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THE EFFECT OF DIFFICULTIES EXPERIENCED BY INDIVIDUALS WITH DIABETES ON THEIR PERCEPTION OF VULNERABILITY TO DISEASES

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ABSTRACT

This study aimed to explore the impact of psychosocial and personal challenges experienced by Type 2 diabetes patients on their perceived vulnerability to illness. It focused on understanding how difficulties in diabetes management influence this perception. The study included 156 Type 2 diabetic patients treated in a university hospital in eastern Türkiye. Data were collected using the Participant Introduction Form, Strengths and Difficulties in Diabetes Scale, and Perception of Vulnerability to Diseases Scale. Statistical analyses included independent t-tests, ANOVA, and structural equation modeling. Participants had an average age of 56.00 ± 14.68 years, with a mean HbA1C level of 10.75 ± 2.10 . 69% did not exercise regularly, and 74.2% did not fully adhere to their diets. A positive correlation was found between high HbA1C levels and psychosocial and individual difficulties. Individual challenges positively affected vulnerability perception, while psychosocial challenges showed a negative relationship. Diabetes management requires not only medical treatment but also education, psychosocial support, and individualized care. These holistic approaches can reduce vulnerability perceptions and enhance health outcomes, highlighting the need for education and psychosocial support programs.

INTRODUCTION

Diabetes is one of the most common chronic diseases in the world and has a significant impact on patients' quality of life. The treatment of diabetes is a complex process that involves not only physical health but also psychological and social aspects. These challenging processes that patients experience can increase their anxiety about their health, and this perception can affect their ability to manage diabetes (Martinez et al., 2016).

Patients with diabetes face situations requiring constant self-care, such as controlling blood glucose levels, taking medication regularly, regulating eating habits, and increasing physical activity (American Diabetes Association [ADA], 2022). The difficulties experienced in this process make it difficult for patients to adapt to the disease and may negatively affect their treatment adherence. Among these difficulties, emotional problems such as depression, anxiety, and anger are common. These conditions can negatively affect patients' self-care skills and glycemic control (Kalra, Jena & Yeravdekar, 2018; McCoy & Theeke, 2019). In addition

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to psychosocial factors, it is frequently emphasized in the literature that patients with diabetes have difficulty in disease management and treatment compliance due to a lack of information (Kalra et al., 2018). In addition, family support significantly impacts patients' success in disease management. Lack of family support may cause patients to feel isolated and lonely, which may weaken their coping strategies (Fisher, Hessler, Polonsky & Mullan, 2012). Therefore, not only medical treatment but also psychosocial support and continuous education are important in the management of diabetes (Berry, Lockhart, Davies, Lindsay & Dempster, 2015).

The perceived vulnerability of individuals with diabetes to the disease is another important factor to be considered. It is a major concern for individuals living with diabetes, as it can profoundly affect their mental health, stress levels, self-management behaviors, and overall quality of life. This perception is often shaped by a variety of psychological and social factors, including the chronic nature of diabetes, its associated complications, and the individual's coping mechanisms (Fisher, Polonsky, Asuni, Jolly & Hessler, 2020; García-Lara et al., 2022). Chronic stress associated with diabetes management has also been shown to lead to increased psychological distress and affect both mental and physical health outcomes, especially during challenging times such as the COVID-19 pandemic (Al-Rahimi, Nass, Hassoubah, Wazqar & Alamoudi, 2021). Supporting individuals with chronic diseases not only physically but also psychologically during such periods is of great importance to alleviate the feeling of vulnerability to infectious diseases (Fos, Honore' & Kellum, 2022). The fear of contracting the disease has also been an important factor leading to the disruption of diabetes management processes. Individuals hesitate to apply to health services due to the fear of exposure to infectious diseases, which leads to serious disruptions in diabetes management and more frequent complications (Abdou, Hassan, Hassanein, Elsebaie & Shamma, 2022).

Individuals with diabetes have difficulty controlling their disease and creating a healthy lifestyle. Undoubtedly, these individuals need holistic approaches incorporating behavioral immune systems, in other words, perceptions of vulnerability and psychological coping mechanisms. In this regard, nurses and other health professionals need to work in team cooperation in order for patients to overcome these challenges. This study aims to examine the effect of the difficulties experienced by individuals with diabetes on the perception of vulnerability to diseases.

MATERIAL AND METHOD

Research Design and Population

This study was planned with a descriptive and correlational design and was conducted in the endocrine clinic of a university hospital in eastern Türkiye. The study population covered patients diagnosed with Type 2 diabetes mellitus who were followed up in the endocrine clinic. The sample size was determined according to the power analysis as 153 patients based on a 95% confidence interval, 0.95 effect size, and 5% bias level, with a 95% population representation. Using random sampling, 156 patients were reached during the data collection process.

Data Collection Tools

Data were collected through face-to-face interviews at the convenience of the patients. Each interview lasted approximately 15-20 minutes.

Participant Introduction Form:

This form was developed by the researchers to determine the sociodemographic characteristics of the patients (age, education, employment, economic status, etc.) and their diabetes-related characteristics (disease duration, treatment type, exercise, etc.). It consists of 21 questions (Fisher, Glasgow & Strycker, 2010; Powers et al. ..., 2017)

Strengths and Difficulties in Diabetes Scale (SDDS)

It was developed by Bilgehan and Inkaya in 2023. The 30-item scale includes 3 subscales: "Psychosocial difficulties" (13 items: 1-13), "Individual difficulties" (9 items: 14-22) and "Lack of knowledge" (8 items: 23-30). The scale items are scored on a 5-point Likert scale from 5 = I always have difficulties to 1 = I never have difficulties. A minimum of 30 and a maximum of 150 points can be obtained, with higher scores indicating higher difficulty levels. In the original form of the scale, Cronbach's alpha value was calculated as 0.852 (Bilgehan & İnkaya, 2023). In our study, the Cronbach alpha value of the scale was 0.896.

Perception of Vulnerability to Diseases Scale (PDSI-S)

The scale was developed by Duncan et al. in 2009 (Duncan, Schaller & Park, 2009). Its validity and reliability in Turkish was established by Ünal et al. in 2023 (Ünal, Özlem & Gökler, 2023). HKSA-S includes 15 items in 2 subscales: Sensitivity to Infectious Diseases (2,5,6,8,10,12,14) and Avoidance of Microorganisms (1,3,4,7,9,11,13,15). Items 3,5,11,12,13,14 are reverse-scored. Scores between 7-105 can be obtained from the scale.

Scoring is done on a 7-point Likert scale with 1=strongly disagree-7=strongly agree, with higher scores indicating a higher perception of vulnerability. In the reliability analysis of the Turkish version of the scale, the internal consistency Cronbach's alpha coefficient was found to be 0.712. In our study, the Cronbach alpha value of the scale was 0.774.

Inclusion Criteria

- Being 18 years of age or older,
- To have been diagnosed with Type 2 DM for at least 1 year,
- Being on oral antidiabetic and/or insulin therapy,
- Being conscious.

Exclusion Criteria

- Having a disability in understanding and communicating in Turkish,
- Having a hearing loss,
- Receiving diet-only and/or exercise-only treatment,
- Being diagnosed with a psychiatric disorder.

Data Analysis

R Studio software was used for descriptive data (frequency, mean, standard deviation, median, minimum, and maximum values), reliability analysis, and multicollinearity analysis. In the second stage, a path analysis was conducted with the observed variables using Structural Equation Modeling (SEM) to determine whether there was an effect between the FGDS subscales, the HKSA-I, and participants' glycemic control (HbA1C). The statistical significance level was set at $p < 0.05$.

Ethical Approval

Necessary permissions were obtained from the relevant institution and ethics committee for the study. The purpose of the study was explained to the participants, and their written informed consent was obtained. Ethical approval (2024/5549) was obtained from İnönü University Health Sciences Non-Interventional Clinical Research Ethics Committee, and the necessary permissions (dated 27/11/2023-376886) were obtained from the university hospital of the university where the study was conducted. The questionnaire, which was filled out by face-to-face interview, included information about the purpose and content of the study. The subjects were told that participation was voluntary. The participants' consent was obtained. The identity information of the participants was not recorded in the questionnaire. This study was conducted in accordance with the Declaration of Helsinki Principles.

RESULTS

The patients' mean age was 56.00 ± 14.68 years, mean BMI was 29.17 ± 6.42 , 56.1% were male, 87.1% were married, 18.1% were illiterate, 42.6% had primary education, 25.2% had high school education, and 14.2% had undergraduate or higher education. The income of 85.2% of the patients was equal to or less than their expenses. The mean duration of diabetes was 12.04 ± 7.77 years, and the mean HbA1C level was 10.75 ± 2.10 . 74.2% of the patients had a family history of diabetes, 96.1% were receiving diabetes treatment, and 85.2% were taking their treatment regularly. 69% did not exercise regularly. 74.2% partially or never followed their diet, 50.3% measured their blood glucose 1-2 times a week, and 62.6% attended regular check-ups. 88.4% of the patients received education about diabetes, and 62.6% had comorbid chronic diseases.

Table 1. Participants' Sociodemographic and Clinical Characteristics

Sociodemographic Characteristics	$\bar{X} \pm SD$	
Age	56.00 ± 14.68	
BMI	29.17 ± 6.42	
Duration of diabetes	12.04 ± 7.77	
HbA1C	10.75 ± 2.10	
	n	%
Gender		
Female	68	43.9%
Male	87	56.1%
Marital Status		
Married	135	87.1%
Single	20	12.9%
Education		
Illiterate	28	18.1%
Primary education	66	42.6%
High School	39	25.2%
Undergraduate and higher	22	14.2%
Income Level		
Income less than expenditure	40	25.8%
Income equal to expenditure	92	59.4%
Income more than expenditure	23	14.8%
Is There Another Diabetes Patient in the Family?		
Yes	115	74.2%
No.	40	25.8%
Treatment received for diabetes		
Oral antidiabetics	63	40.6%
Insulin	35	22.6%
Oral antidiabetics+insulin	51	32.9%
Not receiving treatment	6	3.9%
Do you take the medications regularly?		
Yes	132	85.2%
No.	8	5.2%
Only when needed	15	9.7%
Do you exercise regularly?		
Yes	48	31%
No.	107	69%

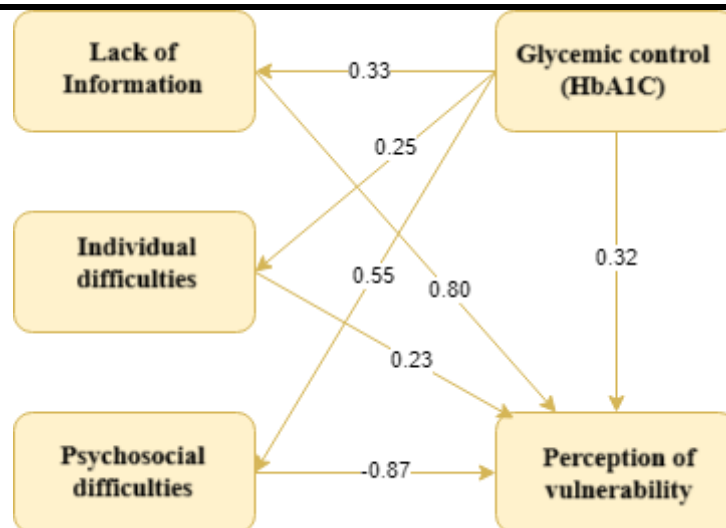
Do you follow the diet?		
Yes	40	25.8%
No.	30	19.4%
Partially	85	54.8%
Frequency of measuring blood glucose		
1 time a day	38	24.5%
2 times a day	39	25.2%
1-2 times a week	78	50.3%
Do you go for regular check-ups?		
Yes	58	37.4%
No.	97	62.6%
Have you received education on diabetes?		
Yes	137	88.4%
No.	18	11.6%
Any comorbidities?		
Yes	97	62.6%
No.	58	37.4%

The participants' mean scores were 52.63 ± 9.68 for Psychosocial Difficulties, 26.83 ± 8 for Individual Difficulties, and 34.69 ± 4.39 for Lack of Knowledge. Their mean Sensitivity to Infectious Diseases score was 27.20 ± 8.80 , and their mean Avoidance of Microorganisms score was 34.87 ± 12.77 . The mean total score of the Strengths and Difficulties in Diabetes scale was 114.16 ± 16.20 , and the mean total score of the Perception of Vulnerability to Diseases scale was 62.07 ± 20.33 .

Table 2. Means scores from the Scales and Subscales

	Min.	Max.	Mean \pm SD
Psychosocial Challenges	22	65	52.63 ± 9.68
Individual Challenges	9	45	26.83 ± 8
Lack of Information	22	40	34.69 ± 4.39
Vulnerability to Infectious Diseases	10	44	27.20 ± 8.80
Avoiding Microorganisms	9	56	34.87 ± 12.77
Strengths and Challenges in Diabetes	53	150	114.16 ± 16.20
Perception of Vulnerability to Diseases	19	100	62.07 ± 20.33

The fit values were $CMIN = 3.619$, $DF = 3$, $CMIN/DF = 1.206$, $RMSEA = 0.025$, $CFI = 0.908$, and $GFI = 0.912$, indicating that the model shows a good fit with the data. In particular, the $CMIN/DF$ value below 3, the $RMSEA$ value below 0.05, and the CFI and GFI values above 0.90 indicate that the model has an acceptable fit. The HbA1C variable had significant and positive effects on individual difficulties ($\beta = 1.249$, $p < .001$), psychosocial difficulties ($\beta = 1.556$, $p < .001$), lack of knowledge ($\beta = 0.331$, $p = .018$) and perception of vulnerability ($\beta = 1.320$, $p = .015$). These findings suggest that with the deterioration of metabolic control, individuals experience more difficulties in various areas and feel more vulnerable.

**Figure1** . Non-Standardized Path Coefficients

Lack of knowledge has a positive and significant effect on the perception of vulnerability ($\beta = 0.804$, $p = .003$). This result indicates that individuals feel more vulnerable as their knowledge level decreases. A negative and significant relationship was found between psychosocial difficulties and perception of vulnerability ($\beta = -0.871$, $p < .001$). This unexpected finding indicates that the perception of vulnerability decreases as psychosocial difficulties increase. This suggests that individuals may have developed psychological resilience in the face of psychosocial challenges. A strong, positive, and significant relationship exists between personal difficulties and perception of vulnerability ($\beta = 1.228$, $p < .001$). This result reveals that individuals feel more vulnerable as the difficulties they experience on a personal level increase (Figure 1, Table 3).

Table 3. Structural Equation Model with Path Analysis

	$\beta 0$	$\beta 1$	SH	Test	p
Individual Difficulties <--- DD	0.386	0.249	0.241	2.189	***
Psychosocial Difficulties <--- DD	0.399	0.556	0.088	5.392	***
Lack of Knowledge <--- GK	0.188	0.331	0.139	3.373	.018
Perception of Vulnerability <--- DD	0.169	0.320	0.044	3.027	.015
Perception of Vulnerability <--- Lack of Knowledge	0.181	0.804	0.266	6.122	.003
Perception of Vulnerability <--- Psychosocial Difficulties	-0.436	-0.871	0.128	-7.588	***
Perception of Vulnerability <--- Individual Difficulties	0.410	0.228	0.154	1.884	***

$\beta 0$: standardized coefficient; $\beta 1$: non-standardized coefficient; GC: Glycemic Control

DISCUSSION

The findings of this study, which aimed to examine the important associations between metabolic control, psychosocial difficulties, knowledge levels, and perceptions of vulnerability

among individuals with diabetes, are discussed in the light of the literature. In particular, higher HbA1c levels, indicative of poorer glycemic control, are significantly associated with increased individual difficulties, psychosocial difficulties, lack of knowledge, and increased perceptions of vulnerability. These results underscore the complex interplay between physiological health and psychosocial factors in diabetes management.

The mean psychosocial difficulty scores of participants with diabetes point to the significant challenges faced by this population. The mean score of 52.63 ± 9.68 reported for psychosocial difficulties is consistent with findings highlighting the prevalence of emotional and behavioral problems among children and adolescents with diabetes, particularly those with type 1 diabetes (Bernstein, Stockwell, Gallagher, Rosenthal & Soren, 2013; S Ahmed, M. M. Monazea, E Abdel- El Naser & A M Kotb, 2016). Individual challenges, with an average score of 26.83 ± 8 , reflect the unique struggles faced by these individuals and are supported by studies highlighting mental health issues such as anxiety and depression that are common in young people with diabetes (Bernstein et al, 2013; Hilliard et al., 2017). Furthermore, the mean score of 34.69 ± 4.39 for lack of knowledge indicates a knowledge gap that may exacerbate psychosocial challenges, as poor understanding of diabetes management has been linked to poorer health outcomes (Schwartz, Cline, Axelrad & Anderson, 2011; Zenlea et al., 2014). Sensitivity to infectious diseases and avoidance of microorganisms scores also underscore the health concerns prevalent in this population (S Ahmed et al, ., 2014). Overall, total scores from the Strengths and Challenges in Diabetes scale and the Perception of Vulnerability to Illness scale highlight multifaceted psychosocial burdens that require targeted interventions to improve the quality of life of these individuals (Schwartz et al., 2011; Westrupp, Northam, Lee, Scratch & Cameron, 2015).

The relationship between worsening metabolic control and individuals' perception of vulnerability is well documented in the literature. As metabolic control worsens, individuals often report increased feelings of vulnerability and psychological distress, as evidenced by elevated HbA1c levels. Research shows that poor glycemic control is associated with increased psychological burden, including anxiety and depression, which may exacerbate perceptions of vulnerability (Hirai et al., 2021; Muszalik, Stępień, Puto, Cybulski & Kurpas, 2022).

The positive correlation between high HbA1c and increased individual and psychosocial difficulties is consistent with the existing literature. Poor glycemic control has been associated with high psychological distress, poor quality of life, and increased burden of diabetes management (Delamater et al., 2001; Fisher et al., 2012). High blood glucose levels can lead

to physical symptoms that disrupt daily activities and contribute to emotional tension, thus exacerbating individual difficulties and psychosocial stressors.

The association between lack of knowledge and increased perception of vulnerability highlights the critical role of patient education in diabetes care. Individuals with limited knowledge about their condition may feel insecure and anxious about managing their health, leading to a greater sense of vulnerability. The finding that lack of knowledge significantly influenced the perception of vulnerability ($\beta = 0.804$, $p = .003$) suggests that individuals with low health literacy may be more exposed to risks associated with their illness. This is consistent with research showing that inadequate knowledge about health conditions can lead to increased feelings of vulnerability and anxiety (Endres et al., 2021; Rizeq et al., 2023; Stock, Zucchelli, Hudson, Kiff & Hammond, 2020). Indeed, effective diabetes self-management education has been shown to improve knowledge, empower patients, and increase self-efficacy, which can alleviate feelings of vulnerability and improve health outcomes (Chrvala, Sherr & Lipman, 2016; Powers et al., 2015).

Of particular interest is the negative and significant ($\beta = -0.871$, $p < .001$) relationship between psychosocial challenges and perceptions of vulnerability. This suggests that as individuals face more psychosocial adversity, they may develop a type of resilience that mitigates their perceptions of vulnerability. Resilience enables individuals to adapt positively in the face of adversity, potentially reducing their perceived vulnerability despite ongoing challenges (Survonen, Suhonen & Joronen, 2024; Windle, 2011). This phenomenon has been shown in several studies that individuals faced with chronic stressors exhibit adaptive coping mechanisms that can change their perceptions of risk and vulnerability (Almuqrin et al., 2023; Ghanem, Evangeli-Dawson & Georgiades, 2023; Shrira, Palgi, Ben-Ezra & Shmotkin, 2011). Resilience may manifest in the form of effective coping strategies, use of social support, or reassessment of stressors and may mitigate the impact of psychosocial challenges on perceptions of vulnerability.

The strong positive association between personal challenges and perceptions of vulnerability ($\beta = 1.228$, $p < .001$) reinforces the idea that personal struggles directly influence how vulnerable individuals feel. As individuals face more individual challenges, such as managing symptoms, adhering to treatment regimens, or coping with lifestyle changes, they may become more susceptible to negative outcomes. This is in line with the biopsychosocial model, which suggests that personal, social, and biological factors interact to shape an individual's health outcomes and psychological state (Almuqrin et al., 2023; Rizeq et al., 2023; Russell & Russell, 2019). This finding highlights the importance of addressing personal

challenges through individualized care plans, psychosocial support, and interventions that enhance coping skills (Herzer & Hood, 2010).

These results illuminate the complex links between metabolic control and psychosocial factors in diabetes management. Interventions aimed at improving glycemic control, increasing patient knowledge through education, promoting resilience, and addressing personal challenges are vital. Such comprehensive approaches can alleviate feelings of vulnerability, reduce psychosocial and individual challenges, and ultimately improve health outcomes for individuals with diabetes.

Limitations of the Study

The most important limitation of this study is that it was conducted with patients hospitalized in the endocrine service of a university hospital in the Eastern Anatolia Region of Türkiye. Therefore, it should not be generalized to all diabetes patients. Further research should be conducted on nurses in other hospitals, such as private endocrine services.

CONCLUSION

This study underlines the important relationship between metabolic control and psychosocial factors in diabetes management. Higher HbA1c levels, indicative of poorer glycemic control, are positively associated with increased individual and psychosocial challenges as well as a higher sense of vulnerability. Effective patient education by nurses can help reduce these vulnerabilities by increasing knowledge and self-efficacy. Furthermore, increasing resilience through nursing interventions may contribute to individuals better coping with ongoing psychosocial challenges. Therefore, comprehensive diabetes care should integrate nursing-based strategies and approaches to improve glycemic control, provide educational support, and address personal and psychosocial needs. This will contribute to the field of Internal Medicine Nursing to better understand the psychosocial needs of patients with diabetes and to tailor nursing interventions accordingly. In particular, developing and implementing structured nursing education programs is recommended to reduce individuals' feelings of vulnerability. In addition, offering training that strengthens nurses' psychosocial assessment skills and encouraging individualized care approaches may improve both patient outcomes and the effectiveness of nursing services.

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THE EFFECT OF THE PSYCHIATRIC AND MENTAL HEALTH NURSING COURSE ON MENTAL HEALTH LITERACY IN NURSING STUDENTS: A QUASI- EXPERIMENTAL STUDY

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ABSTRACT

In the literature, it is suggested that curriculum programs should be updated, sufficient content should be added to the psychiatric and mental health nursing course, and training programs should be organized to improve students' mental health literacy. This study aimed to determine the effect of the psychiatric and mental health nursing course on mental health literacy among nursing students. This study was conducted as a quasi-experimental study with 69 nursing students. The mean age of the students was 21.97 ± 1.14 and 79.7% were female. It was found that the posttest mean scores of the mental health literacy scale and its sub-scales were significantly higher than the pretest mean scores. It is recommended to add sufficient content to the psychiatric and mental health nursing course and support it with clinical practice. In places where there are no units on mental health for the implementation of the course, consultation-liaison psychiatric nursing practice enables students to put the information they receive in the course into practice and increases the mental health literacy level.

INTRODUCTION

Health literacy has become an important priority to people to manage their health, access the health system, and for health systems to improve human health in the 21st century (Sørensen et al., 2012; Sørensen, 2019). Mental health literacy (MHL) is one of the most important components of health literacy, which is defined as the ability to access, understand, and use information to improve and maintain health (Bjørnsen, Eilertsen, Ringdal, Espnes & Moksnes, 2017; Jorm et al., 1997; Jorm, 2019). The concept of MHL was introduced by Jorm et al. in 1997 and defined as "knowledge and beliefs that help recognize, manage or prevent mental disorders" (Jorm et al., 1997; Jorm, 2015).

Mental illnesses are increasing worldwide. According to the World Health Organization (WHO, 2022), approximately 970 million people globally live with a mental illness. The fact that mental illnesses are so common means that many people around us may face mental illness. MHL level plays an important role in the recognition, management, and prevention of mental illnesses. The students of nursing, who will carry out the profession of nursing in many areas

that concern society, should have a high level of MHL to be beneficial to society. Therefore, nursing students should be ready to accurately determine the needs of patients in line with the knowledge they have acquired in undergraduate education, communicate basic health knowledge, and help patients use the health system to best meet their requirements (Saito & Creedy, 2021). In the studies conducted, it was determined that the mental health literacy of the students was not at an adequate level, and even they had a low level of mental health literacy in terms of beliefs about mental illnesses (Al-Yateem, Rossiter, Robb & Slewa-Younan, 2018; Göktaş et al., 2024; Özer & Altun, 2024). In studies conducted on the subject, it is recommended that the nursing education process should be comprehensive and supported by clinical and field practices (McCan, Lu & Berryman, 2009; Özer & Altun, 2024). Nurses with a high level of mental health literacy through such an education can play important roles in providing quality patient care in the clinical environment as well as improving the mental health of the society (Al-Yateem et al., 2018; Özer & Altun, 2024). Therefore, it is important to determine how the education offered to nursing students, each of whom are future nurses, affects mental health literacy.

Nursing students need to be literate about mental health when they complete their education (McCan, Lu & Berryman, 2009). Therefore, it is stated that MHL is an important issue that should be handled in the bachelor's nursing curriculum (Saito & Creedy, 2021). In the literature, it is recommended to update curricula, organize training programs, and develop programs such as simulation to improve students' MHL levels and awareness (Murphy, Klug & Kasimatis, 2023; Öztaş, Ünal, Ölçer, Çal & Öge, 2023; Saito & Creedy, 2021; Turgut, Eryalçın & Kutlu, 2023). In the institution where this study was conducted, the psychiatric and mental health (PMH) nursing course is included in undergraduate nursing education. This course is the most important course in which nursing students gain comprehensive information about mental health and mental illnesses during their undergraduate education. This course, in which many topics related to mental illnesses are discussed, can provide students with important awareness about mental illnesses. Therefore, it is necessary to investigate the impact of the PMH nursing course on nursing students' MHL. Investigating the level of MHL of nursing students is important to better understand whether students are ready to care for patients suffering from mental disorders after completing their education (Liu, Li & Peng, 2018).

MATERIAL AND METHOD

Study Design and Aim

The study was conducted as a quasi-experimental study in a one-group pretest and posttest design. This design is used when only one group is available for the study. Data are collected before and after an experimental intervention on a group (Sullivan-Bolyai & Bova, 2018). Accordingly, the aim of this study is to determine the effect of the PMH nursing course on the MHL level of nursing students.

Hypothesis

H₁: The PMH nursing course has an effect on improving the MHL level of nursing students.

H₀: The PMH nursing course has no effect on improving the MHL level of nursing students.

Place and Time of the Study

This study was conducted during the fall semester of the 2022-2023 academic year in the Nursing Department of the Faculty of Health Sciences at a university.

Population and Sample

The study population was fourth-year nursing students enrolled in the PMH nursing course in the fall semester of the 2022-2023 academic year. All students (75) who had to take the course compulsorily were informed about the research and their written and verbal consents were obtained. All students taking the course were informed that a study would be conducted as part of the course and that their participation in the study was voluntary. Although students' participation in the course was compulsory, they were not obliged to fill in the data collection forms of the study conducted within the scope of the course. The sample of this study consisted of 69 nursing students who participated in the research. The mean age of the students participating in the study was 21.97 ± 1.14 and 79.7% were female. Sixty students participated in both pre and posttest measurements, three students participated only in the pretest measurement, and six students participated only in the posttest measurement. The fact that 6 of the students did not participate in the pretest and three students did not participate in the posttest shows that students' participation in the study was not compulsory. Since all students had to take the course, no control group was selected and randomization was not performed.

Inclusion criteria: To be a fourth-year nursing student, enrolling in the PMH nursing course, agreeing to participate the study

Exclusion Criteria: Absenteeism**Data Collection Instruments**

The Personal Information Form: The form consists of four questions to determine the students' age, gender, and the presence of mental illness in themselves or their relatives.

The MHL Scale: The original version of the MHL scale used to identify the MHL level consists of 26 items. The MHL scale developed by Jung, von Sternberg & Davis (2016) has three sub-scales: knowledge oriented, beliefs oriented, and resource oriented. The validity and reliability study of the MHL scale was conducted by Göktaş, Işıklı, Önsüz, Yenilmez & Metintaş (2019). With the validity and reliability study, the scale was reduced to 22 items. There are 10 items in the knowledge oriented MHL sub-scale, eight items in the beliefs oriented MHL sub-scale, and four items in the resource oriented MHL sub-scale. The score from the scale varies between 0-22 for the whole scale, and it is accepted that as the score increases in the whole scale and each sub-scale, the MHL level increases. The 18 items in the first two sub-scales of the scale are in six points Likert type and the responses are "strongly agree, agree, neutral, disagree, strongly disagree, I don't know". The responses to the four items in the resource oriented MHL sub-scale are "yes" and "no". When "strongly agree", "agree" and "yes" answers are given to the items, they are evaluated as "1 points" and the other responses are evaluated as "0 points". The items of the beliefs-oriented MHL sub-scale of the scale [11-18] are reverse-scored. Cronbach's alpha coefficient of the scale is 0.71.

The study variables

Independent variable: The PMH nursing course

Dependent variables: The MHL scale and sub-scales mean scores

Data Collection

75 students enrolled in the PMH nursing course. Four students who never attended the course did not participate in the study. Two students failed the course and were excluded from the study because their absences in both the theoretical course and hospital practice during the semester exceeded the legal absenteeism period. The data of the study were obtained from 69 nursing students who attended the study. In the first week of the fall semester, the pretest data of the study were taken from the students by applying the Personal Information Form and the MHL scale. The PMH nursing course was conducted as five hours of theoretical and 8 hours of Consultation-Liaison Psychiatric (CLP) nursing practice per week for 14 weeks. In the last

week of the semester, the MHL scale was applied to the students and the posttest data of the study were collected.

Intervention

The PMH nursing course is offered as a compulsory course in the fall semester for fourth-year nursing students. All students in the fourth year of nursing enroll in this course. The theoretical subjects of the course are taught five hours a week for 14 weeks ($14 \times 5 = 70$ hours) during the semester. Students also practice the course in the hospital for eight hours a week ($14 \times 8 = 112$ hours). Since there are no psychiatric hospitals or psychiatry-related units in the province where the students are located, the course was carried out in other clinics in general hospitals in the form of CLP nursing practice. Educational methods such as lectures, presentations, case examples, clinical practice, short videos, movie screenings, homework, and documentaries were used to conduct the course. The 14-week theoretical and practical content of the PMH nursing course is shown in Table 1 (Boyd, 2018; Gürhan, 2016; Townsend & Morgan, 2018; Videbeck, 2020).

