to medical and surgical principles and is responsible for the care of patients known to undergo physiologic changes.^[3] Operating room nurses are the main health personnel in the implementation of care services in the operating room. Operating room nurses provide a wide range of services before, during, and after surgery. Operating room nurses must be excellent

team members to ensure effectiveness and efficiency in patient care, which is their main responsibility.^[4] Within the framework of legal understanding, all health professionals should perform their practices within the framework of the concept of “permissible risk” (complication). In this context, the health-care professional is obliged to take possible precautions before the application – except in emergencies. Even if negative consequences occur due to his/her action within the framework of the permissible risk, this situation does not impose an obligation on the employee.^[5] This is due to the employee’s compliance with the duty of care and attention. Lack of caution and carelessness is medically

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considered “medical malpractice.”^[6] Health-care professionals can commit any error, despite the concept of medical error being broader than malpractice. In an article published in 2016 in the United States of America, it was reported that deaths due to medical errors ranked third among all causes of death.^[7] In the data obtained from European countries, it was determined that 8–12% of hospitalized patients were exposed to medical errors; more than 750 thousand medical errors occurred annually, and this caused approximately 3.2 million hospitalizations, 260 thousand permanent disabilities, and 95 thousand deaths.^[8] In the literature, it has been reported that operating rooms, intensive care units, and emergency departments are higher-risk units in terms of medical errors and patient safety.^[9] Although there is no comprehensive study on operating room-related medical errors in Türkiye, the findings of a study compiled from newspaper reports found that operating rooms ranked first among the units where medical errors were encountered, with a rate of 43.6% and 19.8% of patients underwent faulty surgery. Anesthesia-related errors ranked second with 8.1%.^[10] In another study, it was found that 41% of surgical errors occurred in the orthopedics unit.^[11] Looking at the clinical area where the medical error was applied, it was determined that 36.9% occurred in the operating room surgery department, and the most common type of medical malpractice was surgical malpractice, with 26.9%. When the type of medical malpractice reported in the newspapers within the scope of the study was examined, it was found that 14.6% (n=19) were due to incorrect drug administration, 12.3% (n=16) were due to incorrect diagnosis, 10.8% (n=14) were due to incorrect treatment, 26.9% (n=35) were due to incorrect surgery, 23.1% (n=30) were due to incorrect patient safety, and 12.3% (n=16) were due to other reasons.^[12] In another study, it was found that the most commonly reported type of surgical error was failure to mark the surgical site/side (15.02%). This was followed by failure to verify the patient’s identity information, surgical site, and surgical procedure (6.03%). These two types of errors accounted for approximately one-fifth (21.05%) of all reported surgical errors. Errors in the other group accounted for approximately one-third (34.53%) of all reported surgical errors. It is estimated that the rate of non-reporting of adverse events in health-care organizations varies between 50% and 96% annually.^[6] The most common adverse events encountered in surgical units are; patient transfer from clinic to the operating room or from operating room to clinic; sharp and piercing instrument injuries, foreign bodies forgotten in the operation area, wrong side surgery, transfusion errors, administration of incorrect gas mixture in anesthesia, surgical site infections, urinary catheter related infections,

pressure ulcers, drug administration errors, surgical electrocautery burns, laser-induced injuries, injuries due to falls and immobility, injuries caused by medical devices, ventilator-associated pneumonia, pulmonary embolism, and deep vein thrombosis.^[13–15] Surgical nurses should keep complete records throughout the perioperative process and report all health-care processes (e.g., positioning, pressure ulcers, use of heat probes, presence of implants, drains, and wound dressing, number and duration of tourniquets if used, electro-surgical plate position, etc.).^[15] Çakmak et al.^[16] in their retrospective study on malpractice case files subject to the Court of Cassation, it was found that medical errors occurred mostly in the branches of obstetrics and gynecology and general surgery, and it was determined that medical errors were mostly caused by the selection of the wrong treatment method and surgical errors. The reason why surgical error notifications are lower compared to other errors may be explained by the perception that healthcare workers associate surgical error notifications with malpractice more, and the concerns of the workers about the possibility of being penalized. One of the malpractices encountered by operating room nurses is related to the counting of the materials used during the operation. Forgetting a foreign body in the body is interpreted as clear evidence of a lack of attention. In court jurisprudence, this situation has been evaluated as direct negligence, and an expert opinion was not even needed.^[17] In 2020, a case of forgetting a sponge sheet in the patient’s body was referred to the Court of Cassation. The defendants, including a nurse, were found negligent for forgetting a sponge sheet on the patient’s body during surgery.^[18]

When the patient is being prepared in the operating room, it is important for the patient to tell his/her own name and surname in order to determine the identity information more accurately and to reduce errors.^[19]

To reduce/prevent injury during surgery, the body parts at risk should be emphasized verbally. In this way, the attention of the entire surgical team can be drawn, and the patient can be protected from pressure ulcers and other risks.^[20]

Protecting the sterile field and maintaining sterility are listed among the duties of nurses in the regulations. The nurse must manage this process correctly, starting from preparing the materials to be used in the operation and continuing until the end of the operation. In a malpractice case, both the doctor and the nurse were found guilty and sentenced to imprisonment after an infection developed in the eyes of five patients who underwent eye surgery on the same day.^[21]