Table 1. The Content of the PMH Nursing Course During the Semester

Week	Topics (5 hours)	Practice (8 hours)
1.	Introduction to the PMH nursing Standards of practice for the PMH nursing	Preparations for Practice Case presentation
2.	The history of psychiatry and psychiatric nursing Watching a documentary about psychiatry (Evgin, 2007) Watching a documentary about psychiatric nursing (Gül & Evecen, 2021)	Preparations for CLP nursing practice
3.	History taking and mental status examination Watching short videos about mental status examination Genogram and ecomap Case presentation about genogram and ecomap Homework about genogram and ecomap	CLP nursing practice
4.	Therapeutic relationship and communication Therapeutic and nontherapeutic communication techniques	CLP nursing practice
5.	Therapeutic milieu Seclusion, physical, mechanical, and chemical restraints	CLP nursing practice
6.	Psychiatric observation, interviewing, and recording Watching a video: Interviewing a patient with suicidal thoughts Watching a video and recording an observation	CLP nursing practice
7.	Anxiety disorders, obsessive-compulsive disorder, and nursing process Defense mechanisms Case presentation	CLP nursing practice
8.	Mood disorders and the nursing process Case presentation	CLP nursing practice
9.	Schizophrenia and other psychotic disorders and the nursing process Case presentation Watching a documentary about schizophrenia (Eren & Kaya, 2008)	CLP nursing practice
10.	Psychiatric emergencies and psychiatric nursing, legal issues	CLP nursing practice
11.	Traumatic life events and psychiatric nursing	CLP nursing practice
12.	CLP nursing	CLP nursing practice
13.	Substance use disorders and psychiatric nursing	CLP nursing practice
14.	Personality disorders, eating disorders	CLP nursing practice

Analyzing data

Descriptive statistics and normality test were used in the SPSS 26.0 package program. Since the data did not show normal distribution ($p < 0.05$) as a result of the normality test, Wilcoxon and Mann-Whitney U tests were used in the analysis. To include the data of the students who attended only in the pretest or only in the posttest measurement in the analysis and to prevent data loss, a missing data analysis was performed in SPSS. Statistical significance value was accepted as $p = 0.05$ in the analyses.

Limitations

This study was conducted in a single group pretest and posttest quasi-experimental design. The most important limitation of this study is the lack of randomization and control group. Another limitation is the lack of psychiatry units in the province where the study was conducted. The study results are limited to the research group.

Ethical Considerations

Ethics committee approval (E-84771431-050.03-53970) was received from the Ethical Principles and Ethics Committee of a university. Institutional permission (22/07-1-E.2273) was obtained from the faculty where the study was conducted and permission to use the scale was obtained from the authors who conducted the adaptation study. The participating students gave informed consent for the study.

RESULTS

A total of 69 students participated in the study, with 60 students completing both the pretest and posttest measurements, three students participating only in the pretest, and six students participating only in the posttest. The students' mean age was 21.97 ± 1.14 and 79.7% were female. 1.4% of the students stated that they had a mental illness and 24.6% stated that they had a mental illness in their relatives (Table 2).

Table 2. Participants' Characteristics

Characteristics	n	%
Age (Mean \pm SD = 21.97 \pm 1.14)		
20-22	48	69.6
23-26	21	30.4
Gender		
Female	55	79.7
Male	14	20.3
Having a mental illness		

Yes	1	1.4
No	68	98.6
Having a mental illness in relatives		
Yes	17	24.6
No	52	75.4

The pretest and posttest measurements according to the students' characteristics are shown in Table 3. According to the table, no statistical significant difference was found between the pretest mean scores and the students' age, gender, mental illness status in themselves, and mental illness status in their relatives ($p>0.05$). Likewise, there was no statistical difference between the posttest mean scores and age, gender, mental illness status, and mental illness status in relatives of the students ($p>0.05$).

Table 3. Pretest and Posttest Measurements According to Students' Characteristics

Characteristics	Scale and Subscales	Pretest
Age	Overall MHL	p: 0.171, Z: -1.370
	Knowledge oriented MHL	p: 0.056, Z: -1.912
	Beliefs oriented MHL	p: 0.842, Z: -0.199
	Resource oriented MHL	p: 0.170, Z: -1.372
Gender	Overall MHL	p: 0.490, Z: -0.690
	Knowledge oriented MHL	p: 0.171, Z: -1.369
	Beliefs oriented MHL	p: 0.206, Z: -1.266
	Resource oriented MHL	p: 0.309, Z: -1.017
Having a mental illness	Overall MHL	p: 0.165, Z: -1.388
	Knowledge oriented MHL	p: 0.122, Z: -1.545
	Beliefs oriented MHL	p: 0.683, Z: -0.408
	Resource oriented MHL	p: 0.444, Z: -0.766
Having a mental illness in relatives	Overall MHL	p: 0.389, Z: -0.861
	Knowledge oriented MHL	p: 0.324, Z: -0.985
	Beliefs oriented MHL	p: 0.322, Z: -0.990
	Resource oriented MHL	p: 0.718, Z: -0.631
Characteristics	Scale and Subscales	Posttest
Age	Overall MHL	p: 0.639, Z: -0.469
	Knowledge oriented MHL	p: 0.723, Z: -0.354
	Beliefs oriented MHL	p: 0.505, Z: -0.666
	Resource oriented MHL	p: 0.356, Z: -0.922
Gender	Overall MHL	p: 0.137, Z: -1.488
	Knowledge oriented MHL	p: 0.338, Z: -0.959
	Beliefs oriented MHL	p: 0.093, Z: -1.679
	Resource oriented MHL	p: 0.519, Z: -0.644
Having a mental illness	Overall MHL	p: 0.286, Z: -1.067
	Knowledge oriented MHL	p: 0.388, Z: -0.862
	Beliefs oriented MHL	p: 0.569, Z: -0.570
	Resource oriented MHL	p: 0.530, Z: -0.628
Having a mental illness in relatives	Overall MHL	p: 0.174, Z: -1.361
	Knowledge oriented MHL	p: 0.174, Z: -1.358
	Beliefs oriented MHL	p: 0.527, Z: -0.633
	Resource oriented MHL	p: 0.595, Z: -0.532

The students' mean scores from the MHL scale and its subscales are shown in Table 4. The students' mean MHL scores were 14.80 ± 2.50 in the pretest, and 19.18 ± 2.07 in the posttest. It was found that the posttest mean scores from the MHL scale and its sub-scales were

statistically higher than the pretest mean scores. The differences between pretest and posttest MHL mean scores were statistically significant ($p=0.000$).

Table 4. Comparison of the Students' Pretest and Posttest Mean Scores

Scale and Subscales	Pretest X \pm SS	Posttest X \pm SS	Z	p
Overall MHL	14.80 \pm 2.50	19.18 \pm 2.07	Z: -6.895	p: 0.000
Knowledge-oriented MHL	8.15 \pm 1.33	9.36 \pm 0.87	Z: -5.078	p: 0.000
Beliefs-oriented MHL	4.55 \pm 1.45	6.21 \pm 1.55	Z: -6.497	p: 0.000
Resource-oriented MHL	2.10 \pm 1.33	3.61 \pm 0.76	Z: -5.935	p: 0.000

DISCUSSION

The study was conducted to examine the effect of the PMH nursing course on nursing students' MHL level. The hypothesis "the PMH nursing course has an effect on improving the mental health literacy level of nursing students" was confirmed for the study. The fact that there was no difference between the pretest mean scores and the students' age, gender, mental illness status in themselves, and mental illness status in their relatives showed that the students had similar MHL levels before the PMH nursing course. According to the posttest measurements, the effect of the course on MHL did not change according to the students' age, gender, and the presence of mental illness in themselves or their relatives (Table 3). This means that the PMH nursing course improved the MHL level of all students with different characteristics. Improved MHL is important for early intervention in mental problems, promoting improved mental health, and supporting the community mentally (Al-Yateem et al., 2018). Previous studies conducted in different groups in the literature have also revealed that training programs improve the level of MHL (Morgado et al., 2021; Perry et al., 2014; Skre et al., 2013). These studies support the results of this study.

The knowledge-oriented MHL subscale of the scale aims to assess students' knowledge level about mental illnesses. Lack of knowledge on mental health is the most crucial determinant of negative attitudes and stigmatization towards mental illnesses (Ross & Goldner, 2009). According to the pretest results of this study, we can say that the knowledge-oriented MHL level of nursing students is positive. The results of the study conducted by Saito & Creedy (2021) support this finding. According to the posttest results of this study, students' knowledge-oriented MHL level increased significantly. This shows that the PMH nursing course was effective in increasing students' knowledge about mental illnesses. Improved knowledge about mental illnesses can be very useful both for students and for the patients and relatives they will care for while practicing their profession.

The beliefs-oriented MHL sub-scale of the scale aims to identify attitudes and beliefs toward mental illnesses. According to the pretest of the study, it is difficult to say that the students' level of beliefs-oriented MHL is positive. In the study of Poreddi, Thimmaiah & BadaMath (2017), a significant number of the nursing students had negative attitudes towards mental illnesses, which is consistent with the pretest results of this study. Negative beliefs and attitudes about mental illnesses lead to discrimination and stigmatization of individuals having mental illness and disruption of the therapeutic relationship between nurse-patient (Poreddi et al., 2017). The significant difference between the posttest and pretest mean scores of the study shows that the students had positive attitudes at the end of the semester. Tambag's (2018) study also revealed that the PMH nursing course positively affected students' attitudes towards mental illness.

The resource-oriented MHL sub-scale is related to the knowledge of the institutions, organizations, people, or individuals to whom those receiving education on mental health can inform and refer patients in case of mental illness. This study findings show that the PMH nursing course significantly increased the resource-oriented MHL level of nursing students. This result is crucial in terms of guiding the students who will carry out the nursing profession after graduation in directing individuals with mental problems to the relevant institutions and organizations both in society and in the institutions where they work. Because nurses are the healthcare professionals who have the most contact with patients and families (Özer & Altun, 2022). Nurses have a great role in informing society, developing MHL, and creating a healthy community environment (Tay, Tay & Klainin-Yobas, 2018). This study results show that students are ready to guide the individuals they care for in their professional lives.

The overall MHL level is revealed by the scores from the three subscales of the scale. MHL level is a very important factor in recognizing mental problems and seeking help for these problems (Kim, Yu & Kim, 2020). It is stated that sufficient content regarding mental health should be integrated into the undergraduate nursing curriculum and students should reinforce their knowledge with sufficient clinical experience (Saito & Creedy, 2021). In the study, nursing students were provided with information about mental health within the scope of the PMH nursing course for one semester. The implementation of this course should be carried out in units related to psychiatry or outside psychiatric units as CLP nursing practice. However, since there were no units related to psychiatry in the province where the study was conducted, the students only practiced the course as CLP nursing practice outside the psychiatric units. The increase in the MHL level of the students demonstrates that the PMH nursing course and the CLP nursing practice carried out within the scope of the course are effective in improving MHL.

In a study conducted by McCann et al., (2009), it was found that the MHL level of nursing students increased significantly in the third year. It was stated that this situation emerged due to the effect of the theoretical and clinical education received by the students within the scope of the PMH nursing course in the fourth and fifth semesters. These results support this study's findings. Liu et al. (2018) stated that the MHL level of nursing students is an indicator of whether students are ready to care for individuals having mental problems after graduation. The results of this study show that students are ready to prevent mental problems, intervene early, and take necessary measures. In addition, the most fundamental element of the PMH nursing is the therapeutic relationship between nurse-patient (Lessard-Deschênes & Goulet, 2022). One of the most important factors shaping this relationship is the MHL level (Wang et al., 2023). The results of this study are also important in terms of showing that students can maintain the therapeutic relationship they will develop with patients.

CONCLUSIONS

This study reveals that the PMH nursing course and the CLP nursing practice conducted within the scope of the course improved the general MHL level of nursing students. It was revealed that the students increased their level of knowledge about mental health, developed positive attitudes, and guided individuals with mental problems to the relevant institutions and organizations. This result shows that after completing their nursing education, students are ready to develop therapeutic relationships with the individuals they care for, prevent mental problems, intervene early in the event of mental problems, and take necessary measures. It is recommended to conduct randomized controlled studies on MHL of nursing students.

Implications for Practice

This study determined the effect of the PMH nursing course on the MHL level of bachelor's nursing students. According to the results of the study, the PMH nursing course in the nursing curriculum provides sufficient information that students need about mental illnesses. The CLP nursing practice carried out within the scope of the course contributes to the improvement of students' MHL. It is recommended to add sufficient content to the PMH nursing course in the nursing curriculum and support it with clinical practice. In places where there are no units on mental health for the implementation of the course, CLP nursing practice enables students to put the information they receive in the course into practice and increases the level of MHL.

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EVALUATION OF THE EFFICACY OF SYSTEMICALLY APPLIED DENOSUMAB IN THE REPAIR OF BONE DEFECTS

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ABSTRACT

This study investigated the effect of denosumab on new bone formation, both alone and in combination with different graft materials. To this end, four defects were created in the skulls of 20 New Zealand rabbits. One defect was left empty, while the other three were treated with autograft, xenograft, and calcium phosphate (BCP) grafts. The animals were divided into an experimental group (n=10), which received 10 mg/kg of denosumab subcutaneously once a month for 2 months, and a control group (n=10), which was administered the same dose of physiological saline. After 8 weeks, the animals were sacrificed, and their bone tissue samples were analyzed histomorphometrically. The percentage of bone volume (PBV) was calculated by dividing the area of mature bone tissue by the total tissue area. The PBV in empty defects treated with denosumab was significantly higher than in the control group ($p < 0.05$). Moreover, the combination of denosumab and autograft resulted in a significant increase in new bone formation (NBF) ($p < 0.05$), thus demonstrating the positive effect of denosumab on bone formation. However, further research with larger experimental groups would be needed to determine the practicality, dosage, and duration of this treatment before clinical application.

INTRODUCTION

Major goals of oral and maxillofacial surgery include restoring the anatomical form of the defects caused by various reasons in the mouth and jaw region and regaining the lost functions. Although some of these bone defects resolve through the self-repairing ability of the bone, in large bone defects, various bone graft materials are needed to support the repair of bone tissue or to ensure complete healing of the defects. The harvesting and structural properties of graft materials used for the treatment of bone defects, as well as their effectiveness in new bone formation, show remarkable variation. Among these materials, autogenous bone grafts are commonly used and are known to have osteoinductive and osteoconductive properties. However, the use of these grafts is limited by several factors such as the requirement for an additional surgery, recipient site infections, and inability to obtain sufficient amounts of graft material (Pandit et al., 2012). A viable alternative to autogenous grafts is allografts. However,

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while they proved to be superior to autogenous grafts, their use is associated with several disadvantages, including debated osteoinductive capacity, potential for immunological response in the recipient tissue, and the risk of infectious diseases (Giannoudis et al., 2005). Furthermore, xenografts are widely used in oral surgery and bovine xenografts. In particular, xenografts are frequently preferred because of their similarity to human bone structure, biocompatibility, favorable osteoconductive structure (Stavropoulos & Karring, 2010). Tricalcium phosphate (TCP) and hydroxyapatite (HA) are synthetic bone graft substitutes that do not have an osteoinductive effect and serve only as a skeleton for new bone formation in the defect area (Erbe et al., 2001).

In recent years, various drug applications have become popular in the repair of defects. Of these, a commonly used application is denosumab, which has been extensively applied in the prevention of skeletal adverse events (pain and fractures in the bone) secondary to multiple myeloma or bone metastases from solid tumors (Ahern et al., 2018). More specifically, denosumab was used in adults and skeletally mature adolescents with an unresectable tumor or in cases where surgical resection may cause serious morbidity (Jamshidi et al., 2018), in postmenopausal osteoporotic women with a high risk of bone fracture (Tsourdi et al., 2019), in glucocorticoid (GC)-induced osteoporosis (GCOP) (Iwamoto et al., 2019), and in loss of bone mineral density (BMD) caused by androgen deprivation (Briot et al., 2019). Denosumab was originally approved in 2012 by the Food and Drug Administration (FDA) for the treatment of postmenopausal osteoporotic women at a high risk of fracture and unresponsive to other treatment applications, as well as for the treatment of male patients at a high risk of fracture (Goldhahn et al., 2012; Schwarz & Ritchlin, 2007;). Previous research also demonstrated that denosumab increases BMD and reduces the risk of fractures (Bone et al., 2008; Miller et al., 2008; Lewiecki et al., 2007; Cummings et al., 2009).

Overall, to date, numerous studies have sought to improve the healing of graft materials (Özer et al., 2019, 2022). Contributing to this body of research in the present study, we aimed to investigate the effect of denosumab on bone regeneration by administering denosumab systemically using three different graft materials with osteoinductive or osteoconductive properties in the defects created in the rabbit calvaria, as well as to compare the effects of denosumab on grafts with different characteristics.

MATERIAL AND METHOD

Ethical Approval and Research Design

The study was approved by İnönü University Medical School Experimental Animals Ethics Committee (Approval No: 2013/A-52). All experiments were conducted at İnönü University Experimental Animal Production and Research Laboratory. A total of 20 male New Zealand rabbits with an average weight of 3 kg and aged on average 7 months were used in the experiment. All rabbits were kept in experimental cages in a 12/12-h light/dark cycle at an average temperature of 24 °C and were given ad libitum access to standard food and tap water. The health status of the animals was monitored by a specialist veterinarian. The animals were divided into two groups: the experimental group (n=10) and the control group (n=10). A total of four bicortical defects of 6 mm in diameter were made in the calvarium of each rabbit using a trephine bur (Hokugo et al., 2007). Then, equal volumes of autograft, xenograft, and biphasic calcium phosphate (BCP) were administered to defects, while the remaining defect was left intact. The experimental group received subcutaneous injection of 10 mg/kg Prolia (Denosumab 60 mg solution for injection in pre-filled syringe, Amgen, Turkey) once a month for 2 months, while the control group received subcutaneous injection of 10 mg/kg saline during the same period of time. All animals were sacrificed 8 weeks later with intravenous sodium pentothal (Pentotal, Abbott, USA) and bone tissue samples were sent to the Histology and Embryology Laboratory of İnönü University Faculty of Medicine for histological and histomorphometric examination. Defects in each rabbit were labeled as A, B, C and D. Defect A was left intact in each rabbit; Defect B was filled with the autogenous graft material formed as a result of grinding the bone obtained from the defect using a bone grinder; Defect C was filled with OsteoBiol®Gen-Os (OG) (TecnossDental, Turin, Italy) graft material, which is a bovine-derived xenograft. Finally, Defect D was filled with MIS®4BONE (MB) (MIS, Tel Aviv, Israel) graft material, a fully synthetic graft material made of hydroxyapatite (HA) (60%) and β -TCP (40%) (Figure 1).

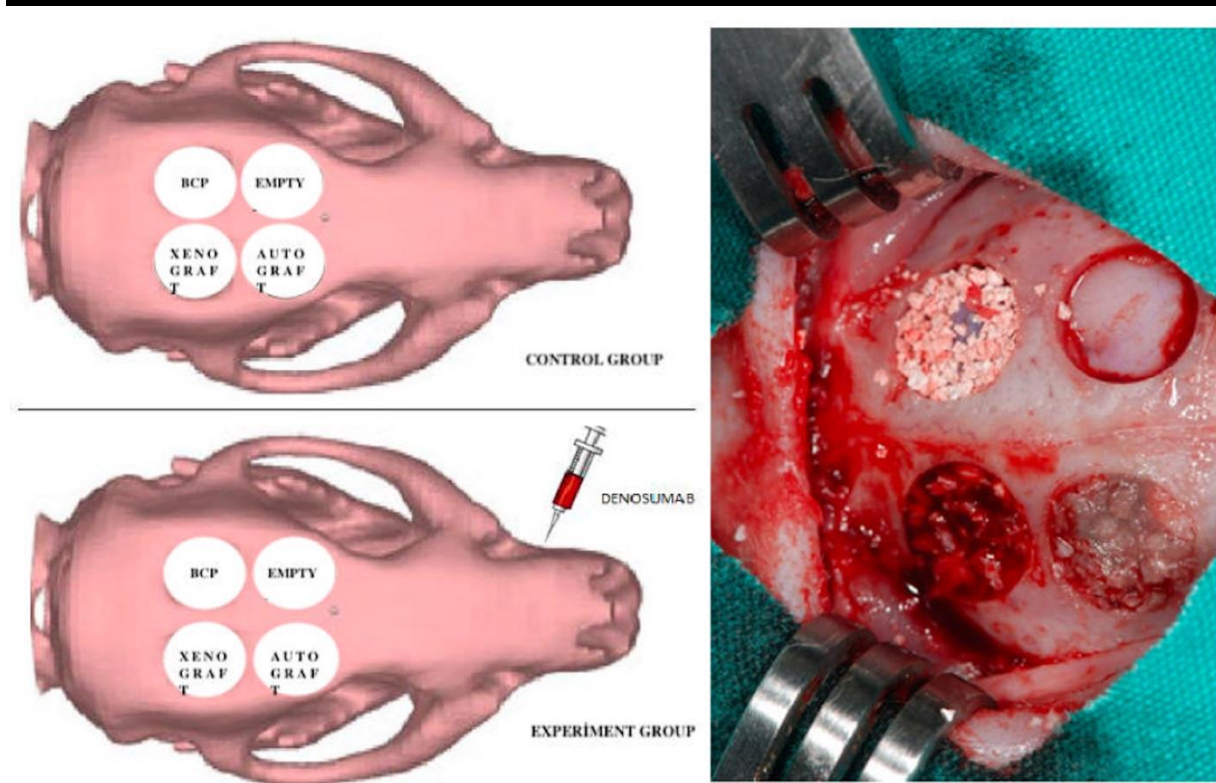


Figure 1. Denosumab-treated control and experimental groups

Histological and Histomorphometric Examination

Bone tissue samples were fixed in 10% formaldehyde for 72 h. After the fixation process, the samples were subjected to decalcification for 12 days in 10% formic acid solution, which was changed every other day. Following the decalcification process and after dehydration through increasing grades of ethanol (50%-99%) and xylene series, the samples were embedded in paraffin blocks. Subsequently, 6- μ m thick sections were obtained from the paraffin blocks using a microtome and were mounted on slides. The sections were stained with hematoxylin-eosin(H&E) and Gomori's trichrome staining and then examined under a Leica DFC280 light microscope, with photographs taken using a Leica Q Win Plus V3 image analysis system (Leica Microsystems Imaging Solutions, Cambridge, UK). The total tissue area in each section and the mature bone tissue areas within this total tissue area were measured on the photographs. The newly formed bone percentage was calculated by dividing the mature bone tissue area to the total tissue area in each section (Gül et al., 2014).

Statistical Analysis

The data were analyzed using SPSS for Windows version 22.0 (Armonk, NY: IBM Corp.). Normal distribution of the data was assessed with Shapiro Wilks test. The groups were compared using Kruskal-Wallis test, in which a *p*-value of < 0.05 was considered to be

statistically significant, followed by post-hoc Mann Whitney U test with Bonferroni correction, in which a p -value of < 0.008 was considered significant.

RESULT

Histological sections of bone tissues in the defects were examined in both experimental and control groups. The results revealed that the bone tissue showed osteoconductive activity in the site extending from the surgical margins to the defect area in all groups. In addition, fibrous connective tissue and bone tissue were observed in the defect areas in all groups (Figures 2, 3).

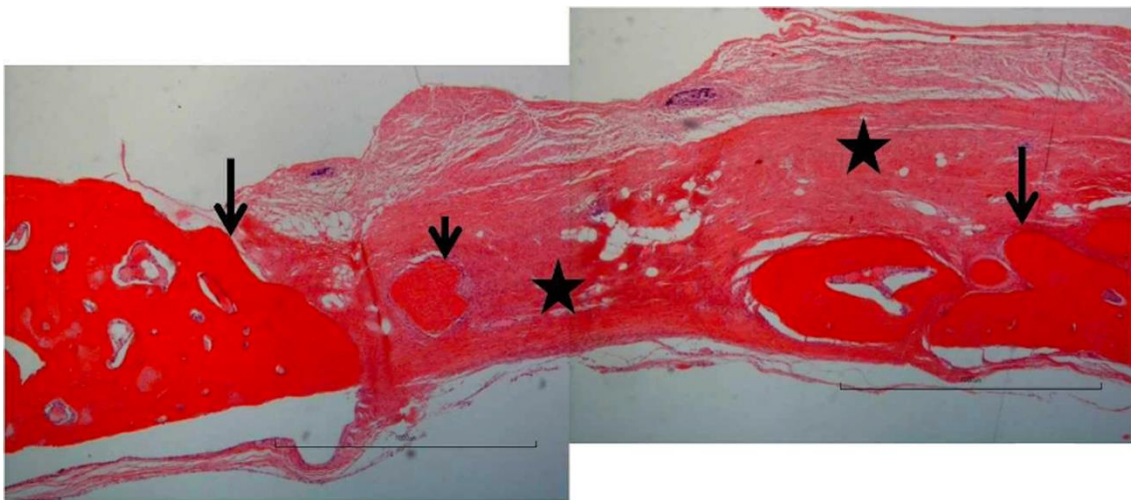


Figure 2a. General histological appearance of control group A (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments. H-E, Scale = 1000 μ m.)



Figure 2b. General histological appearance of experimental group A (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments. H-E, Scale = 1000 μ m.)

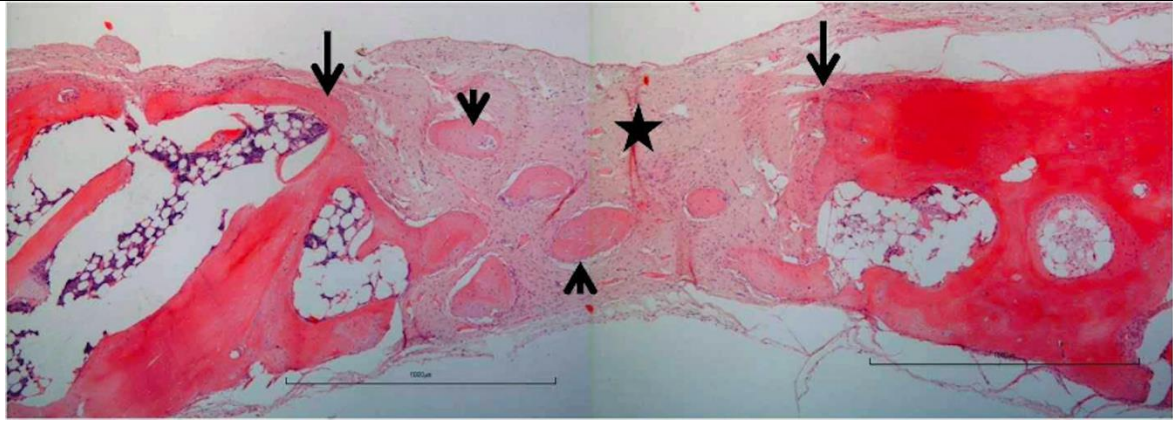


Figure 2c. General histological appearance of control group B (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments. H-E, Scale = 1000 µm.)

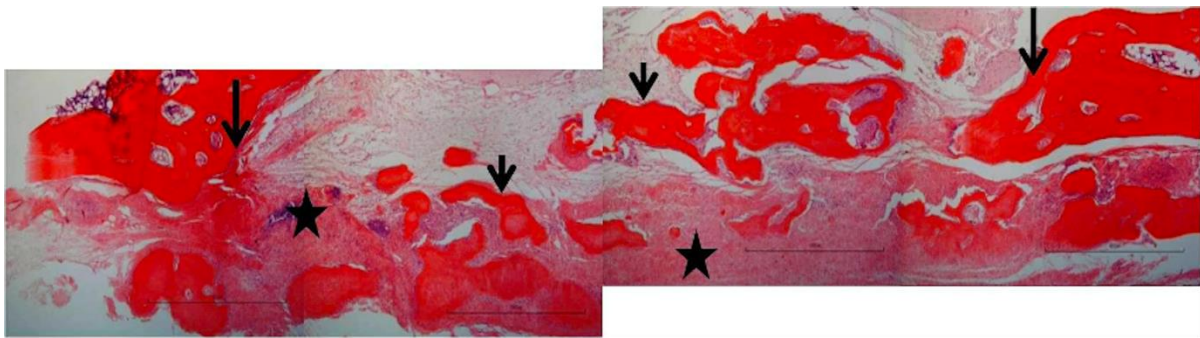


Figure 2d. General histological appearance of experimental group B (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments. H-E, Scale = 1000 µm.)

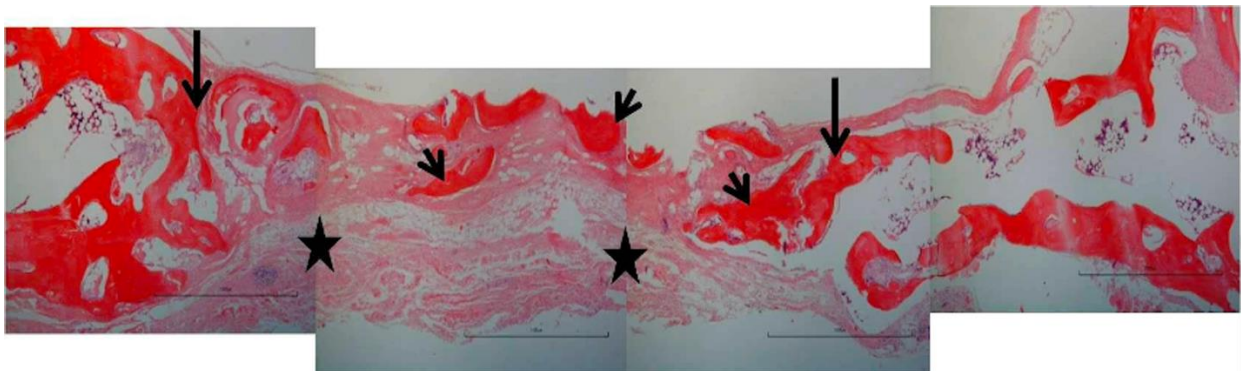


Figure 2e. General histological view of control group C (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments. H-E, Scale = 1000 µm.)

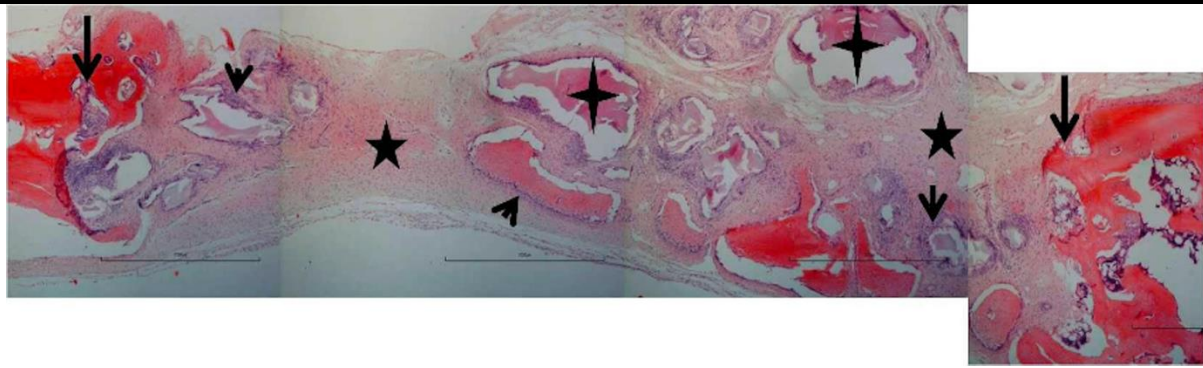


Figure 2f. General histological view of experimental group C (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, four-point star: graft areas arrowhead: osteoblastic-osteogenic activity around graft areas. H-E, Scale = 1000 µm.)

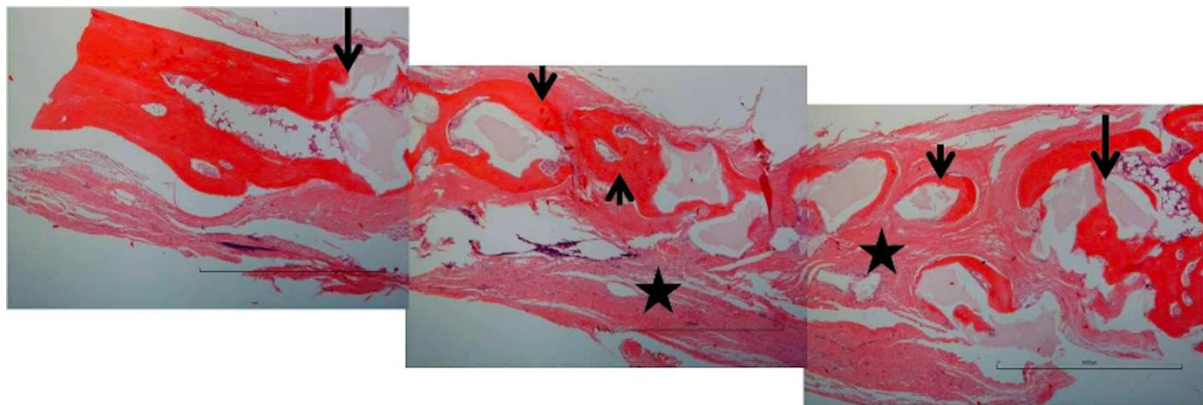


Figure 2g. General histological appearance of control group D (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments. H-E, Scale = 1000 µm.)

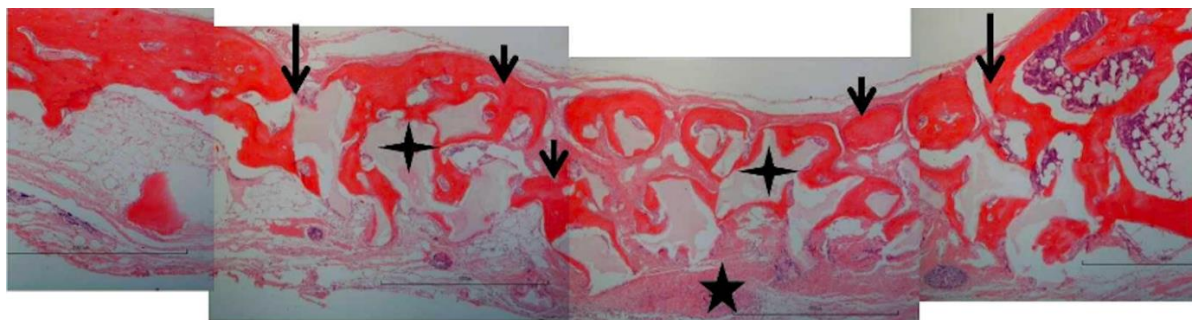


Figure 2h. General histological appearance of experimental group D (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, four-point star: graft areas arrowhead: mature bone tissue fragments in trabecular structure H-E, Scale = 1000 µm .)

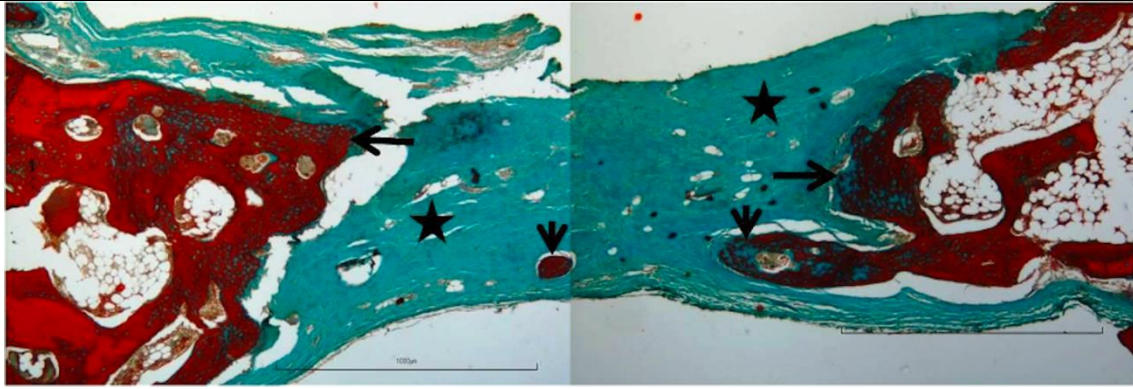


Figure 3a. Example photograph of control group A (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue pieces Trichrome, Scale = 1000 μ m.)

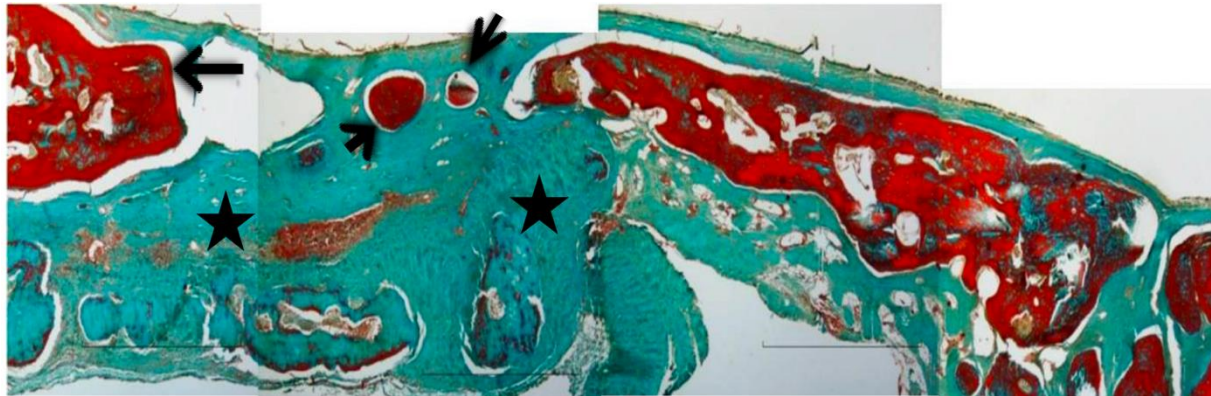


Figure 3b. Example photograph of experimental group A (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments, double-headed arrow: osteoid tissue Trichrome, Scale = 1000 μ m.)

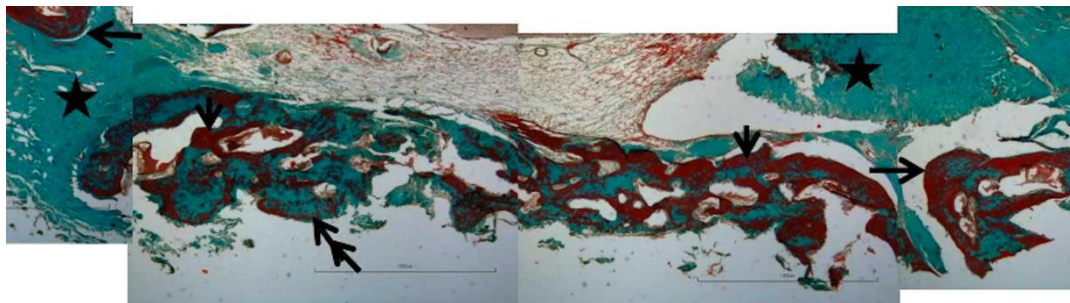


Figure 3c. Example photograph of control group B (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments, double-headed arrow: immature bone tissue trabecular Trichrome, Scale = 1000 μ m.)

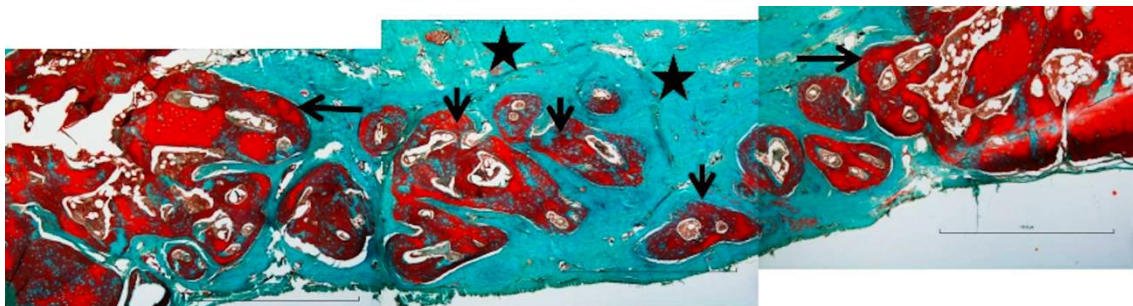


Figure 3d. Example photograph of experimental group B (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue pieces Trichrome, Scale = 1000 μ m.)

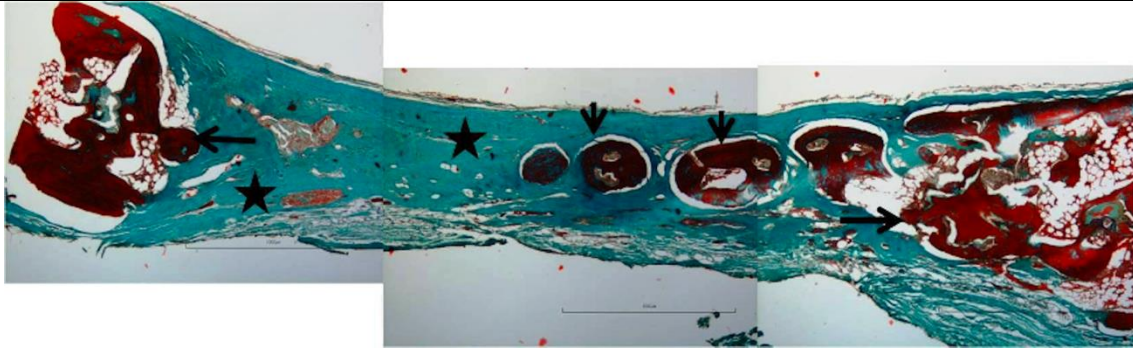


Figure 3e. Example photograph of control group C (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue pieces Trichrome, Scale = 1000 µm.)

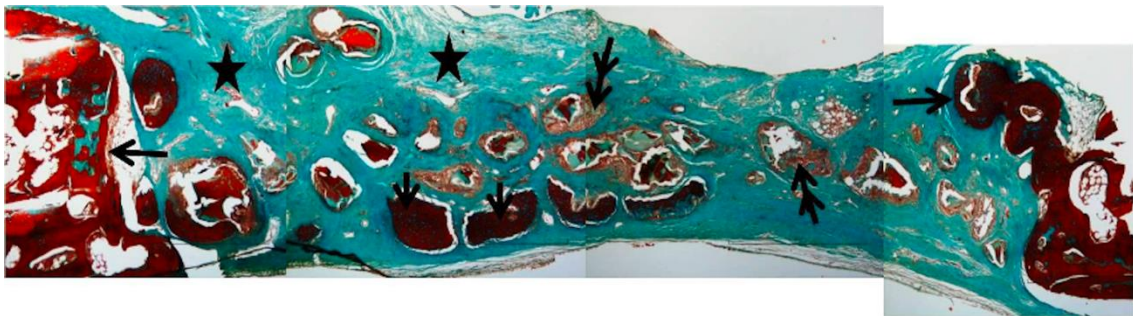


Figure 3f. Example photograph of experimental group C (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments, double-headed arrow: osteogenic activity around graft areas Trichrome, Scale = 1000 µm.)

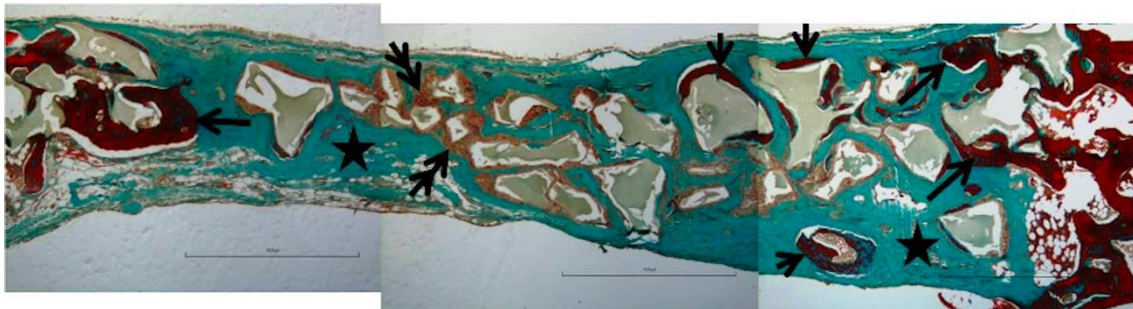


Figure 3g. Example photograph of control group D (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue fragments, double-headed arrow: osteogenic activity at the periphery of graft areas Trichrome, Scale = 1000 µm.)

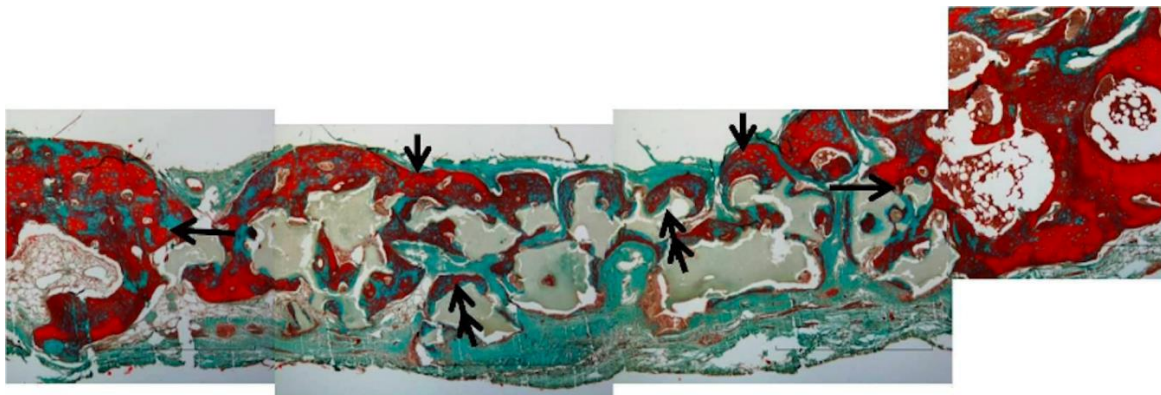


Figure 3h. Example photograph of experiment group D (arrows: bone tissue and osteoconductive bone formation at surgical tips, star: fibrous connective tissue, arrowhead: mature bone tissue pieces, double-headed arrow: immature bone tissue pieces around graft areas Trichrome, Scale = 1000 µm.)

The results of histomorphometric analysis of bone defects did not reveal a statistically significant difference between the averages of new bone formation obtained in the defects in the control group ($p = 0.068$) (Table 1). However, we found a statistically significant difference between the averages of new bone area (NBF) in the defects in the experimental group ($p = 0.015$). The averages of new bone area (NBF) obtained in Experimental groups C and D, as well as in Control group B, were significantly lower than in Experimental group B ($p = 0.08$, $p = 0.007$, $p = 0.032$, respectively). The mean new bone area obtained in Experimental group A was significantly higher than in Control group A ($p = 0.021$), while Experimental group B was significantly higher than Control group B ($p = 0.032$) (Table 1). Finally, the percentage of new bone formation (PBV) values obtained by proportioning the newly formed bone to the total tissue area were statistically significantly higher in Experimental group A than in Control group A ($p = 0.037$) (Table 2).

Table 1. New bone formation (μm^2)

	Control (Mean \pm SD)	Experimental (Mean \pm SD)	¹ <i>p</i>
Group A	308794.43 \pm 534242.25	862607.75 \pm 528867.54 ^a	0.021*
Group B	629952 \pm 441453.39 ^b	1280422 \pm 472561.26 ^c	0.032*
Group C	1004034.8 \pm 554413.45	518225.88 \pm 461998.31 ^b	0.107
Group D	642232.57 \pm 380579.12	432666.14 \pm 504658.1 ^b	0.225
² <i>p</i>	0.068	0.015*	

¹Mann-Whitney U test²Kruskal-Wallis Test* $p < 0.05$ ^a: Significantly higher than in Control group A ^b: Significantly lower than in Experimental group B^c: Significantly higher than in Control group B.

SD: Standard deviation

Table 2. Percent bone volume

	Control (Mean \pm SD)	Experimental (Mean \pm SD)	¹ <i>p</i>
Group A	15 \pm 17	33 \pm 15 ^a	0.037*
Group B	27 \pm 13	38 \pm 2	0.199
Group C	36 \pm 2	19 \pm 18	0.187
Group D	24 \pm 12	14 \pm 14	0.180
² <i>p</i>	0.173	0.060	

¹Mann-Whitney U test²Kruskal-Wallis Test* $p < 0.05$ ^a: Significantly higher than in Control group A

SD: Standard deviation

DISCUSSION

Over time, bones can lose density or undergo various injuries. Therefore, reconstruction of bone defects has been extensively studied both in orthopedics and maxillofacial surgery

research (Becker et al., 1994; Raghoobar et al., 2001; Von Arx & Buser, 2006) were graft materials were widely used in the treatment of bone defects. Graft types commonly used in maxillofacial surgery include autografts, xenografts, allografts, and synthetic grafts, which have differing properties and may have at least one or more of the features such as osteogenesis, osteoconduction, and osteoinduction (Kahnberg, 2008). Autografts, which are the first choice in the repair of bone defects, are the golden standard for bone transplantation, mainly because this graft type contains osteogenic cells and does not cause immunological reaction (Banwart et al., 1995; Younger & Chapman, 1989). In the present study, we assumed that systemically applied denosumab would lead to faster ossification by inducing osteoblastic activity in autogenous, xenogenous, and allogeneic graft applied defects. The results revealed that denosumab increased ossification.

Von Arx and Buser (2006) obtained autogenous bone grafts from the symphysis or ramus region to achieve horizontal ridge augmentation in 42 patients and suggested that intraoral autogenous graft application can be successfully used to achieve ridge augmentation. In another relevant study, Raghoobar et al. (2001) performed maxillary sinus augmentation by using autogenous bone grafts obtained from the iliac bone, symphysis region, and maxillary tuber in 99 patients. The authors reported that the use of autogenous bone graft in maxillary sinus augmentation can provide favorable and reliable long-term outcomes (Raghoobar et al., 2001). Furthermore, Becker et al. (1994) compared autogenous bone grafts with demineralized freeze-dried bone allografts (DFDBAs) and concluded that, although new bone formation was observed after 3 months in the areas where autogenous grafts were inserted, new bone formation was not observed in six out of seven areas where DFDBAs were inserted. The authors also noted that DFDBA could disrupt bone healing (Becker et al., 1994). In the present study, we induced a bone defect by placing an autograft in the defect area after grinding the harvested autogenous bone in a bone grinder. We also found that the mean rate of bone healing was significantly higher in the experimental group than in the control group.

Despite all these positive features, autogenous bone graft materials have several limitations, such as insufficient amount of graft material, requirement of a second surgical site, and prolonged postoperative recovery (David et al., 1990). Because of these disadvantages, allografts, xenografts, and alloplastic materials have become prominent alternatives to autogenous grafts in regenerative treatment of bone defects. The primary aim in using these materials is to facilitate bone regeneration and to use the material that is most similar to bone tissue (Kent et al., 1987). Fresh and freeze-dried allografts are highly antigenic, while freeze-dried and demineralized allografts are minimally antigenic or non-antigenic (Friedlaender et

al., 1976). Xenografts are widely used in oral surgery and appear as a good alternative to other bone grafts. Deproteinized bovine bone grafts are commonly used in maxillofacial surgery, sinus floor augmentation, alveolar crest augmentation, treatment of bone defects around teeth and implants, repair of mandibular and maxillary defects (Hollinger, 1986). Alloplastic grafts, which can be produced in unlimited quantities, are a promising alternative to allografts. These grafts are composed of ceramics, hydroxyapatites derived from sea corals, and bioactive glasses. Synthetic grafts made of hydroxyapatite and tricalcium phosphate are widely used in cranio-maxillofacial, orthopedic, and oral surgery. These graft materials are biocompatible and function as an effective skeleton in new bone formation (Antunes et al., 2013; Cordaro et al., 2008). For instance, Nemcovsky and Serfaty (1996) used hydroxyapatite crystals in 23 extraction sockets, closed the socket primarily by rotating the flap, and followed up the patients for 24 months. The authors indicated that alveolar ridge preservation with minimal ridge deformation provided beneficial outcomes (Nemcovsky & Serfaty, 1996).

Furthermore, Artzi et al. (2004) created a defect in the canine mandible, applied xenograft and BCP grafts to the defects, and observed the bone healing in the grafts at different time points. The results indicated that the xenograft was not completely resorbed at the end of 6 months, while the BCP graft was completely resorbed in 24 months. At the end of the study, complete bone healing was achieved in all grafted defects (Artzi et al., 2004). Of note, no significant difference between the control and experimental groups (in which xenograft and BCP graft were applied) was observed with regard to mean percentage of new bone formation. This could be due to the fact that this study period was not sufficient for the resorption of these grafts and that the drug we applied reduced the osteoclastic activity, thereby preventing resorption.

Denosumab, an agent with antiresorptive potential, has long been used in the treatment of osteoporosis in humans and animals, showing a positive effect on bone microarchitecture, such as increasing bone mass, microarchitecture, and strength (Deeks, 2018). Denosumab exerts its antiresorptive properties by blocking the maturation, function, and survival of osteoclasts that cause bone resorption. Moreover, it was also reported to improve bone turnover and increase BMD (Suresh & Abrahamsen, 2015). However, while numerous osteoporotic or non-osteoporotic animal studies documented positive effects of denosumab on bones, to the best of our knowledge, none of the previous studies evaluated the effect of denosumab in the healing of grafted defects. A previous study investigated the effect of denosumab and alendronate in the healing of femoral fracture in mice and reported that the callus tissue obtained from mice treated with denosumab had a significantly higher percent bone volume (PBV) and

one mineral density (BMD) as compared to the control and alendronate-treated groups at both 21 and 42 days (Gerstenfeld et al., 2009). In another pertinent study on the effect of denosumab on ovariectomized monkeys, Ominsky et al. found that denosumab reduced the level of biological markers of bone remodeling and increased the cortical and trabecular bone mass. The authors also reported that denosumab improved the bone strength by preserving bone quality and increasing the bone mass (Ominsky et al., 2011). Similarly, Kostenuik et al. (2009) reported that both trabecular and cortical bone mass increased in monkeys treated with denosumab. The authors found that denosumab decreased the bone resorption, increased the cortical and cancellous bone mass, and increased the trabecular structure on the micro level. In a 2022 study on the effects of a combined use of denosumab with xenogenic bone grafts on the healing of the defect, Özer et al. (2022) found that the combination therapy had no direct effect on new and total bone volume. In the present study, a comparison of the unfilled defects of the control and experimental groups revealed that denosumab significantly increased the new bone formation. In addition, the new bone formed in autografted defects was found to be significantly greater in the experimental group than in the control group.

CONCLUSION

The results of the present study revealed that the administration of denosumab, which has antiresorptive properties in the repair of bone defects, increased the new bone formation. Prior to clinical use of denosumab treatment, further animal and clinical studies involving larger experimental groups would be needed to substantiate practicality, dosage, and duration of this treatment.

Ethics Committee Approval: This study was approved by the İnönü University Medical Faculty Experimental Animals Ethics Committee with the decision dated 20-06-2013 and numbered 2013/A-52.

Conflict of Interest: The authors confirm that they have no conflict of interest.

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DETERMINATION OF CARDIOVASCULAR DISEASE RISK FACTORS KNOWLEDGE LEVEL IN UNIVERSITY EMPLOYEES

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ABSTRACT

This study aims to determine the cardiovascular disease risk factors knowledge level in adults working at a university. The study is cross-sectional and the study sample consisted of 250 participants. The study was conducted between February 2023 and September 2023. Introductory Information Form, Nutrition Questionnaire, and Cardiovascular Disease Risk Factors Knowledge Level Scale were used as data collection tools within the scope of the study. 50% of the participants were academic staff, the average age was 36.2 ± 7.1 , and the participants received 18.81 ± 4.32 points from the Cardiovascular Disease Risk Factors Knowledge Level Scale in total. The average score of the academic staff was higher. 20% of the participants had a family member diagnosed with cardiovascular disease. The difference in the total score average of the Cardiovascular Disease Risk Factors Knowledge Level scale according to the level of education, income level, smoking, and being a family health worker was statistically significant. The participants' knowledge about cardiovascular disease risk was at a moderate level. To increase the population's knowledge level regarding cardiovascular risk factors with necessary educational programs is recommended.

INTRODUCTION

Cardiovascular diseases (CVD) are the most common and deadly global public health problem (Çakıroğlu, 2023). Being one of the top health problems in the world, CVDs are among the biggest causes of all deaths worldwide (44%) (WHO, 2019). According to the Turkish Statistical Institute (TUIK) data, circulatory system diseases were shown to cause 42.4% of the reported deaths (TUIK, 2024). According to the 2021 National Disease Burden data in our country, it is emphasized that ischemic heart diseases are among the top causes of death, and their prevalence will increase over time (Ministry of Health, 2023).

Cardiovascular disease includes all heart and blood vessel disorders, coronary heart disease (CHD), cerebrovascular diseases, and rheumatic heart disease (WHO, 2023). Atherosclerosis is an essential factor in the formation of all these diseases. Therefore, Cardiovascular diseases are divided into non-atherosclerotic heart diseases and atherosclerotic heart diseases (Dülek, Vural, and Gönenç, 2018). Atherosclerosis has a symptomless, insidious

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progression (Kültürsay, 2011). The symptoms appearance indicates the disease to be in an advanced stage. There exists many causative factors for atherosclerosis. While; age, gender, and genetics are unchangeable risk factors, hypertension (HT), diabetes mellitus (DM), hyperlipidemia, smoking, lack of physical activity, excessive salt consumption, alcohol consumption, unhealthy diet, and obesity are modifiable risk factors (Doğru, Utli, Karaman, 2021; Visseren et al., 2021). Other important risk factors are stress and sedentary lifestyle. The World Health Organization states that three-quarters of all CVD deaths can be prevented with adequate changes in lifestyle. Identifying risk groups in society is an effective way to prevent cardiovascular disease and reduce costs (WHO, 2023; Wang and Zhang, 2024).

Determining cardiovascular risk factors in individuals and creating awareness about them is essential. Health professionals should evaluate risk groups and emphasize awareness programs for individuals and society about cardiovascular diseases (Dülek et al., 2018). Awareness programs can help individuals gain healthy lifestyle behaviors and direct them to treatment when necessary (Lloyd-Jones et al., 2010). The aim of preventing cardiovascular diseases is to reduce surgical interventions, increase quality of life, and avoid damage that may occur from heart diseases. Identifying high-risk individuals in society is very important in preventing cardiovascular diseases, reducing treatment costs, and preventing loss of labor (TKD, 2015). The extent to which people know about the risk factors for cardiovascular disease is generally related to how conscious they are. Knowledge about essential risk factors such as hypertension, dyslipidemia, and smoking is generally more common (Consortium, 2023).

Primary prevention of cardiovascular diseases is essential for public health. Nurses are critical in implementing screening programs for risk factors, identifying risk factors early, taking adequate health history, and directing patients to treatment and rehabilitation. (Berra, Miller and Jennings, 2011; Uysal, Enç, Cenal, Karaman and Topuz, 2015; Enç and Alkan, 2017).

Based on these information, the study aims to determine the knowledge level regarding cardiovascular disease risk factors in adults working at university.

MATERIAL AND METHOD

Type of Research

This research was conducted as descriptive and cross-sectional.

Place and Time of Research

This research was conducted at a university between February 2023 and September 2023.

The Universe and Sample of the Research

The total number of personnel in a university was accepted as the universe. The universe size was N: 568 personnel. Considering this number, the research sample was calculated with a 95% confidence interval and a 5% margin of error with a sample size of 231 personnel. In the study, 250 volunteers who agreed to participate were reached face to face with the improbable sampling method.

Data Collection Tools

Three forms were used as data collection tools: An Introductory Information Form, a Nutrition Questionnaire, and a Cardiovascular Disease Risk Factors Knowledge Level Scale (KARRIF-BD).

Introductory information form: The form, prepared based on literature sources, includes 16 questions regarding individuals' age, education level, occupation, social security, family type, cigarette consumption, genetic factor status, smoking, alcohol use, and physical activity (Thanavaro, Moore, Anthony, Narsavage and Delicath, 2006; WHO, 2023; Wang and Zihang, 2024).

Nutrition questionnaire: This form, created in light of the literature, includes seven questions regarding fruit, vegetable, red meat and fish consumption, salt, and the type of oil used (Choudhury, Das, Koner, Ghosh and Singh, 2024; Lu, Jing, Qian, Fan and Cheng, 2024).

Cardiovascular disease risk factors knowledge level scale (KARRIF-BD): The scale was formed and the validity and reliability of the scale was done by Arıkan et al. (2009). There are 28 items on the scale, and six questions (11,12,16,17,24,26) are reverse-scored. The knowledge level increases as the total score obtained from the scale increases. Participants can answer the items in the scale as “Yes,” “No,” or “I don’t know.” Correct answers are calculated as ‘1’ point. The statement “I don’t know” is always considered wrong. The Cronbach alpha value of the scale is 0.76 (Arıkan, Metintaş, Kalyoncu and Yıldız, 2009). In this study, the Cronbach alpha value was found to be 0.775.