Problems related to the transportation of surgical tissue specimens to the laboratory may generally arise from reasons such as non-coding of the material, incorrect coding,

and a lack of personnel to provide transportation. The safe surgical pathology specimen management process includes defining the place where the specimen will be taken, determining its boundaries, removing it, naming it, fixing it in the appropriate specimen container with protective solution, labeling it, sending it to the pathology laboratory, protecting the integrity of the specimen in all processes, and creating complete records.^[15,22] In a meta-analysis study on the detection of errors in the surgical pathology specimen management process, it was found that 0.05% of the errors were due to incorrect or missing patient information in labeling the specimen and 7.7% were due to the absence of the request form or result report in a sample group in which more than 1,850 materials were followed.^[23]

Another malpractice of operating room nurses is burns that may occur during surgery. Burns may occur due to devices used to heat the patient or cautery used during surgery.^[15,19] Communication problems among health-care professionals are shown to be among the important reasons for the occurrence of medical errors. In a study, it was determined that teamwork, safety climate, and management understanding were effective in the medical error attitudes of surgical nurses and the causes of medical errors. Therefore, it is thought that maintaining teamwork, strengthening team spirit, and reducing communication barriers in health-care service delivery will have positive effects on reducing medical errors and increasing patient safety.^[24] Studies have shown that the worst performance of healthcare workers occurs between 04:00 and 06:00 hours at night. It is thought that the sleep-deprived healthcare worker rushing to finish his/her work faster and to rest paves the way for malpractice. As a result of the decreased performance of healthcare workers, it is observed that aseptic techniques are not followed, erroneous drug administration increases, and patient needs are overlooked.^[25] In a study conducted in 2011, 96% of the operating room nurses who participated in the study stated that they were exposed to the tense behaviors of surgeons in the operating room; 49% stated that they were negatively affected by this situation and that they were angry, and 52% stated that they could not show their anger.^[26] In addition to the concepts of mobbing and crime, it should be kept in mind that the tensions experienced within the surgical team pose a great risk in terms of patient safety, and action should be taken accordingly. The work efficiency or motivation of a nurse who is subjected to mobbing decreases, which may directly lead to a decrease in the quality of care of patients/healthy individuals and malpractice.^[27]

When medical errors were examined, it was reported that mortality rates due to anesthesia during surgery were higher in developing countries than in developed countries.^[28] In

the study of Merry et al.,^[29] it was stated that a large portion of preventable anesthesia errors were human-induced. When we look at Türkiye, it has been observed that the operating room unit ranks first when the departments where medical errors occur are evaluated. It has been determined that approximately 20% of patients who will undergo surgical intervention have an erroneous operation. In a similar study, it was reported that most of the adverse events in the operating room occurred in orthopedic surgeries.^[10,30,31]

Physicians, nurses, unit managers, or pharmacists may be responsible for medication errors.^[6] Barcode management and handheld personal digital assistants increase medication administration safety. Providing real-time patient information, drug profiles, laboratory values, drug information, and documentation can reduce errors. Electronic medication management helps identify incorrect, skipped/canceled, or changed medication orders. Circumventing barcode procedures reduces safety at the point of care.^[32] Errors such as the interaction of the drugs given to the patient with other drugs, miscalculation of drug doses, incorrect drug administration, drug monitoring errors, and unknowingly giving drugs that may cause interaction to a patient with an allergic history are considered within this scope. It is estimated that 34–56% of these errors are preventable.^[6,11]

Studies have shown that the use of the safe surgery checklist (SCCL) improves patient safety by effectively alleviating the undesirable effects of surgery by decreasing the rate of performing the right procedure on the right patients, significantly reducing complication and mortality rates, improving teamwork and communication in the operating room, reducing unplanned returns from the operating room, and reducing the rate of wrong surgery.^[33,34] SCCL is recommended as a tool that improves communication, cooperation, and patient safety among team members.^[35] SCCL has an important role in preventing medical errors that occur due to communication deficiencies. In a study conducted by Haynes et al.,^[34] it was found that the use of the checklist in emergency surgical interventions reduced complications. It was emphasized that the complication rate was 7% when more than half of the items of the SCCL were completed, while the complication rate increased to approximately 19% when less than half of the items were applied in the same study.

Falls may occur during and after surgery due to the effects of anesthesia. The operating room nurse should take the necessary precautions to prevent falls. The anesthesia and surgical team need to act together to prevent falls. The circulating nurse must be at the patient's bedside during the preparation phase of the operation, while the patient is given the operating position, and must take all necessary precautions. It is also stated that determining the risk of falls,

identifying the patient at risk of falling, taking precautions against falls, monitoring and reporting falls, informing patients and their relatives about this issue, using fall prevention warnings, and, importantly, using safe equipment are also mandatory in terms of patient safety.^[36–39]

Conclusion

In reducing and preventing malpractices, which can have significant consequences for patients and health-care professionals and are serious indicators of health-care quality, it is also important to determine the situations that may cause medical errors in advance to make the necessary arrangements and to determine the attitudes and tendencies of health-care professionals toward medical errors. Due to the high number of malpractices affecting patient safety all over the world and their consequences of varying degrees of severity, it is necessary to develop more effective strategies for the prevention and management of malpractices.