Ethical Aspect of the Research

The study was conducted by the principles of the Declaration of Helsinki, and to conduct the study, ethics committee approval was obtained from the Erzurum Technical University ethics committee with decision number 18 dated 29.12.2022. Institutional permission was obtained from the University General Secretariat, and a written voluntary consent form was obtained from the participants.

Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) for Windows 22 package program. The data's compliance with the normality assumption was calculated using the "Kurtosis" and "Skewness" coefficients (± 2). The Independent Groups t-test was used to compare multiple groups in comparing paired groups. In variance analysis and advanced analysis, LSD was used when variances were homogeneous and Dunnet C when they were not.

Limitations of the Study

The fact that the study was conducted on personnel working at one university can be considered a limitation.

RESULTS

76.8% of the participants were 40 or older, 63.2% were male, and 70% were married. 66.4% of the participants were graduates of MA/DR, 82% lived in a nuclear family, 52.8% had an income equal to their expenses, 88.4% did not have a chronic disease.

Table 1. Some Health Behaviors and Family Characteristics of the Participants

		n	%
Individuals Diagnosed with Cardiovascular Disease in the Family	Yes	50	20,0
	No	200	80,0
Smoking Status	Yes	76	30,4
	No	174	69,6
Alcohol Use	Yes	9	3,6
	No	241	96,4
Physical Activity Status	Never	13	5,2
	Rarely	59	23,6
	Sometimes	115	46,0
	Frequently	53	21,2
	Always	10	4,0
Healthcare Worker in the Family	Yes	72	28,8
	No	178	71,2
Place Where Health Information Was Learned	Healthcare personnel	122	48,8
	Newspaper	5	2,0
	Internet	123	49,2
Total		250	100

20% of the participants had a family member diagnosed with CVD, and 37.93% of those diagnosed with CVD had HT. 69.6% of the participants did not smoke, 96.4% did not drink alcohol, 46% sometimes made physical activity, 71.2% did not have a health worker in their family, and 49.2% preferred to learn health-related information from the Internet (Table 1).

Table 2. Distribution of Scores Obtained from the Cardiovascular Disease Risk Factors Knowledge Level Scale

Scale and Subscales	n	Min.	Max.	Mean	SS.
Cardiovascular Disease Risk Factors Knowledge Level	250	5,00	27,00	18,81	4,32

As shown in Table 2, the participants received a total score of 18.81 ± 4.32 from the Cardiovascular Disease Risk Factors Knowledge Level Scale.

Table 3. Comparison of Cardiovascular Disease Risk Factors Knowledge Level Scale Scores According to Nutritional Characteristics

		Cardiovascular Disease Risk Factors Knowledge Level					
		n	%	Mean	SS.	Test	p
Salt Consumption Type	Unsalted	13	5,2	19,15	4,14	F=0,082	0,921
	Low salt	168	67,2	18,84	4,38		
	Salty	69	27,6	18,67	4,27		
Adding Salt Without Tasting	Yes	20	8,0	18,45	4,67	t=-0,386	0,700
	No	230	92,0	18,84	4,30		
Fat Consumption Type	Olive oil	76	30,4	20,39	3,84	F=8,295	0,000
	Vegetable oil	40	16,0	18,70	4,35		
	Butter	134	53,6	17,94	4,35		
Fruit Consumption Frequency	1 or Less per Day	191	76,4	18,54	4,41	F=1,694	0,186
	2-3 per Day	51	20,4	19,57	3,84		
	More than 3 per Day	8	3,2	20,38	4,69		
Vegetable Consumption Frequency	1 Serving Per Day	210	84,0	18,77	4,32	F=0,305	0,738
	2-3 Servings Per Day	34	13,6	18,82	4,43		
	3 Servings Per Day Is	6	2,4	20,17	4,12		
	More						
Frequency of Fish Consumption	Never	227	90,8	18,76	4,36	t=-0,577	0,564
	Once a Week	23	9,2	19,30	3,98		
Frequency of Red Meat Consumption	Never	28	11,2	20,36	3,88	F=2,765	0,065
	1-2 Times a Week	153	61,2	18,84	4,35		
	More than 3 Times a Week	69	27,6	18,10	4,31		

As seen in Table 3, 67.2% of the participants had a low-salt diet, 92% did not add salt without tasting the food, 53.6% consumed butter, 76.4% consumed one fruit or less daily, and 84% consumed one plate of vegetables per day. 90.8% of the participants did not eat fish, and 61.2% consumed red meat 1-2 times per week. The difference in the total score average of the Cardiovascular Disease Risk Factors Knowledge Level scale according to the type of fat consumption is statistically significant ($p < 0.05$). In the advanced analysis (LSD) conducted to determine which group the difference originated from, it was determined that the scores of those consuming olive oil were higher than those consuming vegetable oil and butter.

Table 4. Comparison of Cardiovascular Disease Risk Factors Knowledge Level Scale Scores According to Demographic Characteristics

		Cardiovascular Disease Risk Factors Knowledge Level				
		n	Mean	SS.	Test	P
Gender	Female	92	19,42	4,30	t=1,726	0,086
	Male	158	18,45	4,30		
Marital Status	Married	175	19,07	4,39	t=1,460	0,146
	Single	75	18,20	4,12		
Education Level	High School	14	17,43	4,18	F=3,963	0,009
	Associate degree	13	18,62	3,59		
	Bachelor's degree	57	17,35	3,68		
	Master's degree/ doctorate	166	19,44	4,47		
Family Type	Nuclear	205	18,73	4,40	F=2,370	0,096
	Extended family	38	18,61	4,00		
	Single parent	7	22,29	2,06		
Personnel Type	Academic	125	19,80	4,27	t=3,722	0,000
	Administrative	125	17,80	4,15		
Income Level	My income is less than my expenses	53	17,13	4,96	t=7,673	0,001
	My income is more than my expenses	65	20,18	3,10		
	My income is equal to my expenses	132	18,80	4,35		
Chronic Disease	Yes	29	17,90	4,92	t=1,209	0,228
	No	221	18,93	4,23		
Individuals diagnosed with Cardiovascular Disease in the Family	Yes	50	19,78	4,19	t=1,786	0,075
	No	200	18,57	4,33		
Smoking	Yes	76	17,84	4,96	t=2,159	0,033
	No	174	19,23	3,96		
Alcohol Use	Yes	9	16,00	6,08	t=1,424	0,191
	No	241	18,91	4,22		
Physical Activity Level	Never	13	17,69	6,93	F=0,630	0,641
	Rarely	59	18,36	4,66		
	Sometimes	115	19,07	4,11		
	Frequently	53	19,15	3,74		
	Always	10	18,10	3,45		
Having a Healthcare Worker in the Family	Yes	72	19,82	4,53	t=2,375	0,018
	No	178	18,40	4,18		
Place Where Health Information Was Learned	Healthcare personnel	122	19,11	4,42	F=0,581	0,560
	Newspaper	5	18,20	2,49		
	Internet	123	18,54	4,29		

As seen in Table 4, the difference in the total mean score of the Cardiovascular Disease Risk Factors Knowledge Level scale according to the level of education, type of personnel, income level, smoking, and being a family health worker is statistically significant ($p < 0.05$).

DISCUSSION

To know cardiovascular risk factors plays a vital role in preventing cardiovascular diseases and positively affecting lifestyle habits for cardiovascular diseases. The KARRİF-BD

scale proposed to measure cardiovascular risk factors was used in our study. In the evaluation made on the KARRİF-BD scale, employees received 18.81 ± 4.32 points, which shows that their knowledge level regarding CVD risk factors is moderate. Regarding KARRİF-BD scale studies conducted on different groups, in Andsoy et al.'s study with 300 adult individuals, the average scale score was found to be 21.34 ± 4.00 (Andsoy, Taştan, Iyigun and Kopp, 2015). It can be said that these averages are at a high level. In another study, Tan et al. examined the knowledge levels of women living in rural areas about cardiovascular disease risk factors, and the average scale score was found to be 13.05 ± 6.93 (Tan, Dayapoğlu, Şahin, Cürçani, and Polat 2013). In a study conducted by Uysal et al. on students, the average scale score was 17.1 ± 4.37 in students in the faculty of literature and 21.8 ± 4.37 in nursing students (Uysal et al., 2013). The mean scale score that Badir and his colleagues calculated in their study with undergraduate nursing students was 22.47 ± 3.38 (Badir, Tekkas, and Topcu, 2015). Essential data on how the mean KARRİF-BD scale scores vary among different individuals and groups are available in the literature. The mean score in office workers was 19.23 ± 3.03 (Balcı, Kolaç, Şahinkaya, Yılmaz and Nurgiz 2018), the mean score in the cardiovascular disease risk factors knowledge level scale in the university student group was 19.5 ± 4.6 (Oğuz, Erguvan, Ünal, Bayrak and Çamcı, 2019), the total mean score in adults was 20.18 ± 4.48 (Çoşkun, 2024), 18.65 ± 4.04 in metal sector workers (Gürdoğan, Arı, Ertürk, Genç and Uçar, 2015) and the mean total KARRİF-BD score of the academic staff was 20.23 ± 3.49 (Arslan and Akça, 2020). Considering that the maximum score on the scale is 28, we can say that the level of knowledge about cardiovascular disease risk factors is generally at moderate levels, similar to our study. On the other hand, we believe that the knowledge level of women about cardiovascular disease risk factors was determined to be low because Tan and his colleagues conducted the study only in rural areas. Although it is taken into account that the sample of similar studies consists of various individuals, when we look at the results, we can say that the knowledge level is not as high as desired. The results of the studies show that it is essential to increase the knowledge level regarding the risks of cardiovascular diseases.

Our study found no significant difference between salt, fruit, and vegetable consumption, and fish and red meat consumption with KARRİF-BD scores. Still, an important difference was found in the type of fat consumption. Adequate and balanced nutrition should include healthy fatty acid intake while keeping cholesterol balanced. The Mediterranean diet and the Japanese diet offer various advantages in this respect. Implementing these diets has the potential to reduce the risk of chronic diseases such as heart disease, diabetes, and some types of cancer (Jabbari et al., 2024). In our study, where the main headings of these healthy diets were

questioned, 27.6% of the participants stated that they ate salty food, and 8.0% indicated that they added salt to the food on their plates without tasting it. The TEKHARF study from our country determined that approximately 20% of the people added salt to the food without tasting it (Ünal, Ergör, Horasan, Kalaça and Sözmen, 2013). We see that these data are not compatible with the data of our study; the group we worked with can be evaluated as more conscious about salt use. When the participants were questioned about the type of oil they used, 53.6% stated that they used butter, and 30.4% indicated that they used olive oil. In the TEKHARF study data, the rate of olive oil use in our country was determined to be 27.1%, and butter usage to be 7.1% (Ünal et al., 2013). The fact that the study was conducted in the sample group living in the Eastern Anatolia Region can be interpreted as a reason for butter consumption to be ranked first, unlike the rest of the country. Gan et al.'s 2015 meta-analysis study shows that daily fruit and vegetable consumption reduces the risk of cardiovascular disease. This is an important finding that emphasizes the importance of vegetables and fruits in nutrition. In our study, 23.6% of people consumed 2-3 servings of fruit and vegetables daily, and we believe that awareness of this issue should be increased. The meta-analysis study conducted by Zang et al. in 2020 reported that fish consumption reduces the risk of cardiovascular disease. In our study, fish consumption was found to be at very low rates, but it is seen that the participants preferred to consume red meat. In a study conducted by Al Sahaar et al. 2020 on red meat consumption and cardiovascular disease risk, red meat was quite risky for cardiovascular diseases. Although individuals' education level and economic status are favorable, their negative nutritional behaviors indicate low awareness. We believe that it would be essential to increase the understanding of the participants in our study about nutrition and provide training to make local dishes healthy.

The analyses in our study revealed that the scores obtained from the scale showed significant differences according to demographic variables such as the participant's level of education, being an academic or administrative staff, income level, smoking, and having a health worker in the family. Zengin's study results showed that as the level of education increased, the participants became more knowledgeable about CVD (Zengin, 2019). In the study by Tan and colleagues, which included women in rural areas, it was found that the level of education increased, and the participants were more knowledgeable about cardiovascular diseases (Tan et al., 2013). Various studies have indicated a positive relationship between the level of education and having more knowledge about cardiovascular disease risk factors (Mosca, Ferris, Fabunmi, and Robertson, 2004; Al Hamarneh, Crealey, and McElnay, 2011; Awad and Al-Nafisi, 2014; Mosca et al., 2006). According to the research of Uçar and Arslan,

it was concluded that individuals with lower levels of education are more aware of the causes and risk factors of cardiovascular diseases than those with higher levels of education (Uçar and Arslan, 2017). In our study, it is expected that the average KARRİF-BD scores will be higher because the academic staff is more educated.

Our study found a significant difference between the KARRİF-BD score according to income level. According to the results of the survey by Örs and Tümer, which is another similar study in the literature, it was seen that working women with high-income levels were more aware of cardiovascular disease risk factors (Örs & Tümer, 2020). A study conducted in a hospital in Pakistan also showed that individuals with higher income levels had more knowledge about CVD (Jafary et al., 2005). There are conflicting findings in the literature about the effect of income level and employment status on the health knowledge level of individuals. In their study, Awad and Al-Nafisi did not find a significant relationship between income level and CVD knowledge (Awad and Al-Nafisi, 2014). The fact that conflicting results were obtained in the studies on this subject suggests that different socioeconomic and cultural factors play a role.

Our study found a significant difference between the KARRİF-BD scores of non-smokers. 69.6 of the individuals participating in the study did not smoke. In a study conducted by Uçar and Arslan on 121 individuals who smoked and did not smoke in a family health center, it was determined that smoking did not have a significant effect on KARRİF-BD (Uçar and Arslan, 2017). Sarihan's study found no relationship between smoking and KARRİF-BD scale scores (Sarihan, 2024). In the study conducted by Gürdoğan and his colleagues, no significant relationship was found between individuals' knowledge levels and smoking habits (Gürdoğan et al., 2015). Similar to the literature, the KARRİF-BD mean score of non-smokers in our study was higher than that of smokers. It can be thought that non-smokers adopt more healthy lifestyle behaviors. Another study in the literature reported that as knowledge of CVD risk factors increases in women, behaviors towards a healthy lifestyle also increase. This result supports the findings in our study (Thanavaro et al., 2006). Our study determined that having a health worker in the family significantly affected the KARRİF-BD score. In their research, Yılmaz and Boylu (2016) determined differences in knowledge and attitudes about health issues between health workers and other professional groups. This finding may be because health workers have more knowledge and experience in health-related problems due to their education and profession. Health workers conveying this information to their families may increase awareness of CVD risk factors. This situation shows that health workers can take a more proactive approach to

health issues related to their own families. Such awareness and information transfer can improve the health level of individuals and society.

The most effective strategy for preventing cardiovascular diseases is to adopt a healthy lifestyle and maintain these behaviors in the long term (Karakoç Kumsar & Taşkın Yılmaz, 2017). The active role of nurses in combating cardiovascular diseases is vital in improving the quality of health services and reducing the effects of these diseases. Nurses can undertake many tasks, such as monitoring patients' health, providing education, implementing preventive health services, and actively participating in treatment processes. As a result, the role of nurses in combating cardiovascular diseases is multidimensional and critical. It is possible to reduce the effects of these diseases with the cooperation of all health professionals. Conducting the study on a limited sample may cause the results to be insufficient to represent the general population.

CONCLUSION AND RECOMMENDATIONS

Participants' knowledge of cardiovascular disease risk was at a moderate level. Participants' awareness levels about risk factors important for heart health are limited. Comprehensive education programs should be organized to provide individuals to have more information about cardiovascular disease risks, support for lifestyle changes, nutrition and exercise programs should be created, regular health checks should be performed, and cardiovascular risk assessment and counseling services should be strengthened in universities. These services should be expanded in public institutions such as universities and for their employees.

Note: This study was produced from a master's thesis.

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THE EFFECT OF THERAPEUTIC PLAY ON THE QUALITY OF LIFE AND SYMPTOM CONTROL OF CHILDREN WITH CANCER

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ABSTRACT

Study aimed to investigate effect of therapeutic play on quality of life and symptom control of children with cancer. Participants were 15 children, aged 6-12, who were diagnosed with cancer, and treated in oncology-hematology clinics. Data were collected from two university hospitals between 2019-2021. It was quasi-experimental clinical research with single-group pretest-posttest model. Pediatric Patient Information Form, PedsQL Cancer Module, and Visual Analog Scale for symptoms were used as data collection tools. Mean PedsQL Cancer Module total score of children was 57.97 ± 14.83 before therapeutic play and 62.08 ± 12.97 after therapeutic play. There was no statistical difference between time-dependent median PedsQL Cancer Module total scores of children ($p > 0.05$). According to Visual Analog Scale for symptoms, there was statistically significant difference in all symptoms after therapeutic play intervention ($p < 0.05$). Study showed that therapeutic play affected symptom control of pediatric patients receiving long cancer treatment. No statistically significant difference was found between scores children obtained from PedsQL Cancer Module Child Report before, during, and after therapeutic play intervention. However, PedsQL Cancer Module Child Report total score increased.

INTRODUCTION

Childhood cancers and the treatment process, which affects the child physically and psychologically, are tiring and frightening for the child and the family (Angström-Brännström, Norberg, Strandberg, Söderberg & Dahlqvist, 2010). The symptoms experienced by the child, and the frequency and severity of the symptoms affect the quality of life of both the child and the family and directly reduce it (Chung et al., 2021; E. Stenmarker, Mellgren, Matus, Hakansson & M. Stenmarker, 2018). With the increase in the incidence of pediatric cancers, the importance of nursing care practices has gradually increased to reduce the symptoms associated with chemotherapy (Bahrami & Arbon, 2012).

The successful treatment of children diagnosed with cancer and the increase in survival rates have significantly affected the goals and objectives of nurses in the field of pediatric oncology (Newmani, Haglund & Rodgers, 2018). Today, the goals of nurses in the field of

pediatric oncology are to implement national and international treatment protocols, provide individualized family-centered care, educate children and families about the short- and long-term side effects of treatment, and increase the quality of life of the child by providing psychosocial support during the treatment process (Thrane, 2013). The Association of Pediatric Oncology Nurses (2021) highlighted those nurses should be informed about the problems of children and families during the cancer treatment process and provide guidance in solving these problems (The Association of Pediatric Oncology Nurses, 2021). This has brought the issue of planning necessary nursing interventions to improve the quality of life of the child to the forefront of nursing care. In this process, the most important nursing step that may increase the child's quality of life is to plan and implement nursing interventions that may enable the child to cope with the side effects of chemotherapy with a holistic approach (Newmani et al., 2018; The Association of Pediatric Oncology Nurses, 2021). Non-pharmacological methods are limited in the symptom control and disease process of a child with many physiological and psychological problems, whose quality of life is affected, and who exhibits a series of negative behaviors and reactions (Altay, Törüner & Sarı, 2017). However, to cope with these physiological and psychological problems, it is recommended to apply complementary treatment methods in addition to standard medical treatment (Aslan, 2018; Madden, Mowry, Gao, Cullen & Foreman, 2010).

In this respect, therapeutic play is a method that is used to reduce anxiety and anger that often arises in children. It helps the child grow and develop best by supporting him/her to overcome psychosocial difficulties. Also, therapeutic play facilitates hospitalization and helps the child cope with this process (Altay et al., 2017; Aslan, 2018; Caleffi et al., 2016). The therapeutic play method is recommended for all hospitalized children for any diagnosis (Thrane, 2013). One study conducted on hospitalized children with impaired well-being revealed that play is necessary for children's cognitive, affective, and social well-being (Caleffi et al., 2016). Therapeutic play, which is an effective method for reducing the negative effects of hospitalization in children, establishing the relationship between the child and the healthcare staff, and reducing anxiety levels in hospitalized children, is reported to shorten the recovery process by providing children with physical and emotional relief (Caleffi et al., 2016; Li, Chung, Ho & Kwok, 2016; Silva et al., 2017).

The studies in the literature have investigated the effects of therapeutic play on the identification of the psychosocial needs of children diagnosed with cancer, the creation of an environment of trust between pediatric patients and those who provide nursing care, and the reduction of the negative emotions of pediatric patients in invasive interventions. All these

studies show that when therapeutic play is included in the nursing care process, it provides children with social, emotional, and behavioral development. It is an essential skill and achievement for the nurse to add play to their care (Caleffi et al., 2016; Li et al., 2016; Silva et al., 2017).

Most research has focused on the feelings of pain, anxiety, and fear experienced by children receiving cancer treatment during medical procedures. The physical and psychosocial symptoms of the child, who was hospitalized for a long time and exposed to heavy chemotherapeutic agents, remained in the background. This study is one of the few studies examining the effect of therapeutic play on the quality of life and symptom control of pediatric patients receiving cancer treatment. Since the chemotherapy process is difficult, both physiologically and psychologically, and isolation measures make it difficult to work in this area, therapeutic play intervention, which was carefully planned by taking all precautions, is expected to have a positive impact on the quality of life by helping the child cope with the physiological effects of chemotherapy more easily, providing the child with psychological relief, and reducing feelings such as anxiety and fear.

MATERIAL AND METHOD

Research Questions

Does therapeutic play increase the quality of life of children diagnosed with cancer?

Does therapeutic play reduce the severity of symptoms experienced by children diagnosed with cancer?

Research Hypotheses

H¹: Therapeutic play increases the quality of life of children diagnosed with cancer.

H²: Therapeutic play reduces the severity of symptoms experienced by children diagnosed with cancer.

Aim and Type of Research

The study aimed to investigate the effect of therapeutic play on the quality of life and symptom control of children diagnosed with cancer and hospitalized for chemotherapy treatment in the hematology and oncology clinic.

Research Population and Sample

The data were collected between December 2019 and May 2021 in the hematology-oncology clinics of two university pediatric hospitals in northern and western regions of Turkey.

The hospital in northern Turkey, the oncology clinic is a modern clinic with 20 beds and provides health care services with 15 nurses. The hospital in western Turkey, the oncology clinic is a modern clinic with 24 beds and provides health care services with 19 nurses. The study population consisted of children between 6 and 12 years of age who were admitted to the hematology-oncology clinic for treatment purposes between the specified dates. The research sample was determined by conducting power analysis via G. Power 3.0 program using repeated measurements. The number of interventions was considered in the sample calculation, and the sample size was determined as 15 children with %80 power.

The inclusion criteria: Children between the ages of 6 and 12 years old who have been receiving chemotherapy treatment and staying in the hospital for at least one month and who speak Turkish were included in the study.

The exclusion criteria: Children who stayed in the hospital for less than a month, who were treated with radiotherapy or immunotherapy, and who could not speak Turkish were not included in the study. Between the specified dates, a child wanted to withdraw from the research in the fifth play session; two children did not volunteer to participate in the study; one child had a communication problem, and one did not speak Turkish. Thus, they could not be included in the study.

Data Collection Tools

The Pediatric Patient Information Form, the PedsQL Cancer Module Child Report, and the Visual Analog Scale for symptoms were used to collect data.

1. Pediatric Patient Information Form: This form consists of questions about the socio-demographic characteristics, diagnosis, disease stage, treatments, duration of treatment of children, and the age and gender of parents (Manav & Ocakci, 2016).

2. PedsQL Cancer Module child report for young children (ages 5-7) and children (ages 8-12): The PedsQL Cancer Module child report for young children (ages 5-7) and children (ages 8-12) was developed by Varni & Limbers and its validity and reliability were tested. The scale has 27 items. The scale dimensions are pain and hurt, nausea, procedural anxiety, treatment anxiety, worry, cognitive problems, perceived physical appearance, and communication. The child report has been simplified to a 3-point rating (0, 2, and 4 points). The Turkish validity and reliability study of the PedsQL Cancer Module was conducted by Kabak et al. (2016) and Tanir and Kuğuoğlu (2011), and it was shown that the scale is a valid, reliable, and applicable scale. The scale is short and easy to complete. The internal consistency coefficient is greater than the recommended 0.70 alpha coefficient for group comparison between the 8-18-year-old child

report. For self-reports for the ages of 5 to 7, only the procedural anxiety and treatment anxiety dimensions met the 0.70 standards, while Cronbach's alpha values for most other dimensions ranged between 0.80 and 0.90 (Kabak, Yakut, Çetin & Düger, 2006; Tanir & Kuşuoğlu, 2011; Varni & Limbers, 2009). In this study, Cronbach's alpha of the scale was calculated as pre-, while, and post-intervention values. Accordingly, Cronbach's alpha of the PedsQL Cancer Module for Young Children (ages 5-7) and Children (ages 8-12) was 0.841 pre-intervention, 0.833 while-intervention, and 0.794 post-intervention.

3. Visual Analog Scale for Symptoms: visual analog scales (VAS) are psychometric response scales that measure subjective characteristics or attitudes. A VAS is usually a 100-mm long horizontal line with verbal descriptors (word anchors) at each end to express the extremes of the feeling. For this study, children mark the point on the line that best corresponds to their symptom (pain, anxiety, fatigue, nausea) severity. To this end, they are instructed to put a cross on the straight line at the point that most accurately expresses their degree of agreement. When reading the VAS, the position of the respondent's cross is generally assigned a score between 0 and 10 (A. L. Baxter, Watcha, W. V. Baxter, Leong & Wyatt., 2011; Klimek et al., 2017; van Dijk, Koot, Saad, H. Tibboel & Passchier, 2002).

Data Collection Process

Before the study, the researcher attended training and received a Play Therapy Practitioner Education Certificate. After the training, plans were made for the implementation of the therapeutic play intervention by the researcher. First, toys that could be disinfected were selected for each pediatric patient, and a toy bag was created. Projective toys that the child can reflect his/her feelings and experiences were put in the toy bag. From the day the child patient was admitted to the clinic. The treatment protocol was determined, and the treatment was started. The average hospitalization period of children in the clinic is one month or more. Fifteen children who met the inclusion criteria were involved in the therapeutic play sessions for four weeks, two days a week, for a maximum of 60 minutes. A total of 120 therapeutic play sessions were conducted with 15 children. Preliminary data were collected with the data collection tools before the therapeutic play intervention. Quality of life was evaluated using the PedsQL Cancer Module Child Report at the study's beginning, middle, and end. The physiological and psychological problems of the child before and after each therapeutic play session and the effect of therapeutic play on symptom severity were assessed using the VAS.

The Implementation of Therapeutic Play

Before the therapeutic play: The therapeutic play bag was prepared. The therapeutic play bag included toys that do not threaten the child's health, can be disinfected, and facilitate children's self-expression. Since the clinical playroom was closed due to the COVID-19 pandemic, the therapeutic play process was carried out in the child's room to ensure that the child felt safe.



Figure 1. The Therapeutic Play Bag

During the therapeutic play: On the first day of the therapeutic play intervention, the researcher visited the child with the therapeutic play bag and chatted with the child for the first ten minutes to prepare the child for the game. Then, the researcher opened the bag and showed the toys to the child saying, "You can play with any of these toys while I am here." The purpose of therapeutic play is to allow children to express their feelings. All therapeutic play sessions started in the same way.

Therapeutic play sessions

- After the child finished playing with the toy of his/her choice, the child and the researcher drew a picture with the theme of "nurse and hospital environment," and they talked about the picture in the first therapeutic play session.
- Free play was practiced in the second and sixth games of the therapeutic play process, and the child and the researcher played with the toys the child selected.
- In the third play session, the child and the researcher read the book titled "My Friend is a Nurse"; they discussed the hospital environment and the care practices of the nurses, and the child's questions were answered. Afterward, they read a book belonging to the child.
- In the fourth play session, the child was allowed to freely tell his/her own story with the story cubes.

- In the fifth play session, the child and the researcher played a game that allowed the child to express his thoughts about himself and his family with therapeutic playing cards. Therapeutic communication cards were placed between the child and the play nurse, and each person in turn, drew a card and read and answered the question on it.

- In the seventh play session, a game was played with cards containing around 50 emotions. The cards were shown to the child individually, and he was asked to choose ten emotions he felt. Afterward, he selected the five emotions he experienced the most out of the ten emotions he chose and ranked them. A picture of a person was drawn on a white sheet of paper with the child. Then the child was asked to mark in which part of his body he felt the emotions listed most. The reasons for these feelings were discussed.

- In the eighth play session, the child was asked to match the emotions he had listed in the previous therapeutic game with the colors, and the game named “Three Wishes” was played.

After the fourth week of the therapeutic play intervention, the child and his parents were asked to write a short paragraph to express their thoughts about the games. After the paragraphs, and pictures about the games were prepared, they were submitted to the researcher. The therapeutic play process was completed by allowing children to talk without directing the child. Each game started and ended in the same way. At the end of each therapeutic game, the child was informed about last five minutes and the last minute of the game. After each therapeutic game, the toys were collected and disinfected.

Data Analysis

The data were analyzed using the SPSS Statistics Windows 25.0 program. The descriptive statistical methods (number, percentage, mean, standard deviation, minimum, maximum, median) were used to analyze the data. Non-parametric tests were used in the study because the sample size was less than 30. The Wilcoxon test, the Friedman test, and the Bonferroni test were used. In addition, the Spearman correlation analysis was performed to measure the direction and degree of significance of the relationship between the measurements. The reliability of the scales used in the study was tested with Cronbach’s alpha reliability analysis.

Limitations

The study was planned as a quasi-experimental study with a pretest-posttest design. The study results can be generalized to a sample with the same characteristics. The fact that the study was conducted in two different hospitals can be considered a limitation.

Due to the physiological and psychological problems experienced by the children during the study, plays could not always be performed on the planned day and time. However, eight therapeutic play sessions were played with each child.

Ethical Considerations

The study followed accepted national and international standards (Committee on Publication Ethics (COPE, <http://publicationethics.org/>)). To carry out the research, ethical approval was obtained from the Medical Research Ethics Committee of a university (date: 02.10.2019 Number:19-10T/61), and institutional permission was obtained from the hematology-oncology clinics of two universities in the northern and western regions. The informed consent form obtained the written and verbal consent of children and their parents. The study follows the principles embodied in the Declaration of Helsinki (<https://www.wma.net/policiespost/wma-declaration-of-helsinki-ethical-principles-for-medicalresearch-involving-human-subjects/>) for all investigations involving human subjects and materials.

RESULTS

Sixty percent of the children were male, and the mean age was 9.66 ± 1.79 years. Of these children, 53.3% attended primary school. All the caregivers were mothers. Among the mothers, 66.7% stated that they played games with their children. The socio-demographic characteristics of the children are presented in Table 1.