As a result, we can list the malpractices encountered in the operating room as follows: failure to apply aseptic antiseptic techniques, communication problems, patient falls, failure to perform surgical pathology material management by the technique, failure to manage risks related to drug safety, equipment and material deficiencies, wrong-side surgery, forgetting a foreign body in the body, surgical burns, problems in transfusion of blood and blood products, unexplained events, and events caused by lack of experience and knowledge.

In operating rooms, factors such as work intensity, ignorance, inexperience, carelessness, and an insufficient number of nurses may not cause the steps of safe surgical practice to be skipped, causing harm to people receiving health-care services and the emergence of malpractices. Malpractices arising from the defective actions of operating room nurses lead to their legal responsibilities. In the prevention of these problems, effective use of the SCCL, good management of the operating room environment, keeping the necessary devices and equipment ready for use, not avoiding verbal verification in medication and other health-care practices, keeping complete records, protecting the patient's body integrity in patient transfers, respecting the privacy of the patient, taking care not to remove the catheter-drain and catheter, and establishing good relations within the team are of great importance.

Operating room nurses should know their duties and responsibilities and avoid practices that may cause negligence or error. The fact that there is a wide and complex legislation in health services requires frequent renewal of nurses' knowledge about their legal responsibilities. For this reason, institutions

should definitely address the issue of legal responsibility in in-service training, and it should be repeated periodically. In order to create and maintain patient safety strategies, there should be specialization in institutions that train health professionals, and continuity can be ensured in training programs after graduation. Qualitative and quantitative studies in large samples can be conducted to determine the factors affecting malpractice, and measures can be taken.

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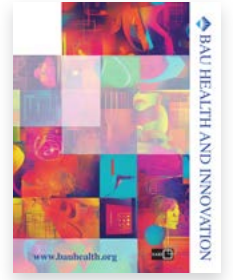
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The Pelvic Floor and Posture: Exploring the Foundations of Functional Balance

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Abstract

Pelvic floor muscles (PFMs) play a crucial role in the support of pelvic organs, the maintenance of continence, and the preservation of postural stability. The functions of the pelvic floor (PF) extend beyond localized muscular activity; they are intrinsically linked to postural control and respiration dynamics. This complex and integrated relationship can be elucidated through neuromuscular interactions, which significantly influence spinal alignment and pelvic positioning. Pelvic floor dysfunction (PFD) may result in postural deviation, diminished spinal stability, and the onset of chronic pain syndromes. This review critically explores the effects of pelvic floor musculature on posture and examines the bidirectional interactions between these systems. Additionally, the clinical implications of the PF–posture relationship are discussed in the context of physiotherapy and rehabilitation approaches. In this regard, emerging evidence underscores the efficacy of exercise programs targeting the pelvic floor to improve postural control and spinal stability. Ultimately, a more comprehensive understanding of the interplay between the pelvic floor and posture may pave the way for innovative, integrative approaches for the prevention and management of PFDs. In this regard, interdisciplinary research and clinical practice will contribute significantly to advancing our understanding of the PF–posture nexus. This review synthesizes a range of perspectives to provide a thorough evaluation of the complex relationship between PF and posture.

Keywords: Pelvic floor, postural stability, postural balance, postural instability, rehabilitation.

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The pelvic floor is a complex system composed of muscles, ligaments, and fascia that supports intrapelvic structures such as the bladder, reproductive organs, and rectum. This structure acts as a sling, ensuring the positioning of pelvic organs and supporting functional stability. The PF originates from the ilium, ischium, and pubic bones, merging posteriorly with the sacrum to form a supportive framework. Active support is achieved through continuous muscle contraction, while passive support from surrounding connective tissues and fascia adds further stability.

The pelvic region contains a complex neural network. This nervous system has a bilateral structure, transmitting information both from the periphery to the central nervous system (CNS) and from the CNS to the periphery. Motor fibers are divided into two main groups: somatic fibers and autonomic fibers. The autonomic nerves consist of two primary components: sympathetic nerves (originating from the spinal nerves between T1 and L2) and parasympathetic nerves (originating from the spinal nerves between S2 and S5). The pudendal nerve is the main nerve of the

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perineum, providing sensory innervation to the external genital organs, anus, and perineal region, as well as motor innervation to the pelvic muscles, including the external anal and urethral sphincters. The pudendal nerve remains tightly anchored to the surrounding tissues along its course, which makes the nerve susceptible to damage due to factors such as compression, entrapment, and tension in the surrounding tissues.^[1] This can result in nerve injury caused by conditions like PFD, pelvic organ prolapse, and vaginal delivery, leading to stretching of the pudendal nerve and subsequent pain. As a result, pudendal neuralgia may develop, causing neuropathic pain. Due to the heightened sensitivity in this region, even mild touch can trigger pain, and the pain response may be exacerbated in the presence of painful stimuli. Depending on the severity of the damage to the pudendal nerve, partial or complete urinary and/or fecal incontinence, along with muscle function loss, may be observed in some cases.^[2]

When intra-abdominal pressure increases, the PFM reflexively contract upward to counterbalance this pressure increase. The active and passive support mechanisms of the pelvic floor not only maintain the positioning of pelvic organs but also play a critical role in postural control and spinal stability. Postural alignment is directly linked to the functional capacity of the PF; optimal posture supports the proper alignment and effective function of the PF, whereas poor posture may lead to insufficient contraction or overloading of the PFMs. Notably, the synchronized functioning of PFMs, abdominal muscles, and the diaphragm during breathing and core stabilization supports both postural balance and pelvic stability.^[3]

Electromyography (EMG)-based studies reveal that PFM activity is influenced by body position, indicating a significant relationship between posture and PF function. The highest PFM activity is observed in the standing position, while the lowest activity is reported in the supine position with bent knees. There is a strong synergistic relationship between the PFMs and abdominal muscles; abdominal muscle activation, particularly in standing positions, enhances PFM activity. However, when the anterior abdominal wall is relaxed, a notable reduction in PFM activity occurs. This finding underscores the critical role of proper posture and abdominal muscle tone in maintaining optimal PF tension.^[4]

The coordinated activity of PFMs with the abdominal muscles and diaphragm is essential not only for maintaining continence but also for ensuring spinal stability. The co-activation of the transversus abdominis (TrA) muscle with the diaphragm, PFMs, and other spinal stabilizer muscles

is recognized as a key factor in lumbar spine stabilization. Research has demonstrated that specific abdominal muscle movements activate the PFMs. These findings highlight the relationship between abdominal muscle activation and PFM activity while emphasizing the importance of proper posture in supporting pelvic floor functions. Ensuring optimal PFM activity, particularly in functional postures such as the standing position, is crucial for maintaining spinal stability and achieving pelvic region rehabilitation goals.^[5]

Therefore, rehabilitation programs should assess the PF not only in the context of pelvic organ function but also as an integrated system with postural control and body biomechanics. This review aims to explore the relationship between PFM functions and posture from various perspectives, compiling the existing literature on the subject. Furthermore, understanding the interactions between posture and PFMs aims to contribute to the development of new approaches for the prevention and management of pelvic floor disorders (PFDs). In this context, different therapeutic methods and approaches will be comprehensively evaluated, and clinical recommendations will be provided.

Materials and Methods

This traditional review was conducted to examine the components of the relationship between the pelvic floor and posture. In this study, the PubMed, Google Scholar, Wiley, and Springer Nature databases were searched. The analysis included randomized controlled trials and clinical studies. The inclusion criteria for the studies were based on keywords such as "pelvic floor," "relationship between pelvic floor and posture," "postural stability and instability conditions," and "studies involving postural control." A search was conducted using these keywords for randomized controlled trials and clinical studies published between 2020 and 2025. Exclusion criteria for the study involved articles unrelated to the topic, studies that did not establish a direct relationship with pelvic floor muscles, studies focusing solely on posture or spinal stability without addressing pelvic floor functions, and studies involving children. Out of 640 studies, 10 met the inclusion criteria.

Co-activation Relationship between Pelvic Floor and Abdominal Muscles

The pelvic floor muscles are one of the key components of the core structure that supports pelvic and abdominal organs and play a significant role in stabilizing body posture. While the PFMs form the lower base of the core system, the diaphragm constitutes the upper base, the abdominal muscles provide anterior support, and the

gluteal and paraspinal muscles ensure posterior stability. The harmonious interaction of these structures is critical for both functional movements and postural stability. Research has shown that abdominal muscles undergo co-contraction during PFM activation, and this synergistic relationship is directly linked to postural control. Studies conducted on healthy individuals have demonstrated that PFMs co-activate in conjunction with the activation of abdominal muscles. This synergy aids in regulating intra-abdominal pressure, thereby supporting pelvic and spinal stability.^[6]

Furthermore, studies have indicated that the PFMs cannot contract effectively without the activation of the TrA and internal oblique (IO) muscles. This finding underscores the importance of the combined action of the PF and abdominal muscles, particularly during standing, walking, and other postural activities.^[7] The TrA is located in the deepest layer of the abdominal region and is also known as the “deep abdominal muscle.” It plays a crucial role in increasing spinal stability. The timing of TrA contraction is particularly critical for maintaining postural control. The TrA muscle typically activates before the body begins to move, which refers to a “pre-emptive” contraction aimed at ensuring stability before the movement.^[8] The timing of TrA contraction improves coordination between the upper and lower parts of the body, and its activation can help prevent issues such as low back pain by reducing the stress placed on the spine.^[9]

The IO muscles, similar to the TrA, are located in the deep layers of the abdominal region and contribute to rotational movements as well as flexion and lateral flexion. The contraction of the IO muscle generally occurs in synchronization with that of the TrA. The coordination and timing of IO contraction are particularly important for dynamic postural control and supporting stability during rotational movements.^[10–12] Early activation of the TrA increases spinal stability, while the contraction of the IO particularly supports dynamic postural control and rotational movements. The correct timing and synchronized action of these two muscles have emerged as a significant rehabilitation strategy for individuals with back pain and lumbar issues.^[8,10]

The synergistic relationship between the PFMs and abdominal muscles also provides an effective mechanism for maintaining postural stability. Postural dysfunction or poor muscle coordination can adversely affect PFM functions. Therefore, in PF rehabilitation, focusing not only on muscle strength but also on postural control and the integration of abdominal muscles into rehabilitation programs may offer an effective approach for preventing and managing dysfunctions.