Table 1. Socio-Demographic Characteristics of Children with Cancer Diagnosis

	X±Sd	Min-Max
Age	9.66± 1.79	6.00-12.00
Gender	n	%
Female	6	40.0
Male	9	60.0
Educational Status		
Primary school	8	53.3
Secondary school	7	46.7
Mean age of parents	X±Sd	Min-Max
Mother	35.33±5.43	24-44
Father	39.93±4.68	34-50
Parent Playing with Child		
Yes	10	66.7
No	5	33.3
Total	15	100

X: Mean, Sd: Standard deviation, Min: minimum, Max: Maximum

Eighty percent of the children were diagnosed with hematological cancer and 66.7% were in the remission-induction stage. Among the children, 53.3% knew about their disease. It was

found that 73.3% of the children did not attend school before chemotherapy. Information regarding children's disease and treatment process is presented in Table 2.

Table 2. Disease and Treatment Process of the Children Diagnosed with Cancer

Diagnosis	n	%
Oncological Cancer	3	20.0
Hematological Cancer	12	80.0
Awareness of the Disease		
Yes	8	53.3
No	7	46.7
Duration of treatment		
1-4 months	9	60.0
5-8 months	2	13.3
9+ months	4	26.7
Previous Treatment		
Chemotherapy	8	53.3
Surgery	1	6.7
None	6	40.0
Pre-Chemotherapy Education Status		
Attending school	4	26.7
Not attending school	11	73.3
Total	15	100

No statistically significant difference was found between the median scores the children obtained from the PedsQL Cancer Module for Young Children (ages 5-7) and Children (ages 8-12) ($X^2=1.200$, $p=0.549$), and from the subscales. There was a difference between the median scores of the children on the procedural anxiety dimension before and after therapeutic play ($X^2=6.906$, $p=0.032$). The median scores for the procedural anxiety dimension were 33.25 before the play intervention and 66.75 after the intervention, respectively. A statistically significant difference was observed between the time-dependent median scores of the children on the perceived physical appearance dimension ($X^2=9.846$, $p=0.007$). The median scores for the perceived physical appearance dimension were 66.75 before the therapeutic play intervention and 50.00 after the therapeutic play intervention. A statistically significant difference was found between the time-dependent median scores of the children for the communication dimension ($X^2=10.840$, $p=0.004$). The median scores of the children for communication were 83.25 ± 22.23 before the therapeutic play intervention, 83.25 during the intervention, and 50.00 after the intervention (Table 3).

Table 3. The Mean Scores of the Children Diagnosed with Cancer on the Pedsql Cancer Module, Its Dimensions, and the Comparison of the Median Scores

			$\bar{x} \pm Sd$	Min- Max	1st quarter	3rd quarter	Median	X ²	p	Bonferroni
PedsQL Cancer Scale	Module	Pre	57.97± 14.83	37.91- 87.25	47.90	67.51	57.19	1.200	0.549	
		While	60.80± 16.54	31.25- 90.63	48.92	77.82	58.34			
		Post	62.08± 12.97	41.16- 85.31	54.92	75.64	61.97			
Pain and hurt		Pre	48.33± 27.49	0.00- 100.00	46.87	65.62	50.00	1.647	0.439	
		While	53.33± 29.68	0.00- 100.00	50.00	75.00	50.00			
		Post	56.67± 24.03	0.00- 100.00	50.00	75.00	50.00			
Nausea		Pre	56.00± 26.13	10.00- 90.00	40.00	80.00	50.00	1.170	0.557	
		While	55.33± 30.21	0.00- 100.00	33.75	91.25	60.00			
		Post	58.00± 25.97	0.00- 100.00	50.00	80.00	50.00			
Procedural anxiety		Pre	38.88± 26.49	0.00- 83.25	25.00	60.37	33.25	6.906	0.032*	1<3
		While	48.87± 26.32	0.00- 100.00	31.18	37.50	50.00			
		Post	61.10± 29.30	0.00- 100.00	39.62	83.25	66.75			
Treatment anxiety		Pre	75.55± 32.04	0.00- 100.00	50.00	100.00	100.00	0.563	0.755	
		While	77.78± 25.72±	33.25- 100.00	50.00	100.00	100.00			
		Post	80.02± 22.88	50.00- 100.00	50.00	100.00	100.00			
Worry		Pre	41.10± 36.11	0.00- 100.00	12.56	83.25	50.00	4.439	0.109	
		While	57.77± 37.19	0.00- 100.00	39.62	91.75	50.00			
		Post	64.45± 22.60	50.00- 100.00	50.00	100.00	50.00			
Cognitive problems		Pre	58.33± 21.99	0.00- 87.50	50.00	75.00	62.50	0.884	0.643	
		While	66.67± 18.70	50.00- 100.00	50.00	80.00	62.50			
		Post	60.83± 21.58	12.50- 100.00	50.00	75.00	62.50			
Perceived appearance	physical	Pre	66.65± 15.39	50.00- 83.25	50.00	83.25	66.75	9.846	0.007*	3<1
		While	48.88± 22.23	0.00- 83.25	41.75	75.00	50.00			
		Post	66.65± 19.90	50.00- 100.00	50.00	87.43	50.00			
Communication		Pre	78.90±22.23	50.00- 100.00	50.00	100.00	83.25	10.840	0.004*	3<1
		While	77.77± 23.29	33.25- 100.00	66.75	100.00	83.25			2<1
		Post	48.88± 22.23	0.00- 83.25	47.93	87.43	50.00			

*p<0.05, 1: Pre, 2:While, 3:Post , X²:Friedman Test

Each child (n=15) who received chemotherapy treatment after being diagnosed with cancer was interviewed eight times during the one-month therapeutic play intervention period, and they were asked to state the symptoms they developed. The children developed the following symptoms: 85% pain, 76.7% fatigue, 57.5% nausea, 62% sadness, 64.2% anxiety, 48.3% insomnia, and 71.7% feeling unwell (Table 4).

Table 4. Development of Cancer-Related and Chemotherapy-Related Symptoms in Children

Symptom	Development of the symptom	Symptom frequency n (%)
Pain	Yes	102 (%85.0)
	No	18 (%15.0)
Fatigue	Yes	92 (%76.7)
	No	28 (%23.3)
Nausea	Yes	69 (%57.5)
	No	51 (%42.5)
Anxiety	Yes	77 (%64.2)
	No	43 (%35.8)
Total		120(100)

A statistically significant difference was found between the symptoms of pain ($z=-3.408$, $p=0.001$), fatigue ($z=-3.410$, $p=0.001$), nausea ($z=-3.409$, $p=0.001$), anxiety ($z=-3.299$, $p=0.004$) before and after the therapeutic play intervention. Children had a lower score in all these symptoms after the therapeutic play intervention than before (Table 5).

Table 5. Visual Analog Scale (Vas) For Symptoms Mean Scores and Comparison of Scores

		$\bar{x} \pm Sd$	Min-Max	Median	z	p
Pain	Pre	3.45 \pm 1.55	1.43- 6.14	3.14	-3.408	0.001*
	Post	0.88 \pm 0.75	0.00- 2.63	0.87		
Fatigue	Pre	2.84 \pm 1.72	0.88- 6.50	2.75	-3.410	0.001*
	Post	0.70 \pm 0.71	0.00- 2.13	0.62		
Nausea	Pre	2.28 \pm 2.27	0.13- 9.00	1.75	-3.409	0.001*
	Post	0.55 \pm 0.85	0.00- 3.13	0.12		
Anxiety	Pre	1.90 \pm 1.58	0.00- 5.13	1.50	-3.299	0.001*
	Post	0.55 \pm 0.80	0.00- 2.38	0.25		

* $p<0.05$, z: Wilcoxon test

A negative relationship was observed between the total score for the pain and hurt dimension after the therapeutic play intervention in the PedsQL Cancer Module for Young Children (ages 5-7) and Children (ages 8-12) and the mean score of the children on the pain dimension of the VAS after the intervention ($r=-0.600$, $p=0.018$). In addition, a negative relationship was found between the PedsQL Cancer Module Child Report total nausea score after the therapeutic play intervention and the VAS nausea mean score of the children after the intervention ($r=-0.656^{**}$, $p=0.008$). A negative relationship ($r=-0.533^{*}$, $p=0.041$) was found between the total score obtained after the therapeutic play intervention from the PedsQL Cancer

Module for Young Children (ages 5-7) and Children (ages 8-12) treatment anxiety dimension and the VAS anxiety mean score the children after the intervention.

DISCUSSION

In this study, the mean PedsQL score of the children after the therapeutic play intervention was 62.0 ± 2.97 . According to child responses, children's overall quality of life scores increased after the therapeutic play intervention; however, this increase was not statistically significant. In the study of Chung et al. (2021), the quality-of-life score of children aged 7-14 years diagnosed with cancer was 63.6 ± 9.8 . Stenmarker et al. (2018) reported that in Argentina, the quality-of-life score of children aged 5-12 was 66.8 ± 12.2 , and in Switzerland, this score was 85.5 ± 5.9 . Another study compared the quality-of-life scores of 16 children diagnosed with brain tumors before and after art therapy. The comparison showed that the quality-of-life scores of children receiving art therapy increased. They reported that they experienced less pain, nausea, and anger and more excitement and happiness (Madden et al., 2010). In Ozcan's (2012) study, eight art therapy sessions were applied to children diagnosed with cancer for one month. No statistically significant difference was found between children's pre and post-quality-of-life scores. However, the quality-of-life score of children who received art therapy was found to be higher when compared to children who did not (Ozcan, 2012). Yıldız (2018) gave symptom control training to children with leukemia through computer-assisted games and reported that the mean quality of life scores of these children was higher than before (Yıldız, 2018). Quality of life is affected by physiological, psychological, sociocultural, and environmental factors (Sitaresmi et al., 2009). In the study, it is thought that the quality of life of children could be affected by the type of disease, stage, and duration of the treatment. In addition, it is estimated that the quality of life of children does not change due to prolonged hospital stays, physiological and psychological symptoms caused by the disease, as well as having to struggle with the side effects of chemotherapy.

Positive emotional changes caused by a fun and safe play environment during the therapeutic play intervention are associated with increased pain threshold and immunity, decreased stress hormones, and positive health (Kurudirek & Arıkan, 2020). The literature describes play as an effective method of reducing hospitalized children's anxiety, fear, and negative feelings. It contributes to the recovery of children by relieving them both physically and emotionally, enabling them to express their feelings and knowledge levels about the disease, and facilitating communication between the child and the healthcare staff. Thus, it is necessary to provide holistic and high-quality care (Al-Yateem & Rossiter, 2017; Caleffi et al.,

2016; Godino-Iáñez et al., 2020; Li et al., 2016). Many studies have reported that play activities with hospitalized children reduce anxiety, fear, and perceived pain (Li et al., 2016; Silva et al., 2017). Studies also state that distracting games effectively reduce pain and fear in invasive procedures (Karakaya & Gözen, 2016). Pain is a common symptom in children diagnosed with cancer. In addition to the physiological effect of cancer on tissues and nerves, medical procedures such as LP, intrathecal treatment, and bone marrow aspiration also cause pain. Pain is often associated with fear, anxiety, and stress. Many nursing interventions provide effective pain management and reduce analgesic consumption. Distraction, imagery, relaxation techniques, and cutaneous stimulation applications are some of these interventions (Karakaya & Gözen, 2016). This study revealed that the therapeutic play intervention significantly reduced the pain experienced by children diagnosed with cancer during inpatient treatment with chemotherapeutic agents. Aslan (2018) determined that the therapeutic play intervention applied to children diagnosed with cancer during invasive procedures effectively reduced pain. Madden et al. (2010) found that art therapy decreased the pain children aged 2-13 experienced during chemotherapy. Studies have shown that practices such as games, listening to music, art, or watching TV/videos effectively reduce and manage pain (Aslan, 2018; Karakaya & Gözen, 2016; Kurudirek & Arıkan, 2020). Studies show that these methods effectively reduce perceived pain, ensure pain management, and increase comfort.

The study revealed that therapeutic play significantly reduced nausea during children's hospitalization and treatment process with chemotherapeutic agents. Griffiths (2005) found that when children diagnosed with cancer played video games during chemotherapy, the frequency of nausea, vomiting, and systolic blood pressure decreased. In the experimental study of Chan et al. (2015), relaxation exercises and dreaming strategies were taught to 4–11-year-old children in the experimental group. Risk management, antiemetic use, and nutrition training were given to the second group. It was found that nausea and vomiting decreased in children in the experimental group after the third day compared to the control group. McCulloch et al. (2014) reported that distraction and daydreaming methods are the most frequently used and very effective in coping with nausea and vomiting in children with cancer (McCulloch, Hemsley & Kelly, 2014).

The study showed that therapeutic play significantly reduced fatigue during the treatment process of children with chemotherapeutic agents. The randomized controlled study by Mohammadi et al. (2021) found that the symptoms of pain, fatigue, and anxiety related to the disease and chemotherapy were reduced in children with cancer who had game-based occupational therapy. In the study, while pain and anxiety were experienced more frequently

and severely in children in the first stages of treatment, more fatigue symptoms were observed in children later (Mohammadi, Mehraban, Damavandi, Zarei & Haghani, 2021).

The study further revealed that the therapeutic play intervention significantly reduced the level of anxiety during the inpatient treatment of children with chemotherapeutic agents. Paula et al. (2011) observed less fear, anxiety, and anger in children who had therapeutic play intervention during chemotherapy treatment in the outpatient clinic (Paula, Artilheiro, De Amorim Almeida, Maria & Chacon, 2011). The systematic review of Thrane (2013) reported that interventions such as virtual reality applications, various mind-body techniques, creative art therapy, music therapy, massage, and hypnosis effectively reduce pain and worry in children with cancer. In their study, Li et al. (2011) played a computer game containing virtual reality with children who had cancer five days a week. The evaluations on the seventh day showed that children playing computer games had fewer depressive symptoms than the control group (Li, Chung & Ho, 2011). Altay et al. (2017) used therapeutic play techniques such as drawing pictures and telling stories in their study with children receiving cancer treatment. They found that the children who used these techniques had less anxiety compared to the beginning of the study. One randomized controlled study by Li et al. (2014) with Chinese children revealed that anxiety and negative mood levels were lower in the experimental group in which therapeutic play was applied (Li, Chan, Wong, Kwok & Lee, 2014). Paula et al. (2011) stated that therapeutic play is associated with positive behavior in preschool children receiving chemotherapy; it improves the feelings of trust by increasing cooperation with healthcare professionals, and children smile during play. Frygner-Holm et al. (2020) applied 6-8 therapeutic play sessions to children with cancer. The children were asked how they felt after each game, and they stated that they were pleased.

Quality of life refers to the child's perception of his or her physical, emotional, social, and spiritual state. Studies have shown that the quality of life of children who experience symptoms caused by the disease or chemotherapy is lower. Rosenberg et al. (2016) reported that the quality of life of children experiencing physical symptom stress due to pain, nausea, and vomiting is lower. In the literature, the children's quality of life is frequently evaluated based on parental information (Kabak et al., 2016; Mohammadi et al., 2021). However, the care process should be planned considering the evaluations of the child, parent, and primary nurse providing care (Rosenberg et al., 2016; Stenmarker et al., 2018; Varni & Limbers, 2009). Nursing interventions planned for symptom control based on the information obtained from the child and parents may increase the child's quality of life.

This study showed that the child with a low mean score for pain and nausea symptoms after therapeutic play had a high quality of life score from the PedsQL Cancer Module pain and hurt and nausea dimensions after the therapeutic play intervention. In addition, it was found that the child with a low mean sadness score before the therapeutic play intervention had a high quality of life score in the PedsQL Cancer Module treatment anxiety dimension after the intervention. It was shown that the child with a low mean sadness score after the intervention had a high quality of life score on the PedsQL Cancer Module anxiety dimension after the intervention. The study revealed that the severity of the symptoms decreases after therapeutic play. As a result, the pain and hurt, nausea, and treatment anxiety dimensions of the PedsQL Cancer Module are positively affected. Li et al. (2013) conducted a study with children aged 9-16 who received cancer treatment, and they found that children with high depression levels had low quality of life scores (Li, Williams, Lopez, Chung & Chiu, 2013). The severity, frequency, and duration of the symptoms are affected by many factors. All these symptoms directly affect the quality of life of children (Linder & Hooke, 2019).

The children in our study participated in the one-month therapeutic play intervention willingly. At the end of the intervention, they said they had an enjoyable time and were very happy. After the intervention, the mothers made comments such as, "You had a very positive influence on my child," "My child loves you very much," "My child wants to stay here just for you," and "My child forgets everything when s/he sees you." These feelings point to the effectiveness of the therapeutic play intervention. It is stated in the literature that symptom control performed by nurses in children receiving chemotherapy positively affects patients' quality of life. The statements, behaviors, and body language of the children showed that they mostly wanted to play games and feel happy, participate in the treatment and care process, and communicate well with healthcare professionals (Bahrami & Arbon, 2012; Campos, Rodrigues & Pinto, 2010). It is seen that play, defined as children's work, has been associated with happiness and fun by children trying to cope with their disease and the treatment process in the hospital environment. The study conducted by Gariepy and Howe (2003) with 3-5-year-old children hospitalized due to leukemia found that play is associated with feeling happy. In the qualitative study of Angström-Brännström et al. (2010), parents reported that their children receiving cancer treatment wanted to play and have fun despite their pain and suffering since this reduced their stress experienced, and they felt better. Campos et al. (2010) conducted a study with hospitalized children and concluded that play is necessary for children's cognitive, affective, and social well-being.

CONCLUSION

The results of study showed that no statistically significant difference was found between the scores the children obtained from the pain and hurt, nausea, treatment anxiety, worry, and cognitive problems dimensions of the PedsQL Cancer Module Child Report before, during, and after the therapeutic play intervention. However, the PedsQL Cancer Module Child Report total score increased. The scores of the children on the PedsQL Cancer Module procedural anxiety dimension were higher after the therapeutic play intervention. According to the VAS Scale, there was a statistically significant difference between the pre- and post-therapeutic medians of the symptoms of pain, fatigue, nausea, and anxiety. It was observed that the children had lower scores in all these symptoms and decreased severity of symptoms after the therapeutic play intervention.

Therapeutic play should be included in the nursing care process as it increases the compliance of children with cancer to treatment, enables children to express their physical problems and emotional reactions, and facilitates coping. Nurses working in pediatric hematology-oncology clinics should receive education on therapeutic play. Nurses working in these units should include therapeutic play in children with cancer care plans.

Therapeutic play is essential for children diagnosed with cancer and hospitalized for treatment in hematology and oncology clinics. Therapeutic play interventions can increase the quality of life and symptom control of children diagnosed with cancer. For this reason, therapeutic play can be added nursing care process to help the child in the difficult treatment process. It is recommended that randomized controlled experimental studies be conducted with a larger sample group.

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INSOMNIA, RELATED FACTORS AND DETERMINATION OF THE STATUS OF COMPLIANCE WITH SLEEP HYGIENE RULES IN ADULT INDIVIDUALS

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ABSTRACT

This study aimed to evaluate insomnia, related factors, and adherence to sleep hygiene rules in adult individuals. The Insomnia Severity Index was administered to 227 adults who applied to the family medicine polyclinic of a university hospital, and their adherence to sleep hygiene rules was also examined. Numerical values showing conformity to normal distribution were analysed by 'Pearson Correlation' analysis, 'Mann Whitney U' test and 'Kruskal Wallis' tests were used to compare categorical variables and dependent variables. As a result of the statistical analyses, 44% of the adults reported different levels of insomnia. A positive correlation was found between the mean Insomnia Severity Index scores and the presence of chronic disease ($p=0.000$), medication use ($p=0.000$), skipping meals ($p=0.007$), being stressed ($p=0.000$), and coffee consumption ($p=0.025$). According to the results of the analyses, it was found that there was a weak/very weak positive correlation between the adults' non-compliance with the sleep hygiene rules and their experience of insomnia. Considering the long-term effects of poor sleep hygiene habits, especially the potential to lead to chronic diseases, it is recommended that both public awareness be increased on this issue and that this issue is not ignored by health professionals.

INTRODUCTION

Despite the fundamental role of sleep in maintaining and improving physical and mental health, it is reported that many individuals sleep less than the recommended amount or experience sleep disorders (Baranwal, Yu & Siegel, 2023). Insomnia is one of the most common sleep disorders. The prevalence of insomnia in the general population is reported to be 10-15% and approximately 10% in the adult population (Bollu & Kaur, 2019; Morin & Jarrin, 2022). Insomnia can result directly from a disorder in the mechanisms regulating sleep and wakefulness or indirectly from accompanying psychiatric or medical conditions (Yetkin & Aydın, 2014). While insomnia can affect all age groups, factors such as gender and old age increase susceptibility to insomnia. Additionally, job stress, shift work, psychosocial factors, certain personality traits, and some psychiatric diseases can increase the risk of insomnia. Lifestyle behaviors such as alcohol use/addiction and excessive smoking can potentially affect the sleep-wake cycle (Bollu & Kaur, 2019). The consumption of caffeinated beverages such as

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coffee/tea and the intake of cereals (bread, pasta, rice, etc.) can lead to difficulty falling asleep and fragmented sleep (Başpınar & Yeşilkaya, 2021; Uysal, Ayvaz & Oruçoğlu, 2018). In other words, these poor lifestyle habits prevent a quality sleep experience. For this reason, it is important to highlight the importance of sleep hygiene, which refers to healthy habits that can be adjusted for a good night's sleep (Irish, Kline, Gunn, Buysse & Hall, 2015).

Sleep hygiene, a concept closely related to lifestyle behaviors, can be achieved by changing behavior and sleep habits (7-9 hours of sleep, avoiding caffeine, alcohol, and heavy meals later, etc), thereby improving sleep in the long term (Baranwal et al., 2023). Poor sleep hygiene habits (all factors that promote arousal or disrupt the normal balance of the sleep-wake cycle) can significantly impact sleep quality and duration (E. M. Alanazi, A. M. M. Alanazi, Albuhairey, A. H. & A. A. A. Alanazi, 2023; Barros, Lima, Ceolim, Zancanella & Cardoso, 2019). As a matter of fact, it is emphasized that poor sleep quality is associated with a range of mental and physical disorders (Alanazi et al., 2023). Due to insomnia, individuals may experience fatigue and lack of concentration, decreased productivity at work, social life disruptions, life-threatening accidents, and an increase in healthcare visits (Barros et al., 2019; Gottlieb, Ellenbogen, Bianchi & Czeisler, 2018; Matthews, Arnedt, McCarthy, Cuddihy & Aloia, 2013). Thus, insomnia can lead to individual and social costs (Barros et al., 2019; Matthews et al., 2013). The importance of sleep hygiene can be related to the following expressions (Work Health Solutions): (1) Having good sleep hygiene habits can help repair body tissues and the immune system. (2) Adequate sleep plays an important role in maintaining physical health. Inadequate sleep has been linked to various chronic health problems. (3) Good sleep hygiene habits can have a significant impact on mental health, reducing the risk of depression, anxiety, and other mental health problems. Getting enough quality sleep can reduce stress and improve cognitive function, including memory, concentration, and decision-making. 4) Good sleep hygiene habits can increase productivity and overall quality of life, improve energy levels, increase focus, and improve performance at work or school (Work Health Solutions).

The literature highlights that poor sleep quality is associated with higher mortality rates and higher prevalence of many chronic health problems. A study found that non-depressed people with insomnia have a twofold risk to develop depression compared to people with no sleep difficulties (Baglioni et al., 2011). As a result of the study conducted by Hublin, Partinen, Koskenvuo & Kaprio (2011), a significant relationship was found between poor quality sleep and mortality risk, especially in those with somatic diseases. A meta-analysis study found that patients with hypertension had significantly worse sleep quality scores (Lo, Woo, Wong &

Tam, 2018). A study by Troxel et al., (2010) found that difficulty falling asleep, non-restful sleep and especially loud snoring predicted the development of metabolic syndrome in adults in the community. The same study concluded that assessing sleep symptoms can help identify people at risk of developing metabolic syndrome. Therefore, it can be said that individuals' physical, psychological, and social performance, as well as their quality of life, are negatively affected. It is thought that the results of this study will provide up-to-date data to the literature on the experience of insomnia in adults living in Turkey. By determining the factors associated with insomnia and compliance with sleep hygiene rules, attention will be drawn to the necessity of planning awareness trainings on the subject.

MATERIAL AND METHOD

Purpose and Type of the Research

This research was planned as a cross-sectional study and aimed to evaluate insomnia, related factors, and adherence to sleep hygiene rules in adult individuals. The research questions of the study are as follows:

- What is the level/severity of insomnia in adults?
- What are the factors associated with insomnia in adults?
- What is the adherence status of adults to sleep hygiene rules?

This research was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement, which provides guidance on what should be included in the reporting of observational studies.

Sample of the Research

Patients were included in the sample using a non-probability convenience sampling method, and the research data were collected between August 1, 2022- December 1, 2022. The population of the research consisted of adult individuals who applied to the family medicine polyclinic of a university hospital. The sample size was calculated using the sample calculation method based on the known incidence of the event in the population. With a 95% confidence interval, a 5% significance level, an incidence rate (the value in the sample study is 21.8%), and a sampling error of $d=0.05$, the sample size was calculated as 227 using the formula $n = \frac{Nt^2pq}{d^2(N-1) + t^2pq}$ (Demir, 2010). Individuals aged 18 and over, literate, and without verbal communication barriers were included in the study.

Data Collection and Analysis

The data of the study were collected with a structured questionnaire and Insomnia Severity Index (ISI). The structured questionnaire was prepared by the researchers in line with the literature. The form included questions about the socio-demographic and health-related characteristics of the individuals, questions to determine the factors associated with insomnia, and questions to determine their compliance with sleep hygiene rules. ISI was developed to assess the severity of insomnia. ISI is a measurement tool with high validity and reliability (Bastien, Vallières & Morin, 2001; Boysan, Güleç, Beşiroğlu & Kalafat, 2010). This measurement tool consists of 7 questions. Scale items are scored between 0-4. The scores that can be obtained from the scale vary between 0-28 (Boysan et al., 2010). This scale, which was developed to determine the degree of insomnia symptoms, can be used in normal population screening and clinical evaluation of insomnia. The scale assessment is as follows: (1) scores between 0-7 indicate clinically insignificant insomnia, (2) scores between 8-14 indicate mild insomnia, (3) scores between 15-21 indicate clinical insomnia (moderate), and (4) scores between 22-28 indicate clinical insomnia (severe) (Önal & Hisar, 2018). The Turkish validity and reliability study was conducted (Boysan et al., 2010). The scale is both a self-report tool and a tool that can be used by the caregiver or clinician for assessment. The internal consistency coefficient of the scale was found to be 0.79 (Boysan et al., 2010; Önal & Hisar, 2018). As a result of our study, Cronbach Alpha coefficient was found to be 0.89.

Data collection forms were administered by researchers using a face-to-face interview technique at the family medicine polyclinic within the hospital. The forms were administered to patients meeting the sampling selection criteria in approximately 15-20 minutes. The family medicine polyclinic was visited three days a week during working hours for data collection. After providing information about the data collection process, written consent was obtained from patients who agreed to participate in the study.

The research data were analysed with ‘Statistical Package for the Social Sciences (SPSS) 22’ software. In descriptive statistics; number and percentage distributions and mean \pm standard deviation (SD) values were given. Whether the data showed normal distribution or not (Kolmogorov-Smirnov or Shapiro-Wilk) was evaluated and numerical values showing conformity to normal distribution were analysed by ‘Pearson Correlation’ analysis, ‘Mann Whitney U’ test and ‘Kruskal Wallis’ tests were used to compare categorical variables and dependent variables. The results are presented at 95% confidence interval and $p < 0.05$ significance level. The strength of the correlation coefficient was evaluated as very weak (0.00-

0.25), weak (0.26-0.49), medium (0.50-0.69), high (0.70-0.89), very high (0.90-1.00) (Akgül, 2005).

Limitations

This research has some limitations. The research was carried out single-center because of the limited amount of manpower, time, and funding. This may restrict the generalisability of results. We suggest that further cross-sectional, multi-centre and larger sample size studies are needed to improve generalizability.

Ethical Aspects of the Research

Ethical approval of the study was obtained from the ethics committee of the nursing faculty of a university. (Protocol No: 2022/299- Approval Date: July 4, 2022 – Number: E-76261397-050.99-195430). The necessary institutional permission to conduct the study between August, 2022 and December, 2022 was obtained from the institution where the study was conducted.

RESULTS

Characteristics of Adult Individuals and Their Insomnia Levels

A total of 394 individuals were assessed for eligibility, of whom 167 refused to participate in the study, stating that they did not have time. The mean age of the individuals in the study was 45.42 ± 17.74 , 60.8% were women and 65.6% were married. 33.5% of the participants were primary/secondary school graduates and 64.8% were not working. Of those who were employed, 15 per cent were working in a shift job. 52.4% of the participants had at least one chronic disease, 14.5% were obese and 48% were taking medication. Table 1 shows the mean ISI score and insomnia levels of the adults, and Table 2 shows the characteristics of the individuals (socio-demographic and health-related characteristics) and their experience of insomnia according to these characteristics. Accordingly, 55.9% of the individuals defined insomnia at a clinically insignificant level, while 44.1% of the total defined insomnia of different severity. When the characteristics of adult individuals were analysed, only the presence of chronic disease, medication use, skipping meals and being stressed were positively correlated with the mean ISI scores (Table 2).

Table 1. Insomnia Severity Index Scoring and Insomnia Levels

	Mean (\bar{x})	SD
ISI Scores	7.19	4.96
	N	%
0-7 ("no clinically significant insomnia)	127	55.9
8-14 (subthreshold insomnia)	82	36.1
15-21 (clinical insomnia/moderate severity)	15	6.6
22-28 (clinical insomnia/severe)	3	1.3

*ISI: Insomnia Severity Index

Table 2. The Characteristics of the Individuals and Their Experience of Insomnia According to These Characteristics

	N	%	ISI Scores
Age (Years) Groups			
18-24	35	15.4	106.16
24-34	37	16.3	106.95
35-44	39	17.2	104.74
45-54	38	16.7	117.76
55-64	40	17.6	117.91
65 and over	38	16.7	129.71
Test and p value			KW = 5602.00; p = 0.347
Gender			
Female	138	60.8	116.01
Male	89	39.2	110.89
Test and p value			MWU= 5864.00; p = 0.565
Marital Status			
Married	149	65.6	117.48
Single	78	34.4	107.36
Test and p value			MWU= 5293.00; p = 0.268
Education Levels			
Literate	18	7.9	133.36
Primary School	76	33.5	127.56
Secondary School	65	28.6	111.15
High School and Postgraduate	68	30	104.06
Test and p value			KW = 7600.00; p = 0.107
Working Status			
Working	80	35.2	107.98
Non working	147	64.8	117.28
Test and p value			MWU= 5398.50; p = 0.236
Shift Working Status			
Shift Working	12	15	111.29
Shift Non working	68	85	107.40
Test and p value			MWU= 1452.00; p = 0.484
Chronic Diseases			
No	108	47.6	132.31
Yes	119	52.4	97.38
Test and p value			MWU= 4448.50; p = 0.000
Using Drug			
Yes	109	48	128.56
No	118	52	100.55
Test and p value			MWU= 4844.00; p = 0.000
Body Mass Index			
Underweight	5	2.2	64.00
Normal weight	111	48.9	107.97
Overweight	78	34.4	122.21
Obese	33	14.5	122.47

Test and p value			KW = 7575.00; p = 0.056
Skipping Meals			
No	138	60.8	122.75
Yes	89	39.2	102.89
Test and p value			MWU = 5238.50; p = 0.007
Stressful			
No	179	78.9	125.49
Yes	48	21.1	99.41
Test and p value			MWU = 4891.00; p = 0.000

*MWU= Mann Whitney U test; KW=Kruskal Wallis test; ISI: Insomnia Severity Index

Adherence to Sleep Hygiene Rules Among Adults

The compliance of adult individuals with sleep hygiene rules was analysed. Most of the participants turned off the lights at bedtime (94.3%), avoided overeating before going to sleep (75.8%), avoided going to bed when very hungry (86.8%), and stopped snacking two hours before bedtime (70.9%), completed their exercises at least 6 hours before bedtime (76.7%), avoided heavy exercise shortly before bedtime (88.1%), got out of bed when they woke up in the morning (80.2%), and took care to get sunlight during the day (93.8%). More than half of the participants stated that they do not do activities such as reading, eating, watching TV in bed (53.7%) and go to bed only when they are tired/sleepy enough to sleep (55.8%).