Pelvic Floor – Lumbopelvic Region Relationship

The pelvic floor muscles and paraspinal muscles provide support to the lumbar spine, enabling an upright posture. Both muscle groups must work in coordination to maintain stability. While PFM activation supports the pelvis in a neutral position, the paraspinal muscles contribute to balancing spinal curvatures. This interaction plays a critical role in maintaining the body's center of gravity during postural activities such as standing, sitting, or walking.^[13]

Dysfunction of the PFMs can lead to misalignment of the pelvis, resulting in increased or decreased lumbar lordosis. This condition may cause asymmetric overloading or inadequate activation of the paraspinal muscles, thereby contributing to the development of postural disorders. Conversely, weakness or asymmetry in the paraspinal muscles can negatively affect the supportive function of the PF, potentially leading to pelvic region dysfunctions.^[14]

The effects of the PFMs and paraspinal muscles on posture are also associated with pain and movement restrictions. The increased risk of lumbar pain in individuals with PFD underscores the clinical significance of the relationship between these two muscle groups. Therefore, integrating the assessment and improvement of postural control with a focus on both the PF and paraspinal muscles is a key aspect of the rehabilitation process.

The relationship between the PF and paraspinal muscles is essential not only for core stability but also for maintaining a healthy posture. In this context, holistic approaches targeting the coordination of these muscle groups can provide an effective strategy for preventing and managing postural disorders.

Urinary Incontinence

Urinary incontinence (UI), defined as the involuntary loss of urine, is a common health issue that negatively impacts individuals' quality of life, leading to social and psychological constraints. This condition is more prevalent in women and is closely associated with PFM weakness or dysfunction. Urinary incontinence is classified into three main subtypes based on its etiology. Stress urinary incontinence (SUI) is the most common type and is characterized by urine leakage during activities that increase intra-abdominal pressure, such as coughing, sneezing, or physical exertion. Urgency urinary incontinence (UUI) involves a sudden and uncontrollable need to urinate, accompanied by involuntary leakage. Mixed urinary incontinence (MUI) is a combination of both stress and urgency incontinence.^[15]

Cochrane reviews and numerous clinical studies have demonstrated the effectiveness of pelvic floor

muscle training (PFMT) in the treatment of urinary incontinence, establishing it as the “gold standard” in management. PFMT aims to enhance both muscle strength and neuromuscular control, enabling PFMs to function more powerfully and in a more coordinated manner. This coordination is particularly critical in SUI, where the timing and strength of PFM activation must counterbalance increases in intra-abdominal pressure.^[16] The PFMs play a central role in the development and management of incontinence. Anatomically, the PF surrounds and supports the urethra, bladder, vagina, and rectum. The tone and upward contraction capacity of the PFMs contribute to the closure of the urethra and other openings while lifting pelvic organs upward, counteracting the effects of gravity. During situations that increase intra-abdominal pressure, both automatic and voluntary activation of the PFMs maintain urethral closure pressure, preventing urine leakage.^[13]

Additionally, the motor control of the PF is closely linked to the coordination between abdominal muscles such as the TrA and IO. Dysfunction in the timing and coordination of these muscles can contribute to weakened bladder control. For instance, it is known that the TrA activates prior to any movement, helping to stabilize the pelvic region and support continence. In contrast, delays or the absence of proper contraction in the TrA and PFMs can impair their functions, thereby increasing the risk of urinary incontinence.^[17] Furthermore, motor control rehabilitation aimed at improving the timing and coordination of these muscles has been shown to significantly enhance continence in individuals experiencing UI.^[18]

Pelvic floor dysfunction can result from motor control issues such as PFM weakness, delayed activation, or excessive contraction. These issues can contribute to urinary incontinence. Insufficient activation of the muscles may reduce urethral closure pressure, leading to urine leakage, while the inability to adequately balance involuntary bladder contractions can exacerbate symptoms.^[19] The functional role of the PFMs extends beyond continence; they also play a significant role in overall pelvic stability. The synergistic relationship between the PFMs and abdominal muscles is essential for maintaining intra-abdominal pressure and pelvic stability. Thus, in the rehabilitation of UI, it is crucial not only to assess and train the PFMs individually but also to address their holistic interactions with abdominal muscles. Multidisciplinary strategies targeting the anatomical and functional characteristics of the PFMs can effectively control urinary incontinence symptoms and improve quality of life.

Rehabilitation Approaches

Conservative methods play a significant role in the treatment of PFD. These include a variety of current, comprehensive techniques such as PF physiotherapy, electrical stimulation, biofeedback, hypopressive exercises, and postural correction therapy. Weaknesses in PFMs caused by risk factors require an effective rehabilitation process. In this process, re-strengthening the PFMs and restoring their functional control are critical. During PF rehabilitation, a holistic approach should be adopted, ensuring that the lumbopelvic region and abdominal muscles are also addressed. Recent studies have demonstrated the impact of PFMs on postural control. This approach aims to maintain posture and optimally support the musculoskeletal system.^[20]

Biofeedback has emerged as an effective method in the treatment of urological dysfunctions. It provides patients with analytical feedback regarding the position and contractility of PFMs, offering the opportunity to monitor progress. Especially in cases of instability or enuresis, biofeedback provides functional training that helps patients learn to control their PFMs and maintain this control in daily activities. Passive stimulation during this process triggers proprioceptive sensations, offering feedback about the muscle's position, size, and strength.^[20] The contribution of biofeedback to rehabilitation is particularly significant due to its role in enhancing postural muscles, which has led to its increased use in clinical settings.

Electrical stimulation is a practical and successful method that can be applied both in outpatient settings and as part of home-based rehabilitation programs. It is an effective approach to increase neuromuscular activation of PFMs, offering both therapeutic and preventive benefits. This technique is particularly preferred for treating conditions linked to weaknesses in PFMs, abdominal muscles, and lumbopelvic region muscles. Electrical stimulation works by activating motor units through low-frequency electrical impulses, strengthening muscle fibers and enhancing their contractile power. This process supports dynamic stabilization of muscles, contributing to the balance between the PFMs and postural alignment.^[21] Research highlights that electrical stimulation improves the neuromuscular control of PFMs, thereby supporting postural stability. Moreover, integrating functional electrical stimulation into home-based programs enhances treatment adherence and strengthens postural control mechanisms in the long term.^[18] However, studies on electrical stimulation often lack standardized parameters, emphasizing the need for further comprehensive research.^[22]

Pelvic floor muscle training is widely recommended due to its capacity to improve PFM strength, endurance, and proprioceptive input. Recently, hypopressive exercises have

gained popularity for their positive effects on PFM strength, postural control, deep core muscle activation, and ventilation capacity. These exercises aim to balance thoracic, abdominal, and perineal compartments by reducing intra-abdominal pressure. Hypopressive exercises also play a key role in the reflexive activation of deep core muscles and striated muscle fibers within the PFM.^[23] Hypopressive techniques, by relaxing the diaphragm and reflexively activating the abdominal muscles, reduce intra-abdominal pressure while increasing the tone of PFMs and other postural stabilizers. During the process, coordinated activation is achieved among deep stabilizers such as the diaphragm, TrA, and multifidus, alongside the PFM.^[24] The implementation of hypopressive exercises consists of three main stages: slow diaphragmatic inspiration, complete expiration, and diaphragmatic aspiration. During diaphragmatic aspiration, the abdominal wall retracts toward the lumbar spine, and the respiratory diaphragm moves upward, reducing intra-abdominal pressure. This reflexively activates both the PFM and abdominal muscles, enhancing their endurance over time.^[25] Hypopressive exercises, as an adjunct to traditional methods, provide a holistic approach to supporting postural control and improving PFM function.

Pelvic floor muscles are not only responsible for continence and supporting pelvic organs but also play a critical role in maintaining postural stability.^[26] In the synergistic activation between posture and PFMs, postural imbalances can negatively affect PFM functions, while PFM weakness may contribute to postural disorders.^[27] Good postural alignment requires coordinated activity between PFMs and core muscles. The synergistic relationship between PFMs and deep stabilizers such as the TrA, multifidus, and the diaphragm supports both mechanical stability and pressure management.^[28]

Postural correction therapy is a holistic approach targeting the functional integration of PFMs and core muscles to strengthen this relationship. This therapy contributes to the improvement of both functional and structural problems by maximizing PFM activation and ensuring postural alignment. Postural correction therapy has proven effective in managing conditions such as pelvic organ prolapse, urinary incontinence, and chronic low back pain.^[29] Literature indicates that posture-focused interventions combined with PFMT improve muscle activation and enhance quality of life.^[30]

Discussion

The PF is a complex system composed of muscles, ligaments, and fascia structures that play a critical role in maintaining the body's posture. While it ensures biomechanical balance

between the spine, pelvis, and lower extremities, it also contributes to essential functions such as continence, organ support, and mobility. Posture is directly related to mechanical integrity, and proper posture significantly influences the effective functioning of PFMs. Postural dysfunctions can lead to unnecessary strain on the PFMs, causing either insufficient or excessive muscle activity. Therefore, the relationship between PFMs and posture is of paramount importance for both biomechanical and clinical alignment. Postural adjustments can support optimal PF functioning, which can, in turn, significantly contribute to quality of life.

Two studies by Bayramoğlu Demirdöğen et al.^[31] (2024) and Fuentes-Aparicio et al.^[32] (2022) investigate the relationship between postural or stability interventions and PFM function in women. Bayramoğlu Demirdöğen et al. reported that PFMT and spinal stabilization exercises (SSE) effectively improved PFM strength and quality of life. They found that SSE had superior effects on body stability, balance, and spinal posture, which suggests broader applicability for patients with additional postural or stability issues. They advocate for the inclusion of SSE as part of a comprehensive rehabilitation approach addressing both incontinence and associated postural dysfunctions. Fuentes-Aparicio et al. compared the effects of an abdominal-pelvic exercise program with a modified version containing postural instructions (AEPPI). Their EMG data showed superior improvement in PFM strength in the AEPPI group, highlighting the importance of postural commands in rehabilitation. Although UI symptoms improved in both groups, no significant differences were found at the three-month assessment, suggesting that AEPPI primarily enhances muscle strength efficiency. In summary, both studies underscore the critical interaction between PF function and posture. We believe that a multidisciplinary evaluation approach would further support the relationship between PF and posture in women with stress urinary incontinence (SUI).