Less than half of the participants made the following statements about other sleep hygiene rules: 'I don't sleep even if I feel sleepy during the day' (35.2%), 'I get up at the same time every morning, no matter what time I go to sleep' (29.5%), 'When I feel that I can't sleep in bed, I don't force myself to sleep, I get out of bed and clear my mind in a quiet room, I go back to bed' (37.9%), 'I go to bed at the same time every day and get up at the same time' (22.5%), 'I stop drinking coffee-tobacco-alcohol-acidic drinks at least 6 hours before going to bed (44, 1%)', 'I avoid situations that may stress me before sleep (41,0%)', 'I stop using electronic devices at least 1 hour before bedtime (39,6%)', 'I make plans for the next day before sleep and in another room (34,4%)', 'I exercise at least 30 minutes 3 times a week (44,9%)', 'If I have difficulty falling asleep at night, I avoid daytime sleep (43,2%)', 'If necessary, I sleep for a maximum of 20 minutes before 15. 00 (27,3%)', 'I avoid napping in front of the TV in the evening (42,3%)', 'I do one of the activities such as relaxation exercises, taking a warm shower, reading a book in a different room, listening to classical music at least 1 hour before sleep (41,9%)', 'I pay attention to go to bed at the same time and get up at the same time even on weekends and holidays (26,4%)'.

Adult Individuals' Experience of Insomnia According to Compliance With Sleep Hygiene Rules

In our study, insomnia experience status of adult individuals according to their non-compliance with sleep hygiene rules was analysed (Table 3). According to the results of the analyses, it was found that there was a weak/very weak positive correlation between the adults' non-compliance with the sleep hygiene rules in Table 3 and their experience of insomnia (Table 3). Accordingly, those who did not comply with the sleep hygiene rules in Table 3 had higher insomnia scores.

Table 3. Adult Individuals' Experience of Insomnia According to Non-Compliance with Sleep Hygiene Rules

	ISI Scores
Not sleeping even if sleepy during the day	r = 0.147 p = 0.027*
Going to bed only when tired/sleepy enough to fall asleep	r = 0.140 p = 0.035*
Going to bed and getting up at the same time every day	r = 0.159 p = 0.017 *
Avoiding overeating before sleep	r = 0.244 p = 0.000*
Stop eating snacks 2 hours before bedtime	r = 0.174 p = 0.008*
Avoiding situations that may cause stress before sleep	r = 0.252 p = 0.000*
Avoiding daytime sleep when there is difficulty falling asleep at night	r = 0.164 p = 0.013*
Making plans for the next day before sleep and in another room	r = 0.231 p = 0.000*
Avoiding naps in front of the TV in the evening	r = 0.329 p = 0.000*
Performing one of the activities such as relaxation exercises, taking a warm shower, reading a book in a different room, listening to classical music at least 1 hour before sleep	r = 0.159 p = 0.016 *
To go to bed and get up at the same time even on weekends and holidays	r = 0.190 p = 0.004*
Getting out of bed when you wake up in the morning	r = 0.226 p = 0.001*

*Pearson korelasyon; ISI: Insomnia Severity Index

Adult Individuals' Experience of Insomnia According to Their Dietary Habits

When the sleep-related dietary habits of adults were analysed, it was found that individuals consumed tea (499.47 ± 513.89 ml) and coffee (113.53 ± 142.37 ml) as daily beverages. It was found that the individuals consumed 83.47 ± 131.33 ml cola/acidic beverage, 55.32 ± 95.84 ml fruit juice and 45.54 ± 97.20 ml herbal tea daily, smoked 3.63 ± 6.84 cigarettes daily and consumed 30.39 ± 153.16 ml alcohol weekly. Individuals consumed 3.87 ± 4.16 slices of white bread, 26.80 ± 52.79 grams of chocolate and 130.46 ± 109.38 ml of yoghurt daily. It was

stated that 2.08 ± 1.90 servings of potatoes, 2.06 ± 2.41 servings of white rice and 1.62 ± 2.08 servings of desserts were consumed weekly.

Adult individuals were analysed according to their dietary habits that may affect their sleep status (Table 4). Only a weak positive correlation was found between coffee consumption and insomnia ($r=0.148$; $p=0.025$).

Table 4. Adult Individuals Experience Insomnia According to Dietary Habits that may Affect Their Sleep

	ISI Scores
Coffee	$r = 0.148$ $p = 0.025^*$
Tea	$r = 0.099$ $p = 0.137^*$
Cola/Acidic Beverage	$r = 0.080$ $p = 0.229^*$
Herbal Tea	$r = -0.045$ $p = 0.505^*$
Fruit Juice	$r = 0.015$ $p = 0.823^*$
Smoking	$r = -0.064$ $p = 0.334^*$
Alcohol	$r = 0.024$ $p = 0.716^*$
Chocolate	$r = 0.017$ $p = 0.794^*$
Yoghurt	$r = -0.014$ $p = 0.828^*$
Dessert	$r = 0.090$ $p = 0.176^*$
White Bread	$r = 0.032$ $p = 0.630^*$
Potato	$r = -0.053$ $p = 0.423^*$
White Rice	$r = -0.094$ $p = 0.157^*$

* Pearson korelasyon; ISI: Insomnia Severity Index

DISCUSSION

Characteristics of Adult Individuals and Their Insomnia Level

In the literature, it has been reported that the frequency of insomnia increases with age, and it has been emphasised that reasons such as increase in life expectancy, increase in chronic disease burden, changing lifestyle and uncertainty of urban life contribute to the spread of insomnia (Roy, Bhattacharjee, Chakraborti & Singh, 2015). The fact that no relationship was found between age and insomnia in our study can be explained by the fact that the mean age of the participants in the study (45.42 ± 17.74) was not high. In a similar study, the mean age of adults was found to be 46.5 ± 11.08 , and it was found that occupation and socioeconomic status were important determinants of insomnia, but similar to our study results, no statistically

significant relationship was found between age and insomnia (Kumari et al., 2018). It was emphasised that 1/3 or 2/3 of adults reported insomnia symptoms of any severity in outpatients (Bonnet & Arand, 2024). In our study, 36.1% of the individuals had mild insomnia and 7.9% had moderate or severe insomnia. In similar studies, the prevalence of insomnia was found to be 12.8%, and 15.4% (Kumari et al., 2018; Roy et al., 2015). In a study conducted with women with insomnia, the mean age of the individuals was 40.5 ± 10.2 years and 34.3% of the individuals had an ISI mean score above 21. In the same study, age, marital status, education level, depression/anxiety, psychological flexibility and beliefs about sleep were evaluated as potential factors associated with severe insomnia (El Rafihi-Ferreira et al., 2022). In our study, only 1.3% had severe insomnia. However, no relationship was found between socio-demographic characteristics and insomnia severity in our study. This may be related to the fact that many people in all segments of the society today, regardless of age, marital status, educational status and employment status, inadequately comply with sleep hygiene rules. In our study, it was observed that 14 out of 24 sleep hygiene rules were not followed by the majority.

In our study, only a weak relationship was found between insomnia and the presence of chronic disease, medication use, being stressed and skipping meals in terms of health-related characteristics of adult individuals. In studies with a similar theme, a significant relationship was found between insomnia and the presence of chronic disease (Kumari et al., 2018; Roy et al., 2015). The effect of stress on sleep was emphasised in the literature, and similar to our study results, a significant relationship was found between the presence of any type of stress and insomnia (Kumari et al., 2018). In a study with a similar theme, a moderate positive correlation was found between insomnia and stress level (Zulfakar et al., 2022). The literature generally reveals a dynamic and complex relationship between stress and sleep (Kalmbach, Anderson & Drake, 2018). Stress and sleep have been reported to be tightly linked. Various biological pathways of sleep disturbances can profoundly affect stress responses and ultimately quality of life. It is emphasized that even a few days of sleep deprivation or circadian mismatch can be enough to increase appetite, calorie intake, blood pressure, insulin and blood glucose. Sleep deprivation can alter the physiological neuroendocrine stress response by increasing sympathetic tone and cortisol levels (McEwen & Karatsoreos, 2015). It has been reported that chronic circadian disruption and reduced sleep duration can significantly increase the risk of developing cardiovascular and metabolic disorders (diabetes and obesity) (Lo Martire, Caruso, Palagini, Zoccoli & Bastianini, 2020; McEwen & Karatsoreos, 2015). For this reason, we think that it would be useful to plan training programs for the public about the short- and long-term problems that may be caused by the relationship between insomnia and stress.

Adult Compliance With Sleep Hygiene Rules

It was emphasised in the literature that it is difficult to objectively measure behaviours related to stimulus control, sleep hygiene and cognitive interventions (Matthews et al., 2013). In our study, the compliance status of individuals with sleep hygiene rules was determined by answering ‘yes or no’ to the questions about the realisation of sleep hygiene. It was observed that the participants complied with 14 of the 24-item sleep hygiene rules to a lesser extent.

In our study, the majority of the participants stated that they turn off the lights when going to bed, take care to get daylight during the day and avoid going to bed when they are very hungry. However, no correlation was found between following these rules and experiencing insomnia. Avoiding overeating before going to bed, stopping snacking two hours before going to bed and getting out of bed when waking up in the morning were found to be positively correlated with insomnia, albeit weakly. The relationship between skipping meals, meal content and sleep disorders is emphasised in the literature (Kim, DeRoo & Sandler, 2011). It has been reported that individuals with shorter sleep duration are more likely to skip meals (skipping breakfast) compared to those with optimum sleep duration (Kim et al., 2011). In another study, unlike our study findings, it was found that there was no statistically significant relationship between skipping meals and insomnia (Anderson, 2020). A study conducted with adult women revealed that increased snack consumption was associated with shorter sleep duration (Kim et al., 2011). These results are in parallel with our study results. While the literature suggests that consuming a meal just before bedtime may disrupt sleep parameters, it has been emphasized that the time between bedtime and meal consumption may increase certain sleep parameters depending on dietary content (Keser & Yüksel, 2024). Individuals with shorter sleep duration may be more likely to skip breakfast compared to those with optimal sleep duration (Kim et al., 2011). It is emphasized that more research is needed to fully explain the effect of various nutrients on sleep parameters (Keser & Yüksel, 2024). We also support this view.

A study found that the most common sleep hygiene habit practised by participants was to organise the bedroom environment to be suitable for sleep, while the least common practice was avoiding light as bedtime approached. According to the results of the same study, it was found that shift workers who had previously heard about the concept of sleep hygiene were more likely to participate in sleep hygiene practices and had better sleep quality (Rampling et al., 2022). In our study, no relationship was found between shift work and insomnia. It may be useful to share the positive results of compliance with sleep hygiene rules with individuals living in the community, to provide educational content on these rules through various methods in health centers and to add them to official health-related web pages.

In a study conducted with adolescents, it was found that there was a moderate relationship between sleep hygiene and sleep quality, and sleep hygiene components could be associated with sleep quality (Chehri, Shetabi, Khazaie & Zakiei, 2023). One study found that a significant relationship between the frequency of sleep problems and poor sleep hygiene practices. According to the results of the same study, the rate of sleep problems in the last 3 months was significantly higher in individuals with poor sleep hygiene interventions. The frequency of excessive/severe daytime sleepiness was significantly higher in adults with poor sleep hygiene habits (Alanazi et al., 2023). One of the behaviors associated with sleep quality is the use of electronic devices (Pham, Chuang, Kuo, Yeh & Liao, 2021). In a study with a similar theme, it was found that one of the risk factors associated with insomnia was the use of mobile devices before going to sleep (Metwally et al., 2023). Although there was no association between the use of electronic devices before going to sleep and insomnia in our study, most adults (60.4%) stated that they did not follow this rule. The use of electronic devices at inappropriate times may cause melatonin suppression due to short-wavelength light emitted from the screens of these devices, which may prolong the time for individuals to fall asleep and reduce total sleep time (Pham et al., 2021). Since this may affect sleep quality, we believe that restricting the use of electronic devices close to bedtime should be emphasized.

Nutritional Habits of Adults That May Affect Sleep

There are different views on the effect of nutrition on sleep in the literature. As a result of a recent study, it was emphasised that there is no evidence that specific diet or food intake has a direct effect on sleep (Netzer, Strohl & Pramsohler, 2024). In another study, it was emphasised that nutrition can have a significant impact on sleep health, and that nutrition can profoundly affect hormones and inflammation that contribute directly or indirectly to insomnia (M. Zhao, Tuo, Wang and L. Zhao, 2020). It has been reported that caffeine causes sleep delay, sleep efficiency and decreased time spent in deep sleep (Clark & Landolt, 2017). In our study, only coffee consumption (113.53 ± 142.37 ml daily) was correlated with insomnia. One study found that moderate doses of caffeine taken at least 6 hours before sleep had a significant effect on sleep disturbance (Drake, Roehrs, Shambroom & Roth, 2013). The result of a study showed that high caffeine consumption more than 2 days a week, especially before sleep, was highly associated with an increased risk of developing insomnia. Mean caffeine consumption was 176.6 ± 201 mg/day in the study on caffeine consumption and insomnia. It was found that sleep duration was inversely correlated with insomnia symptoms (Chaudhary, Grandner, Jackson & Chakravorty, 2016). According to the results of the same study, non-restorative sleep was

associated with the interaction between increased caffeine consumption and sleep duration (Chaudhary et al., 2016). A study with young adults found a statistically significant association between afternoon coffee consumption and sleep disturbance (Gianfredi et al., 2018). Our study results are in parallel with the literature. Since insomnia symptoms seen after caffeine consumption in healthy individuals may lead to a decrease in total sleep time, difficulty falling asleep, increased nocturnal awakenings and daytime sleepiness, it is important to conduct awareness studies to inform the public about the relationship between coffee consumption and insomnia.

CONCLUSION

According to our study results, 44% of adults scored 8 points or more on the ISI. Presence of chronic disease, medication use, skipping meals, stressful state and coffee consumption were found to be factors associated with insomnia. It was observed that adults' compliance with sleep hygiene rules was not at an adequate level. It is very important to increase the level of awareness of health professionals to evaluate both patients living in the community and hospitalised patients in terms of insomnia. Considering the relationship between insomnia and chronic diseases, it is important to support individuals to comply with sleep hygiene rules. The help of sleep hygiene should not be ignored in mild cases of insomnia and thus, progression of insomnia to severe levels should be prevented.

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THE RELATIONSHIP BETWEEN NURSING STUDENTS' PSYCHOLOGICAL WELL-BEING AND VIRTUAL ENVIRONMENT LONELINESS

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ABSTRACT

The aim of this study is to determine the relationship between psychological well-being and virtual environment loneliness of nursing students. This descriptive study was conducted between March and June 2023 at two state universities located in Northern and Eastern Anatolia, Türkiye. The research sample comprised 472 students. Data collection utilized a Personal Information Form, the Psychological Well-Being Scale, and the Virtual Environment Loneliness Scale. For data analysis, descriptive statistics, t-tests, ANOVA, and Bonferroni analyses were employed. A statistically significant moderate negative correlation was identified between students' psychological well-being and their levels of virtual environment loneliness ($p < 0.05$). The study also found that students experienced moderate levels of virtual environment loneliness. It was determined that as students' psychological well-being levels increase, they are likely to experience less loneliness in virtual environments. Therefore, in order to increase the psychological well-being levels of male nursing students, reduce their virtual environment loneliness, and ensure that they use social media less, it is recommended to create social activity environments that will increase their face-to-face communication both in the university environment and in social responsibility projects and to encourage and create opportunities for students to participate in these activities.

INTRODUCTION

The Internet, while a useful tool that offers significant advantages when utilized appropriately and constitutes a vital component of our daily lives, has given rise to a new area of concern regarding its excessive and inappropriate use. Such excessive and malicious utilization of the Internet is acknowledged as a significant factor contributing to the emergence of problematic Internet use (J. Jia, Tong, Zhang, Liu & Fang, 2021). Furthermore, as one of the environments where change and development are most pronounced within the daily life cycle, the Internet has facilitated the emergence of the concept of social media through its inherent transformations and advancements (Hattingh, Dhir, Ractham, Ferraris & Yahiaoui, 2022).

Social media is a platform where individuals share their personal stories and experiences in the form of words, images, and audio files. In other words, social media extends beyond

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merely allowing individuals to share their narratives; it is also one of the newest environments where institutions promote their products and advertisements, and where news spreads most rapidly (Waqas, Hamzah & Mohd Salleh, 2021). Today, social media has become a tool frequently used by young adults to publicly display every aspect of their private lives (Farsi, 2021). Research indicates that adolescents use social media more than adults, exhibit addictive behaviors, and that there is a strong relationship between excessive social media use and self-identity perception. Globally, Facebook, Instagram, and Twitter rank as the top three platforms, while there has been reported growth in users of Pinterest and Snapchat (Smith & Pearce-Dunbar, 2023).

One of the primary factors contributing to social media increasingly becoming a ritual in human life is the ability of individuals to meet their psychological needs (Uram & Skalski, 2022). Loneliness is an unpleasant condition that can be experienced multiple times throughout life and has been increasingly prevalent in societies due to various factors in recent years. It is a phenomenon that disturbs individuals psychosocially and warrants examination (Crowe, Liu, Bagnarol & Fried, 2024). Lonely individuals often join certain virtual social media groups to experience a sense of belonging, establish friendships, and enhance their social lives, seeking to be active. In these virtual environments, they can establish relationships more easily and comfortably, setting their own boundaries, and distancing themselves from social anxieties, thereby reducing the loneliness they encounter in real life (Şensoy & Kurttaş Çolak, 2020).

Visuals shared on social media can increase feelings of loneliness among individuals. Social media users can continuously post positive and engaging content. This situation leads individuals who are exposed to such posts to question their own lives and experience loneliness. The pursuit of relationships that are devoid of responsibility and seek fulfillment in virtual environments accelerates individuals' disconnection from the real world and their alienation from society (Erica, Pudjiati & Boediman, 2024).

Psychological well-being, unlike the absence of mental disorders, encompasses how individuals perceive themselves, their level of satisfaction with themselves, the presence of meaning and purpose in life, the relationships they establish with others, their satisfaction from these relationships, the challenges they face, and their coping strategies for these challenges (Kaya, Güç, Şimşek Kirlangiç & Uyar, 2022). Sustainable psychological well-being is not always a result of the individual being happy and peaceful. Therefore, negativity in an individual's life can negatively affect the level of psychological well-being (Kaplan & Öztürk, 2022).

Nurses, as one of the professions providing healthcare, play a vital role within the healthcare system. However, they frequently experience job-related stress, encounter psychological violence in the workplace, and face burnout and stress. Common causes of stress include challenging working conditions, fatigue, insomnia, uncertainties regarding their authority and responsibilities, and issues related to patients and their families (Guo, Ni, Liu, Li & Liu, 2019). These challenges, along with the accompanying stress, hinder nurses' ability to cope with their daily routines, resulting in decreased performance, negatively impacting their health, and increasing rates of attrition, injury, infection, and medical errors (Bozkurt Öz, Batmaz & Gezgin Yazici, 2022). It is crucial for nursing students preparing for the profession to maintain positive emotions throughout their educational process (Soerensen, Nielsen & Pihl, 2023).

Universities are environments where students can intensely experience interpersonal relationships. Nursing students, in particular, engage in significant relationships with a variety of individuals who have diverse needs and expectations (Di Mattio & Hudacek, 2020). It has been reported that nursing students face communication issues with patients, healthcare teams, and clinical educators during clinical practice, express a need for additional training, and fear independent practice, which adversely affects their psychological well-being (Heier et al., 2024).

Young people, in times when social life is most active, most complex, and full, start to study at a university in a period when their personalities are fully established and their new personalities are starting to be completed. Young people who cannot socialize in real life may experience isolation from real life as a result of socializing in virtual environments. It is stated that spending too much time on the internet and in virtual environments negatively affects both the academic success and psychology of nursing students. Transferring social relations and communications to virtual platforms through mass media not only creates a feeling of loneliness in individuals but also drags them into a process of virtual loneliness (Ceylantekin, Çevik Özdemir, Öcalan & Kılıç, 2024). This situation may also negatively affect the patient care practices of nursing students, who are future nurse candidates. However, nursing students are the group that will soon begin to provide care to both healthy and ill individuals as professional practitioners. Within a holistic approach, the psychological well-being of future nursing candidates is as important as the health of the individuals they will care for. It is anticipated that nursing students with high levels of psychological well-being will experience lower stress levels, create a positive communication environment while providing care to patients, have lower levels of loneliness, and exhibit reduced levels of problematic Internet use. In this study,

it was aimed to determine the relationship between psychological well-being and virtual environment loneliness of nursing students.

MATERIAL AND METHOD

Study Design

This descriptive study was conducted with students studying in nursing departments of state universities in Northern Anatolia and Eastern Türkiye between March and June 2023.

Research Population and Sample

The population of the study consisted of 1,300 students enrolled in nursing programs. The sample size was determined to be a minimum of 472 using the G-POWER program, with an effect size of 0.15, a power of 95%, and a margin of error of 0.5 (df=2; F=3.086). Nursing students who used the internet, aged 18 and older, who voluntarily participated in the research at the university where the study was conducted were included in the study. A total of 503 students (37% participated) who agreed to participate constituted the sample group.

Data Collection Tool

In the data collection process, a Demographic Information Form, the Psychological Well-Being Scale (PWBS), and the Virtual Environment Loneliness Scale (VELS) were utilized.

Demographic Information Form

This form, developed by the researchers through a literature review related to the topic, consists of 8 questions, including students' age, gender, academic year, and social media usage status (Hattingh et al., 2022; Kabaklı Çimen, 2018; Uram & Skalski, 2022).

Psychological Well-Being Scale

Developed by Diener and colleagues and adapted into Turkish by Telef, this scale is a Likert-type measure consisting of 8 items (1 = strongly disagree, 7 = strongly agree). The lowest possible score on the scale is 8, while the highest is 56, with higher scores indicating higher levels of psychological well-being. The factor loadings of the scale items range from 0.61 to 0.77. Cronbach's alpha coefficient for internal consistency is 0.87 (Telef, 2013). In our study, the Cronbach's alpha value for the scale was found to be 0.77.

Virtual Environment Loneliness Scale

This scale is used to determine individuals' levels of loneliness in virtual environments and the effects of these environments on individuals' feelings of isolation. The scale consists

of 20 items with a 5-point Likert format and includes 3 subdimensions: virtual socialization (8 items): (1.2.3.4.5.6.7.8), virtual sharing (7 items): (9.10.11.12.13.14.15), and virtual loneliness (5 items): (16.17.18.19.20). The scale is scored as 1.00-1.79 “very low”, 1.80-2.59 “low”, 2.60-3.39 “medium”, 3.40-4.19 “high”, 4.20-5.00 “very high”. The ratio of the total mean score of VELs to the number of items was calculated as $(49.74/20) = 2.48$. In this case, it was determined that the students' general virtual environment loneliness was at a medium level. Cronbach's alpha value calculated for the scale, developed by Korkmaz and colleagues in 2014 to assess individuals' levels of loneliness in virtual environments, is 0.81 (Korkmaz, Usta & Kurt, 2014). In our study, Cronbach's alpha value for the scale was found to be 0.80.

Data Collection

Data for the study was collected between March and June 2023 through face-to-face interviews in a classroom setting after the researchers explained the purpose and scope of the research to the students outside of their class hours. The data collection process took approximately 10 to 15 minutes.

Statistical Analysis

The data analysis was conducted using SPSS 25.0 (Statistical Package for the Social Sciences). Descriptive statistics, including percentages, means, and standard deviations, were utilized. The normality of the data distribution was assessed using Kurtosis and Skewness coefficients. Additionally, independent t-tests, one-way ANOVA, and post hoc analyses (Bonferroni) were employed. A significance level of $p < 0.05$ was accepted. Cohen (d) and Eta squared (η^2) coefficients were used to calculate the effect size. To estimate the minimum sample size, it was conducted a G*Power Analysis, with an effect size of 0.15, a power of 95%, and a margin of error of 0.5.

Ethical Approval

Prior to the commencement of the study, approval was obtained from the ethics committee of a state university in eastern Türkiye (Date: January 26, 2023, Reference No: B.30.2.ATA.0.01.00/91). Written consent was obtained from students who agreed to participate in the research. The study adhered to the principles outlined in the Declaration of Helsinki.

Limitations

The study is limited to students enrolled in the Nursing Departments of two Faculties of Health Sciences. This limitation restricts the generalizability of the findings.

RESULTS

It was determined that 95.2% of the participants were aged between 18 and 24, 63.4% were female, and 29.2% were in their second year of study. Furthermore, 99.4% reported using social media, 81.7% had been using social media for less than nine years, and 70.4% used social media for 2 to 6 hours daily. Additionally, 72.4% were connected to social media exclusively via mobile devices. The usage rates of various platforms among students were as follows: 98.4% used WhatsApp, 90.4% used YouTube, 84.8% used Instagram, 84.4% used Google, 54.8% used Twitter, 18.2% used Facebook, and 11.8% used Telegram (Table 1).

Table 1: Distribution of Students by Descriptive Characteristics (n=503)

Characteristics	n	%
Age group		
18-24 years	479	95.2
25-33 years	24	4.8
Gender		
Female	319	63.4
Male	184	36.6
Grade		
1 st grade	120	23.9
2 nd grade	147	29.2
3 rd grade	121	24.1
4 th grade	115	22.9
Social media usage status		
Uses	500	99.4
Does not use	3	0.6
Duration of social media use		
9 years and below	411	81.7
10 years and above	89	17.7
Daily duration of social media use		
1 hour and below	94	18.7
2-6 hours	354	70.4
7 hours and above	52	10.3
Type of device used for social media applications		
Desktop devices	136	27.0
Mobile devices	364	72.4
Social media applications used*		
WhatsApp	492	98.4
YouTube	452	90.4
Google	422	84.4
Instagram	424	84.8
Twitter	274	54.8
Facebook	91	18.2
Telegram	59	11.8
Snapchat	35	7.0
LinkedIn	33	6.6
Wattpad	6	1.2

* Due to the multiple response format, the counts (n) and percentages exceed the sample size.

The mean total score for psychological well-being among students was calculated to be 30.32 ± 7.02 . The mean total score for perceived loneliness in the virtual environment was

49.74 ± 12.23, while the mean score for virtual socialization was 21.11 ± 5.77, the mean score for virtual sharing was 14.92 ± 7.15, and the mean score for virtual loneliness was 13.70 ± 4.76 (Table 2).

Table 2: Mean Total Scores of the Psychological Well-Being and Virtual Environment Loneliness Scales (n=503)

	X ± SD	Min.	Max.
PWBS Total	30.32 ± 7.02	8.00	40.00
VELS Total	49.74 ± 12.23	26.00	100.00
Virtual Socialization Subscale	21.11 ± 5.77	8.00	40.00
Virtual Sharing Subscale	14.92 ± 7.15	7.00	35.00
Virtual Loneliness Subscale	13.70 ± 4.76	5.00	25.00

* Mean: Arithmetic Mean, X: Average, SD: Standard Deviation, Min: Minimum, Max: Maximum, PWBS: Psychological Well-Being Scale, VELS: Virtual Environment Loneliness Scale.

Students' Psychological Well-Being Scale (PWBS) scores showed a significant difference based on gender ($t=2.867$; $p=0.004$, $d=0.261$, $p<0.05$). Cohen (d) and Eta squared (η^2) coefficients were used to calculate the effect size. The effect size shows whether the difference between the groups is large enough to be considered significant (Büyüköztürk, Çokluk & Köklü, 2018). The mean total PWBS scores for females were higher than those of males. Additionally, Virtual Environment Loneliness Scale (VELS) scores also exhibited significant differences by gender ($t=-3.688$; $p<0.001$, $d=0.339$, $p<0.05$), with males scoring higher in VELS, virtual socialization, and virtual sharing compared to females (Table 3).

Table 3 indicates that students' PWBS scores significantly differed by class level ($F=5.709$; $p=0.001$; $\eta^2=0.033$, $p<0.05$) (η^2 =Eta squared). The observed difference was attributed to fourth-year students having higher PWBS scores than first- and second-year students.

The scores for VELS, as well as those for virtual socialization and virtual sharing, exhibited significant differences based on the duration of social media usage ($t=-3.574$; $p<0.001$; $d=0.401$, $p<0.05$). Participants who had used social media for 10 years or more had higher VELS total scores compared to those who had used it for 9 years or less. Significant differences were also found in virtual socialization scores based on the duration of social media use ($t=-4.582$; $p<0.001$; $d=0.508$), with individuals using social media for 10 years or more scoring higher than those using it for 9 years or less. Furthermore, virtual sharing scores showed significant differences according to the duration of social media usage ($t=-3.127$; $p=0.002$; $d=0.345$), with those using social media for 10 years or more having higher scores than those using it for 9 years or less ($p<0.05$).

Significant differences were found in total VELS scores, as well as in virtual socialization, virtual sharing, and virtual loneliness scores based on daily social media usage duration

($p < 0.05$). Total VELs scores differed significantly according to the type of device used to access social media ($t = 2.625$; $p = 0.009$; $d = 0.256$), with users of desktop devices scoring higher than those using mobile devices ($p < 0.05$). Similarly, significant differences were observed in virtual socialization scores based on the type of device ($t = 3.316$; $p < 0.001$; $d = 0.327$), again showing that desktop users had higher scores than mobile users ($p < 0.05$) (Table 3).