The studies by Denizoglu Kulli and Gurses^[33] (2022) and Qu et al.^[34] (2021) explore the relationship between PFMs and posture in terms of childbirth history, respiratory muscle strength, and balance. Kulli and Gurses assessed postural control and PF function in women with diastasis recti abdominis (DRA) through balance tests, abdominal endurance, and respiratory muscle strength measurements. They found that an increased inter-recti distance (IRD) was associated with poorer postural control. However, no direct relationship was found between PF function and respiratory muscle strength. The study highlighted the potential impact of DRA on postural control and argued that postural evaluation should be integrated into physical therapy

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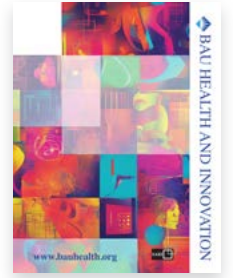
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Case Report

Transcutaneous Auricular Vagus Nerve Stimulation in Trigeminal Neuralgia: A Case Report

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Abstract

Trigeminal neuralgia is a chronic pain syndrome characterized by sharp and sudden pain on one side of the face, which negatively affects patients' quality of life. Painkillers and surgical procedures such as nerve blockage are preferred in the treatment, but it requires the application of neuromodulation methods due to its side effects and controversial efficacy. In this current report, we describe a 55-year-old female patient who has been experiencing pain due to trigeminal neuralgia for about 20 years. This case highlights the effectiveness of transcutaneous auricular vagus nerve stimulation (taVNS), one of the neuromodulation methods, on pain. It is emphasized that taVNS is an effective neuromodulation method for the suppression of pain symptoms and an important modality for improving the quality of life of patients.

Keywords: Chronic pain, trigeminal neuralgia, vagus nerve stimulation.

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Trigeminal neuralgia is a recurrent neuropathic pain disorder characterized by sudden and severe attacks of pain on one side of the face related to involvement of the trigeminal nerve.^[1] Pain, which can occur when chewing or speaking, has a significant impact on patients' quality of life. Current treatment options for patients with trigeminal neuralgia include pharmacological treatments, surgery, and nerve blocks. However, each of these methods has different side effects and limitations.^[2]

In recent years, neuromodulation techniques such as vagus nerve stimulation (VNS) have shown promising results in the treatment of chronic pain disorders.^[3] The vagus nerve plays a central role in pain regulation by modulating brainstem and limbic circuits. Transcutaneous auricular VNS (taVNS), a non-invasive method, targets the auricular

branch of the vagus nerve via electrodes placed on the ear, particularly on the tragus and concha.^[4]

Anatomical studies have demonstrated that the auricle is innervated not only by the vagus nerve but also by branches of the trigeminal nerve. This overlapping innervation creates a neuroanatomical basis for possible interactions between vagus and trigeminal inputs within the brainstem nuclei, including the spinal trigeminal nucleus and the nucleus tractus solitarius.^[5] This convergence suggests that VNS may indirectly influence trigeminal nociceptive processing, which could be relevant for conditions such as trigeminal neuralgia.^[6]

The present case report aimed to evaluate the clinical effects of taVNS in a patient diagnosed with trigeminal neuralgia who was resistant to conventional treatment

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approaches. By illustrating the clinical outcomes of this non-invasive neuromodulation technique, we aim to contribute to the growing body of literature supporting taVNS as a potential adjunct therapy in the management of neuropathic facial pain.

Case Report

This case report included a 55-year-old female with a diagnosis of trigeminal neuralgia and facial pain symptoms for about 20 years. The physical characteristics of this patient were height 150 cm, weight 46 kg, and body mass index 20.4 kg/m². This patient described her pain attacks as 3–5 days a week, lasting 1–2 min. The patient described the location of the pain in the left side of the throat and ear, and complained of pain that woke her up from sleep. No etiological cause of trigeminal neuralgia was found in previous examinations. The patient had previously undergone surgery for the left trigeminal nerve block. After the surgery, her pain partially decreased, but her complaints persisted. Oxcarbazepine 600 mg/day and pregabalin 300 mg/day were reported as the medications used. The patient had no other chronic disease other than trigeminal neuralgia. Physical examination revealed tenderness on palpation in the masseter and temporalis muscles and cervical paravertebral muscles on the left side. In addition, no other pathological findings were found. Initially, the patient's pulse rate was 70/min, systolic blood pressure was 110 mmHg, and diastolic blood pressure was 75 mmHg.

When the patient was invited to the physical therapy clinic for pain relief, the physiatrist planned a total of three sessions of taVNS with one session/week. taVNS intervention was performed with the Vagustim (Copyright Vagustim, 2023, Vagustim Health Technologies, San Francisco, CA) device. The current parameters were such as: frequency-10 Hertz and pulse width-300 μ s, intervention time: first session 20 min, second session 30 min, and third session 45 min. Stimulation was delivered via the tragus and concha using bilateral superficial electrodes in the ear. As these areas are very close to the trigeminal nerve, the first three sessions were performed once a week, and the application time was gradually increased. The procedure to be applied to the patient was explained, and an informed consent form was obtained. At the end of the third session, the patient's discomfort decreased, no side effects were observed, and it was recommended to continue the treatment at home for 20 min a day.