Table 3: Differentiation of Psychological Well-Being and Virtual Environment Loneliness Scale Scores by Descriptive Characteristics (n=503)

	PWBS X ± SD	VELS X ± SD	Virtual Socialization X ± SD	Virtual Sharing X ± SD	Virtual Loneliness X ± SD
Age group					
18-24 years	30.35±6.95	49.89±12.16	21.13±5.77	14.98±7.18	13.78±4.77
25-33 years	29.67±8.48	46.63±13.54	20.75±6.00	13.83±6.66	12.04±4.33
t=	0.467	1.278	0.316	0.765	1.754
p=	0.641	0.202	0.752	0.444	0.080
Gender					
Female	31.00±6.67	48.23±11.92	20.69±5.63	14.15±6.93	13.39±4.73
Male	29.15±7.46	52.35±12.36	21.85±5.95	16.27±7.35	14.23±4.76
t=	2.867	-3.688	-2.176	-3.238	-1.917
p=	0.004	0.000	0.030	0.001	0.056
Grade					
1 st grade	29.38±7.29	49.13±10.89	20.73±5.57	14.68±6.77	13.73±4.12
2 nd grade	29.33±6.83	50.33±11.25	21.37±5.57	15.21±7.07	13.75±4.93
3 rd grade	30.34±6.32	48.63±11.03	20.60±5.50	14.29±6.93	13.74±4.67
4 th grade	32.55±7.25	50.77±15.54	21.72±6.46	15.49±7.88	13.57±5.27
F=	5.709	0.809	1.022	0.681	0.040
p=	0.001	0.490	0.382	0.564	0.989
PostHoc	4>1, 4>2				
Social media usage status					
Uses	30.37±6.97	49.72±12.24	21.11±5.78	14.90±7.16	13.71±4.76
Does not use	22.67±13.28	52.33±13.28	21.33±5.51	19.00±4.36	12.00±3.61
t=	1.899	-0.368	-0.066	-0.990	0.621
p=	0.058	0.713	0.947	0.323	0.535
Duration of social media use					
9 years and below	30.29±6.84	48.82±11.81	20.57±5.49	14.44±6.88	13.81±4.65
10 years and above	30.73±7.56	53.88±13.35	23.61±6.44	17.03±8.05	13.24±5.24
t=	-0.544	-3.574	-4.582	-3.127	0.960
p=	0.587	0.000	0.000	0.002	0.339
Daily duration of social media use					
1 hour and below	29.77±7.69	46.72±12.56	18.43±5.41	13.41±6.78	14.88±5.31
2-6 hours	30.67±6.70	49.77±12.09	21.46±5.56	14.65±6.89	13.65±4.54
7 hours and above	29.37±7.32	54.83±11.09	23.58±6.27	19.27±8.08	11.98±4.73
F=	1.229	7.541	16.512	12.452	6.442
p=	0.294	0.001	0.000	0.000	0.002
PostHoc		3>1, 3>2	3>1, 3>2, 2>1	3>1, 3>2	3>1
Type of device used for social media applications					
Desktop devices	30.90±6.86	52.06±13.28	22.50±6.09	15.99±7.94	13.57±4.98
Mobile devices	30.17±7.01	48.85±11.73	20.59±5.58	14.49±6.82	13.76±4.69
t=	1.042	2.625	3.316	1.952	-4.12
p=	0.298	0.009	0.001	0.052	0.680

* t: Independent Samples t-test, F: ANOVA, PostHoc: Bonferroni, Mean: Arithmetic Mean, s: Standard Deviation, PWBS: Psychological Well-Being Scale, VELs: Virtual Environment Loneliness Scale.

A negative moderate correlation was identified between total PWBS and total VELs scores ($r=-0.038$, $p<0.05$). Additionally, a weak correlation was found between total PWBS and both virtual socialization and virtual sharing ($p<0.05$). Conversely, a positive moderate correlation was established between VELs and virtual socialization, virtual sharing, and virtual loneliness ($p<0.05$) (Table 4).

Table 4: Correlation Analysis of Psychological Well-Being and Virtual Environment Loneliness Scales (n=503)

		PWBS	VELS	Virtual Socialization	Virtual Sharing
VELS	r	-0.038	-		
	p	0.398			
Virtual Socialization	r	0.089*	0.766**	-	
	p	0.045	0.000		
Virtual Sharing	r	-0.142**	0.836**	0.519**	-
	p	0.001	0.000	0.000	
Virtual Loneliness	r	0.008	0.386**	-0.025	0.015
	p	0.854	0.000	0.571	0.739

* $p<0.05$; ** $p<0.01$; r: Pearson Correlation Analysis, PWBS: Psychological Well-Being Scale, VELs: Virtual Environment Loneliness Scale.

DISCUSSION

In this section, the findings obtained in determining the relationship between the psychological well-being of university nursing students and virtual environment loneliness are discussed in light of the literature.

The results indicated that the overall psychological well-being score of the students was at a moderate level. A literature review revealed that a study conducted by Zhao in China with 318 nursing students reported similar results regarding the total psychological well-being score (Zhao, 2023). In a study involving 330 nursing students in Türkiye, similar findings were noted, emphasizing the significance of the relationship between psychological well-being scores and levels of anxiety and depression (Yüksel & Bahadır-Yılmaz, 2019). Another study conducted in Australia with 498 participants also found that the total psychological well-being score was at a moderate level (Foster, Roche, Giandinoto & Furness, 2020). In a 2022 study in Jordan, nursing students reported experiencing high levels of psychological distress while indicating that their psychological well-being was at a moderate level. These students suggested that their distress negatively affected their mental health (AL-Sagarat et al., 2022). The clinical practice stress experienced during nursing education, along with the pursuit of professionalism in preparing for the nursing profession, adversely impacts students' psychological states and contributes to increased levels of anxiety.

The study found that the total psychological well-being score of female students was higher than that of male students. Similar results have been reported in studies conducted in

Thailand, Trkiye, and Spain (Ergl Topu, Yasak, Kalafat & Altinoęlu Dikmeer, 2021; Matud, Lpez-Curbelo & Fortes, 2019; Tangmunkongvorakul et al., 2019). According to the results of this study, it can be said that the fact that female students have lower virtual loneliness scores than male students is effective in female students having better psychological well-being. It is thought that being able to communicate face-to-face increases psychological well-being scores. In addition, it suggests that males may prefer face-to-face communication instead of virtual environment friendship.

The study determined that the psychological well-being levels of fourth-year students were higher than those of lower-class students. Similar findings were reported in a study involving 171 nursing students in Trkiye (Tekir, 2022). The university environment is considered a period during which students adapt to both their professional and academic lives, as well as to interpersonal relationships with society and themselves (Prieto et al., 2021). During the initial transition to university, students often have to alter some of their routines. Adjusting to living in a different city, distancing from family, and changing social circles are all situations that require adaptation. The higher psychological well-being levels among fourth-year students may be attributed to their successful navigation of this adaptation process.

The study found that students also experienced moderate levels of virtual environment loneliness, indicating that while it was not severe, they were indeed experiencing some degree of loneliness. Research in the literature supports the notion that students generally experience moderate levels of virtual environment loneliness (Kabaklı imen, 2018; zsat, İřiktař & řenol, 2022; Turan et al., 2020). In another study conducted in Trkiye, it was found that a sample group of 354 individuals, including university students, teachers, and academic staff, also reported moderate levels of virtual environment loneliness (Usta, Korkmaz & Kurt, 2014). A study conducted in China in 2023 with 459 participants indicated that individuals have begun to shift from real social lives to virtual social activities. The authors noted that, contrary to expectations in combating this loneliness, the likelihood of experiencing cyberbullying in online environments may increase (Tian & Wang, 2023). In line with this information, we can say that our study findings support the literature.

It was found that the virtual environment loneliness scores of male students were significantly higher than those of female students. Similar results have been reported in two different studies involving 328 and 280 students, which indicated that male students were more likely than female students to engage in sharing and forming friendships in virtual environments (Kabaklı imen, 2018; Kenyon, Kinakh & Harrison, 2023; zdemir, Akakanat & İzgden, 2017). With this finding, it can be said that male students use virtual chat environments more

than female students, make more online friends, spend more time with their online friends and share their problems, and are in a sense more addicted to virtual friendships.

The study also revealed that individuals who used social media for longer periods reported higher scores of virtual environment loneliness. Studies in the literature corroborate these findings (W. Jia, Liu & Peng, 2024; Jiang, Li & Shypenka, 2018; Sönmez, Gürlek Kısacık & Eraydın, 2021). As students' duration of social media use increases, their virtual socialization and sharing also rise, resulting in higher scores of virtual environment loneliness. Thus, the study's results align with existing literature.

Although mobile devices were the most preferred type of device for accessing social media, students using desktop devices reported higher virtual environment loneliness scores. A similar result was found in a study conducted in the United States in 2023 with a sample of 2,005 students (Voss, Shorter, Mueller-Coyne & Turner, 2023). It is of course important that mobile devices, which have quite advanced hardware today, have the ease of connecting to social media sites. In our study, it was seen that the students' ages were between 18-24 and that the virtual environment loneliness scores of students in this age range were higher (49.89 ± 12.16). It is thought that these students prefer devices because they want to feel safe.

It was found that there is a significant moderate negative correlation between students' psychological well-being levels and their levels of virtual environment loneliness. It is suggested that as students' psychological well-being levels increase, they are likely to feel less loneliness in virtual environments. This finding aligns with results from the literature. In a study conducted in Türkiye in 2020, it was determined that as the levels of social media use increased among 325 participants, their levels of virtual environment loneliness also rose, leading to a decrease in psychological well-being (Şensoy & Kurttaş Çolak, 2020). In another study, nursing students who used social networking sites to alleviate their loneliness, create social environments, and make new friends reported higher levels of psychological well-being compared to those who did not use such platforms. The same study noted the growing popularity of social networking sites, particularly among young people, and the considerable amount of time they spend online (Turan et al., 2020). This result can be explained by the fact that students with increased psychological well-being levels spend less time on social media and thus their loneliness in virtual environments decreases.

In a study conducted in Australia in 2021, it was highlighted that humans, as social beings, seek both happiness and pleasure while attempting to alleviate their unhappiness and loneliness in virtual environments. It was emphasized that fulfilling these needs could enhance individuals' psychological well-being; however, improper use of virtual environments might

lead to psychological distress, underscoring the need for caution (Graciyal & Viswam, 2021). Indeed, a study conducted with nursing students indicated that those who spent extended periods in virtual environments experienced negative effects on their academic performance, resulting in a decline in their success at school (Pınar Bölüktaş, 2022).

In a different study conducted in 2022 with 379 university students, it was reported that when students faced social anxiety, difficulties in real life, or situations where they felt pressure, they experienced feelings of loneliness and turned to virtual environments to alleviate those feelings. The same study noted that while students spending long periods in virtual environments might find temporary relief psychologically, their loneliness could increase in the long term without conscious use (Özsat et al., 2022). In a study involving medical students, it was suggested that individuals with submissive personalities felt lonely and preferred to spend time in virtual environments to alleviate that loneliness and achieve happiness (Wongpakaran, Wongpakaran, Pinyopornpanish, Simcharoen & Kuntawong, 2021). A literature review of a study conducted in Australia in 2023 found that participants experiencing loneliness derived considerable enjoyment from spending time in virtual environments and reported feeling better psychologically (Oppert et al., 2023). The results of our study are consistent with the findings in the literature.

CONCLUSION

In this study, the relationship between the psychological well-being of nursing students and virtual environment loneliness was examined. In the study, it was determined that both the psychological well-being and virtual environment loneliness levels of the students were at a moderate level. In addition, a significant, moderate negative relationship was found between the psychological well-being levels of the students and the virtual environment loneliness levels. At the same time, it was concluded that the total psychological well-being score of female students was higher than that of male students, and the psychological well-being levels of fourth-year students were higher than that of lower-year students. It was also determined that male students, students who used social media for a long time and preferred to access social media via desktop devices had higher virtual environment loneliness scores.

Therefore, in order to increase the psychological well-being levels of male nursing students, reduce their virtual environment loneliness, and ensure that they use social media less, it is recommended to create social activity environments that will increase face-to-face communication both in the university environment and in social responsibility projects and to encourage and create opportunities for students to participate in these activities. It is also

recommended that advisor faculty members prepare projects that can support their students in order to support their psychological well-being before they reach their final year.

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A COMPARATIVE STUDY OF UNET VARIANTS FOR LOW-GRADE GLIOMA SEGMENTATION IN MAGNETIC RESONANCE IMAGING

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ABSTRACT

Brain tumors originating from glial cells are pathological entities that significantly impact quality of life and are classified based on their malignancy into low-grade gliomas (LGGs) and high-grade gliomas (HGGs). While the more aggressive HGGs have been extensively studied, LGGs are of critical importance for early diagnosis due to their potential progression to HGGs if left untreated. This has driven researchers to develop methods for the rapid and consistent diagnosis of LGGs. In this study, three models—UNet, Transformer UNet, and Super Vision UNet—were comparatively evaluated for the automatic segmentation of LGGs using magnetic resonance imaging (MRI) data. Multimodal MRI scans from 110 patients, retrieved from The Cancer Imaging Archive (TCIA), were used to train the models. Performance was evaluated using Dice Coefficient, Tversky Index, and Intersection over Union (IoU) metrics. The Super Vision UNet achieves the highest Dice (0.9115) and Tversky (0.9154) scores, while the Transformer UNet attains the highest IoU (0.8789). Both advanced models demonstrate superior segmentation performance with lower loss values compared to the conventional UNet. Visual outputs indicate that the modern architectures delineate tumor contours with greater precision. These results highlight the effectiveness and reliability of contemporary UNet-based and Transformer-based architectures in segmenting complex tumor structures such as LGGs. Integrating these models into clinical decision support systems holds promise for enhancing the speed and accuracy of the diagnostic process.

INTRODUCTION

Brain tumors are abnormal growths that can seriously affect the central nervous system and significantly reduce a patient's quality of life (Ostrom et al., 2014). These tumors are typically categorized into two main types: low-grade gliomas (LGGs) and high-grade gliomas (HGGs). Gliomas, which arise from glial cells, constitute the most frequently occurring brain tumors. Based on their growth rate and level of malignancy, gliomas are divided into different grades. According to the World Health Organization (WHO) classification, they are categorized into four grades, from Grade I to Grade IV (Louis et al., 2016).

Among them, glioblastomas (Grade IV), which are a type of HGG, are the most aggressive and have the lowest survival rates (Sanai & Berger, 2008). Because of this, most

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research and funding have focused on HGGs, while LGGs have received less attention (Van Dijken, Van Laar, Holtman, & Van Der Hoorn, 2017). However, LGGs can slowly grow and spread into surrounding brain tissue. If not treated early, they may develop into HGGs, which makes them more dangerous over time (Ostrom et al., 2014). This highlights the need for more research on the diagnosis and treatment of LGGs.

Features such as the tumor's size, shape, grade, and location are very important for deciding on the right treatment (Ostrom et al., 2014). One of the first steps in diagnosing a brain tumor is medical imaging, especially Magnetic Resonance Imaging (MRI) (Van Dijken et al., 2017). MRI is a non-invasive method that provides detailed images of the brain and is widely used to detect brain tumors (Ghadimi et al., 2025).

A critical part of analyzing MRI scans is the segmentation process. Segmentation means identifying and outlining the tumor area in the image. This helps doctors understand where the tumor is and how big it is, which is useful for diagnosis and treatment planning (Verma, Shivhare, Singh, Kumar, & Nayyar, 2024). Although manual segmentation by experts is still considered the most reliable method, it takes a lot of time, requires expertise, and may vary between observers. To address these challenges, researchers have increasingly focused on developing automated segmentation systems.

In recent years, deep learning methods—especially models based on UNet and transformer architectures—have demonstrated remarkable performance in medical image analysis and segmentation. These technologies allow for fast and accurate tumor detection. In this study, we test the performance of UNet and its variants in segmenting LGGs from brain MRI images.

The remainder of this paper is structured as follows. The next section presents a review of related work in the field of brain tumor segmentation using deep learning. This is followed by a detailed description of the materials and methods used, including the datasets, preprocessing steps, model architectures, and evaluation metrics. Subsequently, the experimental results and their discussion are provided, highlighting the models' performance across the test dataset. Finally, the paper concludes with a summary of the findings and potential directions for future research.

Related Works

This section presents previous studies focused on the segmentation of low-grade gliomas (LGGs). Naser and Deen (2020) developed a deep learning-based approach for segmenting brain tumors and grading LGGs using magnetic resonance imaging (MRI). In their study, a

UNet-based convolutional neural network (CNN) was used for tumor segmentation, while a VGG16-based transfer learning model was employed for tumor grading. The segmentation model was trained on a dataset consisting of T1-precontrast, FLAIR, and T1-postcontrast MRI scans from 110 patients, achieving a Dice Similarity Coefficient (DSC) of 84%.

Lefkovits, Lefkovits, and Szilágyi (2022) developed a CNN-based system for the segmentation of both high-grade (HGG) and low-grade gliomas (LGG) using the Amazon SageMaker platform. Six different CNN models were trained on BraTS 2017–2020 datasets, and the best-performing model was selected through hyperparameter optimization. Furthermore, an ensemble model was created based on the weighted average of these models to improve the accuracy of tumor boundary detection. The results were compared with the Dice scores from the BraTS 2020 challenge, and the proposed method ranked within the top 25%.

Shomirov, Zhang, and Billah (2022) addressed the class imbalance problem in tumor segmentation by introducing a 3D UNet model with a Weighted Focal Loss (WFL) function. Designed for both HGG and LGG segmentation, the model was tested on the BraTS 2019 and 2020 datasets. It demonstrated high accuracy in segmenting tumor core (TC), whole tumor (WT), and enhancing tumor (ET) regions.

BabaAhmadi and FallahPour (2023) conducted a comparative study on three models for LGG segmentation: DeepLabV3+, UNet, and a novel Transformer-based approach. Their findings showed that the MobileNetV3-based DeepLabV3+ model achieved the best overall performance. However, the Transformer-based model demonstrated superior segmentation accuracy, memory efficiency, and adaptability to different image sizes. Additionally, transfer learning techniques were applied to further improve the models' performance.

Similarly, Wan et al. (2023) proposed a segmentation model based on DeepLabV3+ and RegNet, which incorporated not only MRI scans but also patients' genetic data and clinical information for a more comprehensive analysis. The model included a novel loss function called outlier-region loss, designed to reduce the influence of small, misclassified areas. Experiments on the Lower-Grade Glioma (LGG) Segmentation dataset yielded a Dice score of 94.36% and an Intersection over Union (IoU) score of 91.83%, outperforming several existing methods.

Dattangire, Biradar, and Joon (2024) proposed a UNet-based AI-assisted model for LGG segmentation. Aiming to address the challenges of manual segmentation caused by the heterogeneous nature of tumors, their model was designed to support radiologists through automated segmentation. Trained on the BraTS dataset, the model was evaluated using accuracy, Dice score, and IoU metrics, and the results indicated that it could be effectively integrated into clinical decision support systems.

Bentaher et al. (2025) present R2A-UNET, a deep learning model for accurate glioma segmentation in medical images. By integrating residual blocks with channel and spatial attention mechanisms (NCA and NSA), the model enhances feature extraction and focuses on relevant regions. It achieved high DSC and IoU scores on both the LGG and BraTS 2018 datasets, and demonstrated strong cross-dataset generalizability. Grad-CAM visualizations and Wilcoxon ranksum tests further validated its clinical potential.

MATERIAL AND METHOD

The Dataset

The dataset utilized in this research was sourced from The Cancer Imaging Archive (TCIA) and consists of clinical and imaging data from 110 patients diagnosed with low-grade gliomas (LGGs) (Pedano et al., 2016). The patients were collected from five different medical institutions. Among them, 50 were classified as Grade II, 58 as Grade III, while 2 patients had unknown tumor grades and 1 had an unspecified tumor subtype. The tumors were categorized into three subtypes: Astrocytoma, Oligoastrocytoma, and Oligodendroglioma. The distribution of these tumor types is shown in Table 1.

Preoperative imaging data include three MRI sequences: non-contrast-enhanced T1-weighted (T1), FLAIR, and contrast-enhanced T1-weighted (T1CE) images. Each patient has between 20 and 88 slices, each with a resolution of 256×256 pixels. A total of 3,929 images were used, comprising 1,373 images containing tumors and 2,556 without visible tumor regions. Figure 1 presents sample slices from five patients in the dataset. These include the non-contrast T1, FLAIR, and contrast-enhanced T1 sequences. To aid interpretation, Figure 1 also shows a merged visualization of the three modalities, a FLAIR image with a hot colormap for improved contrast, and the tumor region overlaid on the merged image.

Segmentation masks were manually annotated by Buda et al. (2019) based on FLAIR images. These annotations are publicly available in TIF format along with the corresponding MRI scans. Each sample in the dataset consists of a three-channel image, where the channels represent the non-contrast T1, FLAIR, and contrast-enhanced T1 sequences. In cases where imaging data were incomplete (six patients missing T1 and nine missing T1CE images), the missing channels were filled using available FLAIR scans to ensure data consistency.

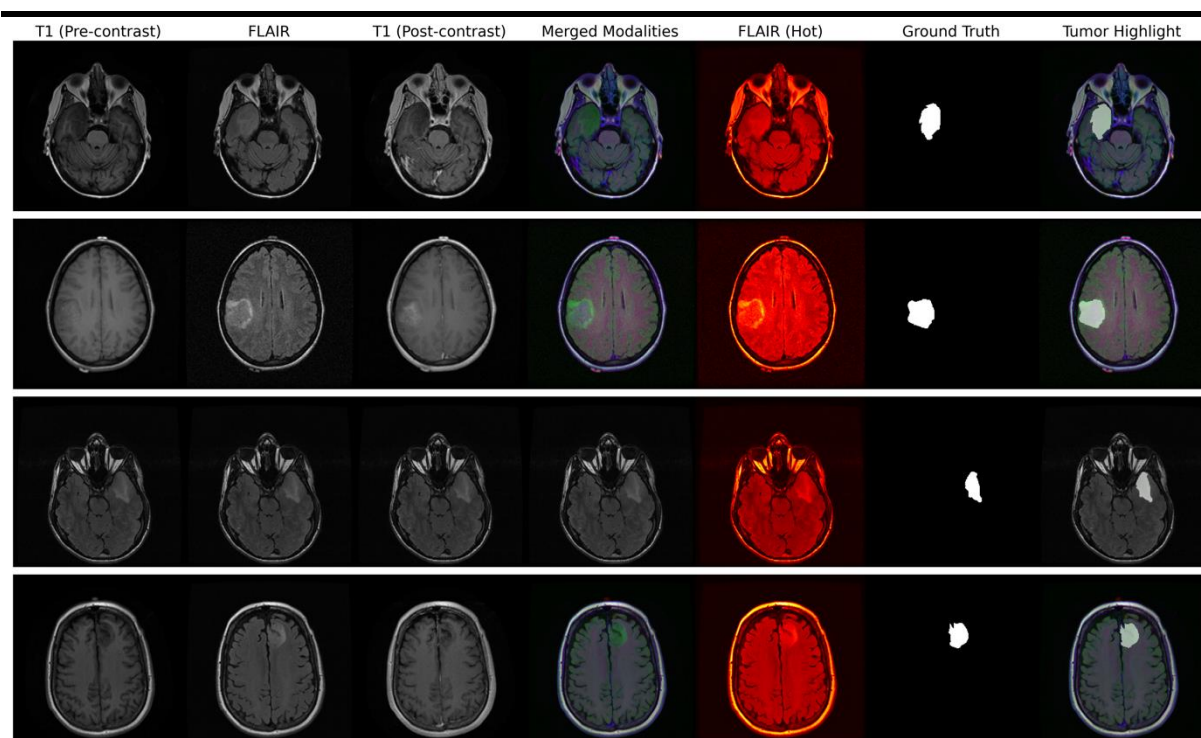


Figure 1. Visualization of multimodal brain MRI scans from five patients diagnosed with low-grade glioma. Each row represents a different patient. The columns show: (1) T1-weighted (pre-contrast), (2) FLAIR, (3) T1-weighted (post-contrast), (4) a merged visualization of the three modalities, (5) FLAIR with a hot colormap for enhanced contrast, (6) the ground truth tumor mask, and (7) the tumor region overlaid on the merged image.

Table 1. Distribution of Tumor Grades and Subtypes in Low-Grade Glioma (LGG) Cohort

	Grade II	Grade III	Unknown
Tumor sub-types			
Astrocytoma	8	26	-
Oligoastrocytoma	14	14	1
Oligodendroglioma	28	18	-
Unknown	-	-	1
Total	50	58	2

To minimize bias and enhance the reliability of model evaluation, the dataset was randomly partitioned at the patient level into three distinct subsets: training, validation, and testing. Specifically, 70% of the patients (77 patients) were assigned to the training set, 15% (16 patients) to the validation set, and 15% (17 patients) to the test set. As a result, the training set contains 2,738 images, the validation set includes 579 images, and the test set comprises 612 images. Dividing the dataset by patient ensures that images from the same individual are not split across different subsets, thereby allowing a more accurate assessment of the model's generalization performance. Prior to model training, min-max normalization was applied to all images to scale pixel intensity values to the [0, 1] range. This preprocessing step helps improve numerical stability during training and ensures that the input data is standardized across all subsets.

The Deep Learning Models Used

In this study, three state-of-the-art deep learning models commonly employed for semantic segmentation tasks were utilized: UNet (Ronneberger, Fischer, & Brox, 2015), Supervision UNet (Le'Clerc Arrastia et al., 2021), and Transformer UNet (Petit et al., 2021). The models were developed using Python (v3.10) and the TensorFlow framework (v2.11) for deep learning. Among these, the architecture of the Supervision UNet model, which achieved the lowest loss value during training, is illustrated in Figure 2.

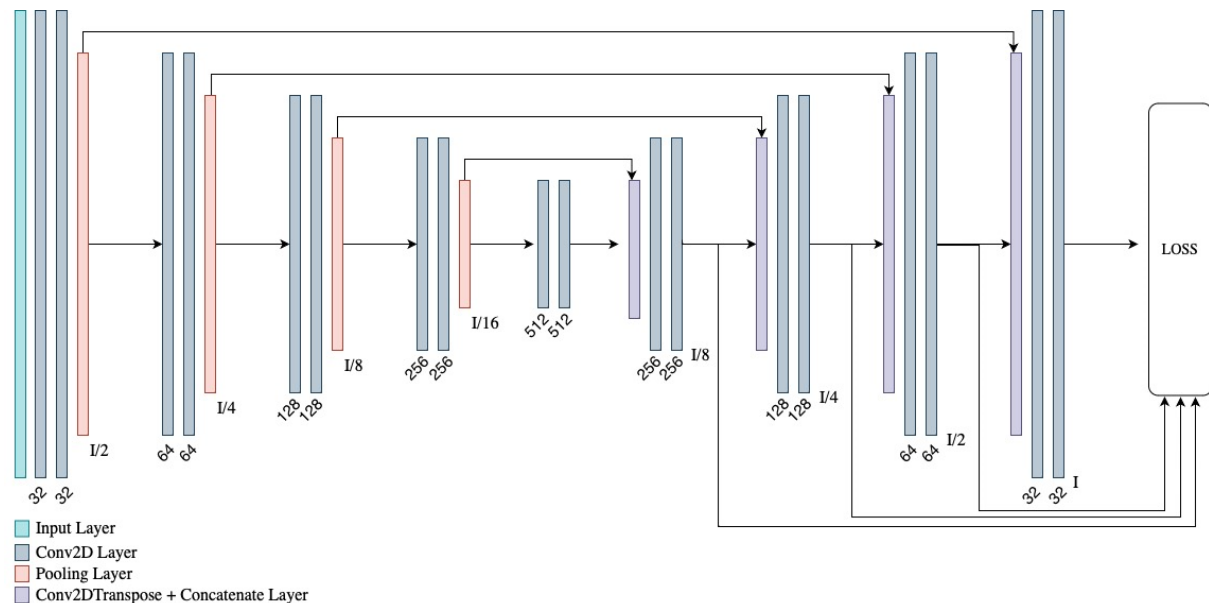


Figure 2. The architecture of Super Vision UNet

To effectively train the models, several data augmentation techniques were applied during preprocessing. Specifically, standard augmentation methods such as random rotations and horizontal flips were utilized. These data augmentation techniques were applied exclusively to the training dataset in order to increase data diversity, improve model performance, prevent overfitting, and enhance generalization ability. In the context of segmentation tasks, all transformations were synchronously applied to both the input images and their corresponding ground truth masks to preserve spatial consistency. These augmentations were implemented on-the-fly during training, meaning that each epoch was exposed to slightly different versions of the original training images. Although the total number of stored images remained unchanged, the effective size and variability of the dataset were significantly increased through dynamic augmentation. In addition, hyperparameter optimization was carried out to fine-tune critical parameters that are not learned during training but significantly influence performance, such as learning rate and batch size. A grid search strategy was adopted for hyperparameter optimization. Specifically, batch sizes of 2, 4, and 8, loss functions including Binary Cross

Entropy (BCE) and Dice Loss (Milletari, Navab, & Ahmadi, 2016), and learning rates of 1×10^{-2} , 1×10^{-3} and 1×10^{-4} were tested. The optimal combinations were selected based on the models' performance on the validation set. In all models, the number of training epochs was set to 150, and an early stopping mechanism with a patience value of 15 was employed. This configuration was designed to ensure a balanced and effective training process, maximizing both model accuracy and generalization capacity.

Evaluation Metrics

To assess the performance of the segmentation models proposed in this research, three widely used metrics from the literature were employed: the Tversky Index (Tversky, 1977), Intersection over Union (IoU) (also known as the Jaccard Index) (Jaccard, 1912), and the Dice Coefficient (Milletari et al., 2016).

The Tversky Index is a similarity measure between the predicted and ground truth regions, commonly used in segmentation tasks. It can be considered a generalization of both the Dice and Jaccard indices. What makes the Tversky Index particularly valuable is its flexibility in handling imbalanced class distributions. By introducing the parameters α and β , it allows different weights to be assigned to false positives (FP) and false negatives (FN), making it especially effective in medical imaging applications where class imbalance is a common challenge. The Tversky Index is defined mathematically as shown in Equation (1):

$$Tversky\ Index = \frac{TP}{TP + \alpha \cdot FP + \beta \cdot FN} \quad (1)$$

where TP (True Positives) refers to pixels correctly predicted as part of the tumor, FP (False Positives) are pixels incorrectly predicted as tumor, and FN (False Negatives) are actual tumor pixels missed by the model. α and β are hyperparameters that balance the penalties for FP and FN, respectively.