Visual Analog Scale (VAS), short form 36 (SF-36), and neuropathic pain impact on quality of life questionnaire (NePIQoL) were administered to assess treatment efficacy and pain intensity at baseline and after treatment. The

change in pain experienced by the patient was observed using a scale of 0–10 on the VAS. Zero indicates no pain, whereas a score of 10 indicates the worst possible pain. The SF-36 measures general health and quality of life. This form assesses eight different health domains, such as physical functioning, social functioning, emotional state, and general health perceptions. It is widely used in clinical research and health services to monitor patients' responses to treatment and changes in their health status. NePIQoL is used to measure the impact of neuropathic pain on quality of life. This scale has 42 items. Rather than giving a single total score, the scale gives a total score for each subscale separately. The subscales assess health on a scale of 0–100, where 0 indicates poor health and 100 indicates good health.^[7–9]

The changes in the patient's VAS, SF36, and NePIQoL scales at baseline and after taVNS are shown in Table 1.

There were improvements in each parameter that had a positive impact on the patient's life compared to baseline.

Discussion

The current case report demonstrated significant improvements in pain perception, facial muscle tenderness, and quality of life following a structured 3-week taVNS protocol. These outcomes were supported by improvements in VAS, SF-36, and NePIQoL domains.

taVNS contributed to a marked reduction in pain symptoms associated with trigeminal neuralgia. Administered once weekly over a 3-week period, the intervention resulted in measurable improvements in pain intensity and disability. Notably, the therapeutic gains were sustained over a 10-day follow-up period with continued home-based stimulation, indicating a potential for prolonged efficacy.

The existing literature supports the efficacy of taVNS in chronic pain conditions. Several studies have highlighted its ability to modulate central pain processing and enhance parasympathetic activity.^[3,10–12] These effects are mediated through the nucleus tractus solitarius and associated brainstem circuits, which play critical roles in pain regulation.^[13] The findings in our case are consistent with such mechanisms, as the patient exhibited clinically significant improvements in both pain perception and functional capacity.

Oshinsky et al.^[12] investigated the role of VNS in managing trigeminal allodynia and reported significant reductions in periorbital sensitivity following a brief stimulation period in animal models. Importantly, they also demonstrated a decrease in glutamate concentrations within the trigeminal nucleus caudalis.^[11] Among the proposed mechanisms underlying taVNS, glutamate modulation has received consistent empirical support. Early morphological studies

Table 1. Percentage changes in VAS, SF36, and NePIQoL scale scores after taVNS

	Baseline (%)	After taVNS (%)	10 days after the end of treatment (%)
VAS	100	30	40
NePIQoL			
Pain and other symptoms	42	44	71
Relationships	45	55	75
Daily activities	19	35	35
How pain makes you feel	40	62	55
Personal/self-care	42	62	45
SF36			
Physical functioning	30	85	45
Role limitations due to physical health	0	75	25
Role limitations due to emotional problems	0	66	66
Energy/fatigue	5	55	55
Emotional well-being:	36	48	60
Social functioning	0	87	87
Pain	10	80	57
General health	25	35	40
Health change	50	100	100

VAS: Visual analog scale, SF36: Short form 36, NePIQoL: Neuropathic pain impact on quality-of-life questionnaire, taVNS: Transcutaneous auricular vagus nerve stimulation.

have shown that a large proportion of trigeminal ganglion neurons are glutamatergic, and that glutamate injection into the masseter muscle can evoke pain and allodynia.^[14,15]

In our case, the patient exhibited pronounced reductions in masticatory muscle tenderness and unilateral facial pain following taVNS. VAS scores declined from 100% to 30% post-treatment and stabilized at 40% after 10 days. NePIQoL scores, particularly in the “Pain and Other Symptoms” domain, improved from 42 to 71, representing a 69% relative enhancement. Improvements were also observed in SF-36 parameters such as physical functioning, pain, and emotional well-being.

Anatomical studies have shown that the auricle is innervated by both the auricular branch of the vagus nerve and branches of the trigeminal nerve.^[16] This overlapping innervation provides a plausible basis for indirect stimulation of trigeminal pathways during taVNS. Functional neuroimaging data further support this interaction: Badran et al.^[13,17] demonstrated via concurrent taVNS and functional magnetic resonance imaging that stimulation of the tragus activates not only vagal-related nuclei but also broader somatosensory and limbic regions associated with pain processing.

In addition, a recent study by Hatik et al.^[18] demonstrated the functional impact of taVNS during physical exertion, further

supporting its potential in modulating neurophysiological responses. Furthermore, a comprehensive review by Yuan and Silberstein emphasized the growing evidence base for taVNS as a non-invasive treatment for headache disorders, suggesting translational value for conditions such as trigeminal neuralgia.^[19]

Although this is a single case report, the observed improvements and literature support underline the potential of taVNS as an adjunct modality in the management of refractory trigeminal neuralgia. However, randomized controlled trials with larger sample sizes are needed to determine optimal stimulation parameters, treatment duration, and the specific contribution of trigeminal–vagal convergence to clinical outcomes.

Conclusion

In conclusion, taVNS should be regarded as a promising non-invasive neuromodulation technique for the management of pain in patients with trigeminal neuralgia. This case report demonstrated the clinical utility of taVNS in reducing pain and disability. The findings contribute to the growing body of evidence supporting taVNS and underscore the need for larger-scale, randomized studies to further elucidate its therapeutic mechanisms and optimize clinical protocols.

Disclosures

Ethics Committee Approval: This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

Informed Consent: Informed consent was obtained from the patient for the publication of the case report and the accompanying images.

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