The Dice Coefficient, shown in Equation (2), offers a harmonic balance between precision and recall, providing a comprehensive evaluation of segmentation quality. It is especially effective when measuring overlap between predicted and actual tumor regions.

$$Dice\ Coeff = \frac{2 \cdot TP}{2 \cdot TP + FP + FN} \quad (2)$$

The Intersection over Union (IoU) metric, which directly measures segmentation accuracy, quantifies the overlap between the predicted region and the ground truth region. It is calculated using Equation (3):

$$IoU = \frac{TP}{TP + FP + FN} \quad (3)$$

By combining these three metrics, the segmentation performance of each model can be assessed comprehensively, considering not only overall accuracy but also sensitivity to class imbalance and boundary precision.

RESULTS AND DISCUSSION

The test set performance of the models is presented in Table 2, and the hyperparameters that contributed to these results are shown in Table 3. Additionally, example segmentation outputs for visual comparison are provided in Figure 3. As indicated in Table 2, segmentation performance was significantly improved by the Transformer UNet and Super Vision UNet, relative to the baseline UNet model across all major evaluation metrics. These models achieved lower loss values while improving the Dice Coefficient, Tversky Index, and IoU scores.

Specifically, Super Vision UNet achieved the highest scores in Dice Coefficient (0.9115) and Tversky Index (0.9154), whereas Transformer UNet reached the best performance in IoU (0.8789). These metrics are key indicators of segmentation quality, as they reflect how accurately the model delineates tumor boundaries and how strongly the predicted tumor region overlaps with the ground truth.

Table 2. Performance of Deep Learning Models on the Test Dataset

Models	Loss	Tversky Index	Dice Coeff	IoU
Transformer UNet	0.1364	0.9091	0.9073	0.8789
Super Vision UNet	0.0934	0.9154	0.9115	0.8777
UNet	0.1346	0.8663	0.8654	0.8341

Table 3. Optimally Tuned Hyperparameters of the Deep Learning Models

Models	Batch Size	Loss Functions	Learning Rate
Transformer UNet	4	Dice Loss	1×10^{-4}
Super Vision UNet	8	Dice Loss	1×10^{-4}
UNet	8	Dice Loss	1×10^{-3}

An analysis of the hyperparameter settings (Table 3) shows that models trained using Dice Loss outperformed those trained with alternative loss functions such as Binary Cross Entropy (BCE). This suggests that Dice Loss provides a more effective learning process for medical segmentation tasks involving class imbalance, such as distinguishing between tumor and healthy tissue in MRI scans, thus enhancing segmentation performance.

Figure 3 displays example segmentation results from selected image slices. A visual examination reveals that both Transformer UNet and Super Vision UNet consistently generate segmentation masks that are closely aligned with the ground truth, particularly in terms of boundary fidelity and completeness of tumor regions. Notably, these models were able to

capture finer details at the tumor margins and reduce under- and over-segmentation issues. Super Vision UNet, in particular, appears to better delineate subtle tumor edges, which may contribute to its superior Dice Coeff performance. On the other hand, the UNet model occasionally exhibits under-segmentation (missing parts of the tumor) or boundary inaccuracies, especially in more complex or infiltrative cases, as seen in the third and eighth columns of Figure 3.

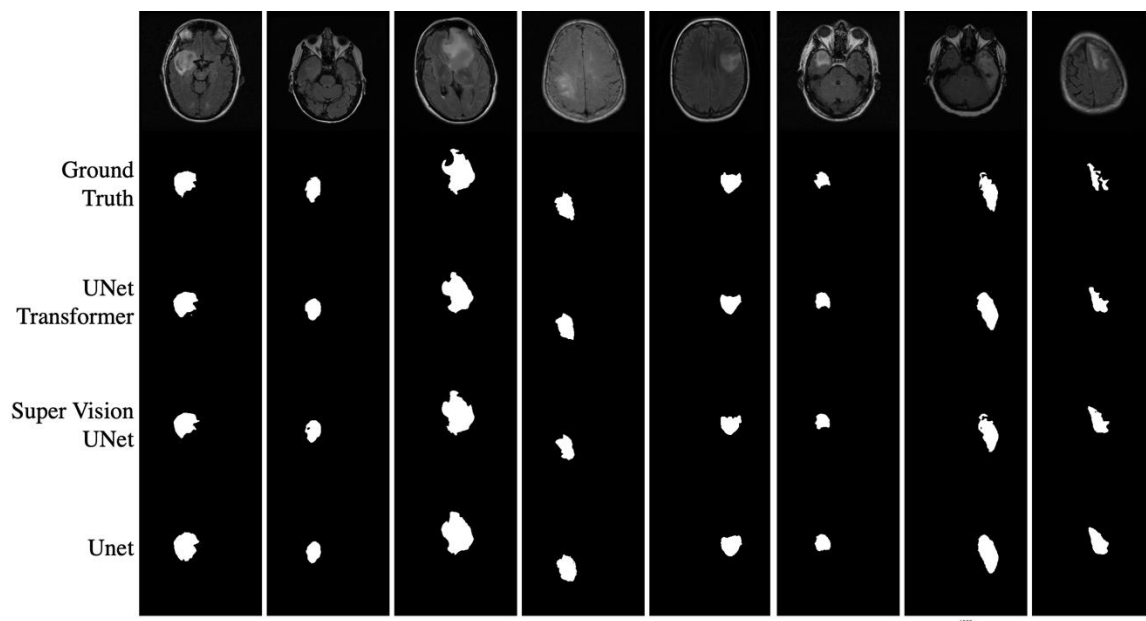


Figure 3. Sample prediction results from the models

Previous studies in the literature (e.g., Naser & Deen, 2020; Lefkovits et al., 2022) have also demonstrated the effectiveness of deep learning models in brain tumor segmentation, while emphasizing that architectural modifications can further enhance accuracy. The findings from this study reinforce the idea that modern variants of UNet, such as Transformer UNet and Super Vision UNet, have significant potential for more precise boundary delineation, particularly in LGGs, which often exhibit infiltrative and heterogeneous characteristics. Additionally, the use of Dice Loss, which is more sensitive to class imbalance, appears to be a critical factor in achieving higher model performance. This loss function's alignment with the structure of medical imaging data helps the models better distinguish between tumor and non-tumor regions.

In summary, both the quantitative results (Tables 2 and 3) and qualitative visual assessments (Figure 3) indicate that Transformer UNet and Super Vision UNet outperform the traditional UNet in LGG segmentation. The comparable performance of these two models suggests that both are strong candidates for deep learning-based medical image segmentation tasks.

CONCLUSION

In this study, three different deep learning models—Transformer UNet, Super Vision UNet, and the conventional UNet—were evaluated for the task of low-grade glioma (LGG) segmentation in brain MRI images. The results indicate that enhanced UNet-based approaches and Transformer-based architectures achieved higher Tversky Index, Dice Coefficient, and IoU scores compared to the traditional UNet, thus delivering more accurate segmentation performance. Furthermore, the segmentation masks produced by these models closely reflect the actual tumor boundaries, highlighting the strong potential of deep learning models in medical image analysis.

Accurate and efficient segmentation is especially critical in the case of LGGs, which, although classified as low-grade, possess an infiltrative nature. Reliable segmentation can significantly support clinical decision-making processes. The automatic segmentation capabilities offered by these models may help reduce the workload of radiologists and neurosurgeons while minimizing subjective errors.

Future studies may focus on further improving these models by training them on larger and more diverse datasets and evaluating their effectiveness across different tumor grades. Additionally, integrating multimodal data, such as genomic and clinical information, into deep learning frameworks could enhance the precision and utility of such systems, offering more comprehensive support in the diagnosis and management of gliomas.

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IMPACT OF HEAVY METALS ON THE ENVIRONMENT AND HUMAN BODY

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ABSTRACT

In the past decades, now and in the future, the issue of food security and the harmful effects of volatile contaminants on food quality, agriculture, human health, the environment, food security, and spoilage are critical issues. As technology has evolved, heavy metals have found their way into drinking water. Heavy metals cause soil contamination problems in artificial areas used for agriculture. When it comes to environmental toxins, heavy metals top the list. Even at the lowest concentrations, several of them can cause cancer and other diseases as well as autoimmune disorders. One of the major sources of water pollution by heavy metals is the decomposition and combustion of fossil fuels, exhaust fumes from vehicles, mining, agriculture, decomposition, and incineration of solid and liquid wastes. Heavy metals also occur naturally from natural events due to the toxicity of the heaviest metals to both humans and aquatic life, this pollution of the water poses a threat to all living creatures. They have many negative effects on various organisms, including plants, animals, and humans themselves, many other variables may intervene, such as lifestyle and dietary habits, levels of exposure to metals and age, gender, smoking, and mutation of ancestry. In this review, we intend to introduce further heavy substances that affect the human body in many ways.

INTRODUCTION

Metals have more technological applications whether freestanding or alloy and composite (Balci, Dagdelen, Mohammed & Ercan, 2022; Dagdelen et al., 2020; Kök et al., 2020; Kok, Qadir, Mohammed & Qader, 2022; Mohammed, Kök, Qader & Coşkun, 2021; Mohammed, Qadir, Kök & Qader, 2021; Mohammed, Balci, Dagdelen & Saydam, 2022; Mohammed et al., 2022; Mohammed et al., 2020; Mohammed, Kök, Qader & Qadir, 2022; Mohammed, Kök, Qader & Dagdelen, 2019; Mohammed Safar Saeed et al., 2020; Mohammed, Mohammed & Balci, 2023; Mohammed, Özen Öner, Ateş, Kanca & Kök, 2024; Mohammed, Qadir, Hassan, Mohammedamin & Ahmed, 2023; Qader, Mohammed & Dagdelen, 2022; Qader et al., 2021). The phrase “heavy metals” often refers to a class of metals and metalloids (semi-metals), along with the pollution they are often exposed to, causing ecological problems and toxicity. “Heavy metals” generally refers to a class of metals and their compounds, often referred to as “metals” or “semi-metals,” and their contamination, which often causes toxicity and ecological problems. It makes no sense if there was no consensus among experts. Furthermore, it was

recommended that any attempt to identify heavy metals based on density be abandoned as it would only lead to confusion, given that the International Union of Pure and Applied Chemistry (IUPAC) never defined the term "heavy metals." In some samples of heavy metals (HMs) such as mercury (Hg), arsenic (As), nickel (Ni), cobalt (Co), copper (Cu), cadmium (Cd), and chromium (Cr), zinc (Zn), and other elements with higher atomic weights and densities. This illustrates even more of the ambiguity around the phrase. The definitions of the phrase before 1936 were "large guns or shot" and "great ability" (Duffus, 2002; Zaynab et al., 2022). Typically, heavy metals with an atomic number higher than 20 and a density larger than 5 grams per cubic centimeter are referred to as heavy metals. In most cases, metals function as cofactors, are involved in a variety of enzymatic and metabolic pathways, and are necessary for trace amounts of nutrients. However, high concentrations of these metals can become fatal or very suppressive to all living things, including people, animals, plants, and microbes. While some metals, such as mercury (Hg), arsenic (As), and cadmium (Cd), are exceedingly hazardous at very low concentrations (Mishra et al., 2019). Three classes are identified for the classification of metals and metalloid ions. Lead, mercury, and cadmium are Class I metals that can be hazardous in small amounts. Class II metals, including arsenic, thallium, bismuth, indium, and antimony, contain the least dangerous metals. Class III includes the minerals zinc, cobalt, copper, iron, and selenium; these substances are essential for several chemical and metabolic functions in the body and are dangerous only in low concentrations (Mishra et al., 2019; Verma, Vijayalakshmy & Chaudhry, 2018). Heavy metals, among other pollutants found in indoor dust, should be studied carefully because of their high toxicity, incomplete nature, and adverse effects on humans. Furthermore, ingestion, inhalation, and skin contact are the three ways in which powdered heavy metals may enter a person's body (Tan, Praveena, Abidin & Cheema, 2016). When heavy metals enter the soil, they cause organic matter to become more mineralized, which alters the soil-absorbing complex negatively by replacing calcium and magnesium. Since helpful microbes become less viable, the soil's enzymatic activity declines (Baibotayeva, Kenzhaliyeva & Bosak, 2019). The fact that makes this type of pollution the worst is that it is hidden, continuous, and irreversible (Zhang, 1999). As a result, the US Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry have listed them within the top 20 list of hazardous compounds (Rai, Lee, Zhang, Tsang & Kim, 2019). Aquatic systems are seriously harmed by the mixing of metal pollutants through processes of dissolution, sewage, and waste leaching. The tanners produce a lot of chemicals throughout the process, which causes the water to become contaminated with harmful materials. The environment of fast urbanization, land, and population increase is now seriously threatened

by pollution. Pollutants like radioactive materials, heavy metals, and different kinds of organic materials are being dumped more often by industries, contributing to environmental inorganic matter, and thus one of the main causes of metal contamination for aquatic creatures is the garbage industry (Pandey & Madhuri, 2014). Some metals are carried by wind or water, causing numerous ecological issues, while some are left behind as tailings strewn or disseminated in open or partially covered pits during mining procedures. Pb levels in soils that are too high may reduce soil production. Metal pollution refers to the toxicity of metals displayed by the mining, smelting, coal-burning, hydroelectric, and agricultural sectors, among other sources. As naturally occurring components of the earth's crust, heavy metals are persistent pollutants because they cannot be broken down or eliminated (Pandey et al., 2016; Sharma & Singh, 2015). In this review, we want to introduce heavy metals and their adverse effects on the environment, especially on humans.

SOURCE OF HEAVY METALS

Both manmade and natural processes have the potential to release heavy metals into the environment. Major sources of heavy metal contamination in soil environments include air sedimentation, animal feces, wastewater irrigation, mineral insecticides, and herbicides. Consumption of food products contaminated by pollen transport from soil to plant tissue or direct atmospheric deposition on plant surfaces, in addition to natural sources, poses serious health risks to humans (Rai, Lee, Zhang, Tsang & Kim, 2019). Heavy metals are persistent in the environment after being released from the earth's crust, where they have harmful impacts on humans, plants, animals, and microbes. These factors make the presence of heavy metal pollution in our environment one of the most pressing environmental problems of our day and a major source of concern for the future (Rahman & Singh, 2019). However, when heavy metal concentrations rise above a certain threshold, adverse consequences are manifested (Ali, Khan & Sajad, 2013). Large amounts of heavy metals often have harmful consequences, while the most dangerous heavy metals are those that are considered no-level poisons. Given their elevated levels of toxicity, they are most commonly referred to as toxic heavy metals (THMs) (Gavhane, Sapkale, Susware & Sapkale, 2021). These metals have a strong effect on disrupting biological activities, which makes them directly affect biological toxicity and environmental pollution (Yadav, Gupta, Kumar & Singh, 2017). The effects of heavy metals on humans can be from man-made or natural sources. For example, some human activities release more chromium into the environment (Hadzi, Ayoko, Essumang & Osae, 2019). Cadmium was first found in sewage, mining, industrial, and electroplating processes. Cigarette smoke is another

source of cadmium. Foods also contain cadmium; however, the concentration fluctuates, and individual consumption varies owing to eating habits. Mercury may have industrial, coal-burning, or acid rain-induced soil leaching as its source. Lead can come from paint, mining, and vehicle exhaust (Ojo, Osho, Adewole & Olofintoye, 2017). Lead gasoline, lead solder feed cans, lead plumbing pipes, engine exhaust (lead tetraethyl), plastics, paints, antibacterial agents, scientific agencies, photography, fuel waste, solvents, battery fragmentation units, mining, electroplating, paints (cadmium yellow), wood preservatives, pesticides, and glass/copper solvents are some sources of heavy metals (Shah, 2017). The source of heavy metals and their harmful effects on human health are shown in Figure 1.

ENVIRONMENTAL IMPACT OF HEAVY METALS

Because metals are widely dispersed throughout the natural environment, the growing global population and yearly metal consumption per capita will eventually pose ecological issues. All soils, waterways, and living things naturally contain heavy metals. While many of these metals are necessary for a healthy life, high concentrations may have a severe detrimental effect on biological systems (Tiller K, 1989). In this chapter, the most important effects of heavy metals on the environment are discussed.

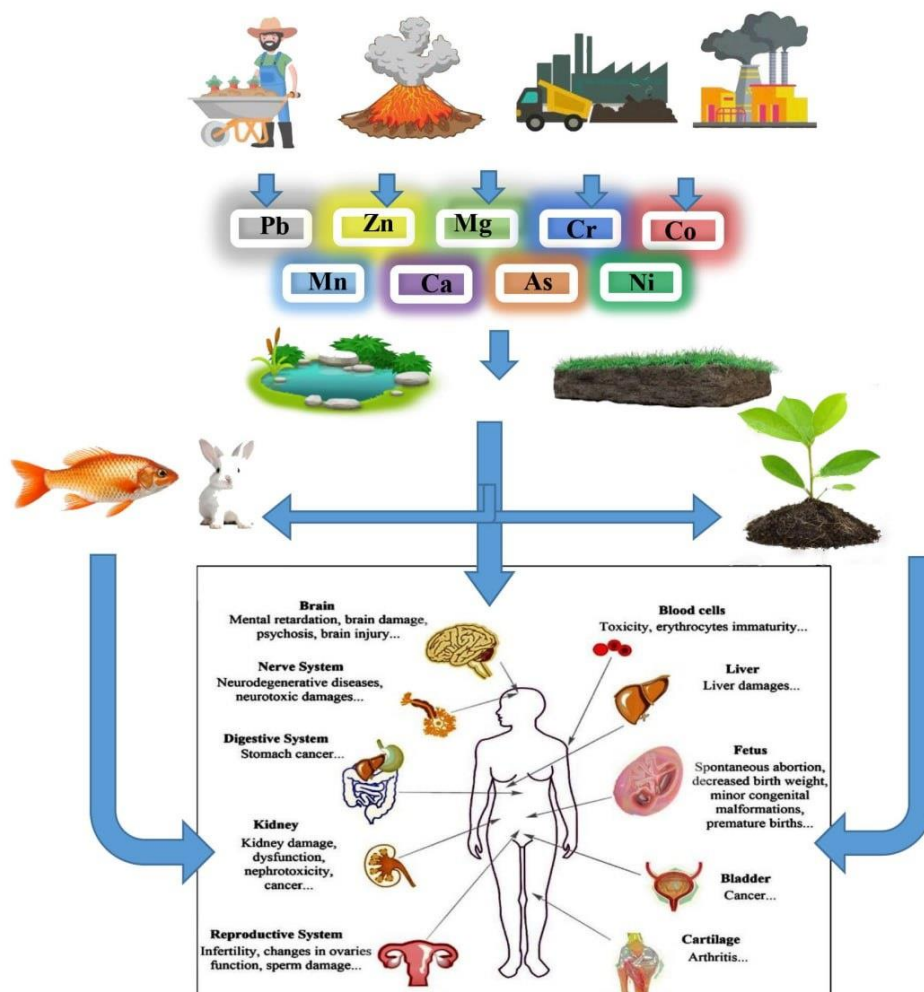


Figure-1. Source of Heavy metals and their harmful effects on human health (Sonone S S, Jadhav S, Sankhla M S and Kumar R, 2020).

Bioavailability of HMs in food webs

Food chains have the potential to transport and bio-accumulate heavy metals. There is also a pressing need for efficient monitoring of heavy metal concentrations in the marine environment. Issues are currently being brought to the fore at local, regional, and national levels due to concentrations of heavy metals (HMs), as well as their impacts, distribution, and environmental origin. Most organisms are significantly affected by heavy metal bioaccumulation patterns. Various sources of heavy metal release have negative effects on marine life (Khan, Zaidi & Musarrat, 2009). Due to their presence in the environment, which results from human activities such as farming, industry, or vehicle emissions, as well as contamination during food processing and storage, metals can arise as residues in food. It has been shown that the level of lead concentration in bread was affected by automobile exhaust fumes (Weli & Iwowari, 2014). There is a correlation between the number of cars and the amount of lead in the bus terminal (Al-Hassan & Norziah, 2012; Singh, Gupta, Kumar &

Sharma, 2017). Edible vegetables near road construction sites have been contaminated with heavy metals, affecting humans and animals living there (Otitoju et al., 2012). Herb toxicity is another problem, where herbs have long been used to treat and prevent a variety of diseases, including headaches, stomach pain, diabetes, hypertension, and others (Sankhla, Kumari, Nandan, Kumar & Agrawal, 2016; Song & Li, 2015). The presence of contaminants, including pesticides, bacteria, heavy metals, chemical toxins, and adulterants, may be the cause of phytotoxicity (Saad et al., 2006). Plants that are part of food need minerals as micronutrients. Plant roots contain large amounts of minerals involved in nitrogen metabolism, enzymes, and a significant proportion of many different proteins (Baby Joseph, Jency George & Jeevitha, 2012). Seafood has a high percentage of arsenic (Chouhan, Meena & Poonar, 2016). In agriculture, phosphate-based fertilizers, wastewater irrigation, livestock manures, atmospheric deposition, and metal pesticides are among the sources of heavy metals (Gall, Boyd & Rajakaruna, 2015). Many meals also contain lead, but the most important sources are fruits and vegetables. Zinc is abundant in dairy products, meat, fish, poultry, and grains. The range of arsenic is more limited, most commonly found in meat, fish, poultry products, and shellfish, but it is not important in the diet. It has been discovered in recent years that cereals are significant food sources (Rai, Lee, Zhang, Tsang & Kim, 2019).

Bioaccumulation of HMs in Seafood

Water is an essential need for all organisms on Earth. Since contaminated water can put citizens' health at risk through direct or indirect exposure to hazardous substances, clean water is necessary for a healthy lifestyle. Human activity and the industrial revolution have exacerbated environmental degradation. Large-scale pollution releases into the ocean have put coastal habitats at grave risk. Heavy metals (HMs) are extremely dangerous environmental contaminants due to their chronic toxicity, non-biodegradability, and environmental bioaccumulation (Munir et al., 2021; Zaynab et al., 2022). When minerals come into contact with water, they are dissolved. Acid mine drains are formed when sulfur rocks in mining are exposed to ambient oxygen. Consequently, heavy metal concentrations are important indicators of quality (Diami, Kusin & Madzin, 2016). Even when wastewater is treated in sewage treatment plants, heavy metals are typically not removed, which increases the danger of heavy metal contamination of the soil and, eventually, the food chain (Fytianos, Katsianis, Triantafyllou & Zachariadis, 2001). One of the main contaminants in our food supply is heavy metals. The human diet is incomplete without vegetables, which are especially rich in the well-known trace elements and heavy metals. If minor or trace elements originate from organic or

plant sources, they are necessary for optimal health. On the other hand, they turn harmful if they originate from a metallic or inorganic source. The cycling of nutrients, including trace elements, from soil to plant is essential to plant development processes. Because their leaves absorb heavy metals, vegetables—especially leafy vegetables—accumulate larger concentrations of toxic metals (Mohamed et al., 2010). In cities, municipal drainage as a source of industrial land and soil-related wastes has been a common practice in many parts of the world for the past 400 years. Twenty million hectares (ha) of agricultural land globally are thought to be irrigated using wastewater. Studies conducted in several Asian and African cities reveal that 50% of vegetable wealth in urban areas comes from agriculture that relies on wastewater for irrigation (Wallvik, Sjölander, Johansson, Bjuhr & Jansson, 2007). Fish may be harmed by chromium released onto the water's surface (Sall, Diaw, Gningue-Sall, Efremova & Aaron, 2020). Many terrestrial and aquatic animal and plant species are hazardous to concentrations of cadmium. For example, it might distort small freshwater fish bones (Pinto et al., 2003). Fish that consume cadmium are known to have elevated blood pressure and cardiac disorders. Research indicates that mercury causes hemorrhages, blood cell depletion, and damage to the blood vessels in fish (Sonone, Jadhav, Sankhla & Kumar, 2020). Anemia and growth and development retardation are brought on by zinc deficiency (Duruibe, Ogwuegbu & Ekwurugwu, 2007).

Bioaccumulation of HMs in soil

The primary components of the earth's crust are heavy metals, which are persistent environmental pollutants that can only be converted into benign forms via pure biodegradation (Mishra S et al., 2019). Acting as a non-renewable resource that is a barrier between land, air, and water, soil is currently dealing with complex pollution caused by human activities, indicating a significant contribution to elevated ambient metal concentrations. Heavy metal contamination may affect soils in various ways, especially when the soil is near industrial areas (Cocârță D, Neamțu S and Reșetar Deac A, 2016). Because of the natural dissolution of parent materials, heavy metals are present in the soil at uncommon concentrations and are not always harmful. In an attempt to become more mobile in the soil and subsequently, biologically accessible than soil formation processes, heavy metals originate from man (Kaasalainen M and Yli-Halla M, 2003; Kabata-Pendias A, 2004; Pierzynski G M, 2000). The physiochemical characteristics of the soil and the relative effectiveness of crops in removing the metals from the soil determine how quickly heavy metals accumulate in the soil. Through various exposure mechanisms, heavy metals deposited in farmed soils can be transmitted to humans and hurt

their health (Qishlaqi A, Moore F and Forghani G, 2008). Lead and Cadmium (Pb, Cd) are examples of metals without known physiological effects. Unintentionally adding Cd and potentially hazardous elements to the soil, such as Iron (Fe), Lead (Pb), and Mercury (Hg), is a result of certain phosphatic fertilizer applications (Mishra S et al., 2019). Many well-known pesticides that were once frequently used in agriculture had high metal concentrations. Arsenic-containing compounds were commonly used to manage livestock ticks and insects in banana plants (McLaughlin M, Hamon R, McLaren R, Speir T and Rogers S, 2000). The way plants use chromium is regulated by a system, on the other hand, plants show genetic changes when chromium concentration in soil is too high i.e. when it becomes toxic. Furthermore, plant uptake of chromium may affect soil acidity (Hayat S et al., 2012; Shanker A K, Cervantes C, Loza-Tavera H and Avudainayagam S, 2005). In general, this scenario is only dangerous if plants are stored in areas where the soil contains large amounts of minerals. PH (soil acidity) affects how well plants absorb minerals. Minerals are more soluble and mobile in acidic environments, increasing the likelihood that they may be absorbed and stored by plants. Thus, some heavy metals are transferred from the soil to the human body during the use of plants of this class (Fu Z and Xi S, 2020). When the concentration of heavy metals in the soil gradually increases, it hurts fertility and yield. The most common harmful element in soil is lead (Pb) (Mishra S et al., 2019; Zaynab M et al., 2022). The most significant soil chemical factor affecting the mobility of heavy metals in the soil is frequently the pH of the soil. It significantly affects metal speciation at the soil–solution interface and metal solubility, adsorption, and desorption processes. The redox reactions and pH-dependent precipitation or dissolution of the hydrated metal oxides in the soil might explain this. The redox reactions and pH-dependent precipitation or dissolution of the hydrated metal oxides in the soil might explain this (Abdu N, Abdullahi A A and Abdulkadir A, 2017).

Bioaccumulation of HMs in air

Air pollution from heavy metals by many human activities releases significant amounts of heavy metals into the biosphere, including mining, transportation, agriculture, and industrial production. Fossil fuel combustion is the main cause of metal pollution. Cities in emerging nations are mostly caused by unchecked pollution levels, which are a result of contributing factors including the expansion of industry and a sharp rise in the amount of petroleum-fueled transportation. Factors such as irrigation with tainted water, use of fertilizers and metal-based insecticides, industrial emissions, transportation, harvesting, storage, and/or sales can all lead to heavy metal contamination (Munir N et al., 2021; Sardar K et al., 2013). After their release

and appearance in human and natural forms, heavy metals are released into many natural systems, such as the pedosphere, hydrosphere, biosphere, and atmosphere (Ayub H, 2020). Airborne minerals can be obtained through emissions from chimneys or pipes, gas or vapor spills, and temporary emissions such as dust from landfills and storage facilities. Metals from airborne sources are often released into the gas stream as particles. Certain metals such as Pb, as, and Cd can also adsorb at high temperatures (Tchounwou P B, Yedjou C G, Patlolla A K and Sutton D J, 2012). Gasoline combustion and volatile Pb emissions into the atmosphere increase, another significant cause of soil contamination, dramatically elevating Pb content in soils near roadways and in urban areas (Chen M and Ma L Q, 1998). The metals that are contained in the tailings are often dispersed by wind and water after their disposal reduced emissions may result from wet rain that eliminates some of the gas or from natural airflow over a large area that can circulate until it dries (Adriano D C and Adriano D C, 2001; Navarro E et al., 2008).

Bioaccumulation of HMs in plant

Certain heavy metals, such as Arsenic (As), Cadmium (Cd), Mercury (Hg), Lead (Pb), or Selenium (Se), are not necessary for plant development since they are not known to carry out any physiological functions in plants. Other elements, such as Cobalt (Co), Copper (Cu), Iron(Fe), Manganese(Mn), Molybdenum (Mo), Nickel (Ni), and Zinc (Zn), are necessary for plants to grow and function normally, but when their concentrations are higher than ideal levels, they can quickly cause poisoning (Garrido S, Campo G M D, Esteller M, Vaca R and Lugo J, 2005; Rascio N and Navari-Izzo F, 2011). Metal pesticides, phosphate fertilizers, use of untreated processed sewage sludge, runoff from roads and industrial areas, and atmospheric deposition of metal-containing particles are some of the ways metals may leak into soils (Gall J E, Boyd R S and Rajakaruna N, 2015). The movement of the metal and its availability in the soil determines the risk of entering the food chain. Minerals can accumulate in plants and other soil-dwelling organisms when they separate from these soil particles and enter the soil solution. The application of waste composts to enhance vegetable-growing soils may be a concern for agricultural productivity, since they may have unintended negative impacts. Given that most vegetable species include edible parts of the plant, it is important to be concerned about the possibility of heavy metals being transferred from soil to people (Jordao C, Nascentes C, Cecon P, Fontes R and Pereira J, 2006). Temperature, moisture, organic matter, pH, and the availability of nutrients are only a few of the variables that affect how heavy metals are absorbed and accumulate in plant tissue (Singh J and Kalamdhad A S, 2011). However, because soil

metals are insoluble, only a small portion of them are easily absorbed by plants. Metal ions can enter plant tissues through the cellular membrane of the root and be transported there. Metals are first taken up by the roots apoplast, a free intercellular area that faces the xylem. Plant tissue experiences apo-plastic translocation of heavy metals because of the continuity of the root's cortex and epidermis (Sandeep G, Vijayalatha K and Anitha T, 2019). Plant development, yield potential, and growth pattern are all negatively impacted by metal pollution, which can have both acute and long-term harmful effects. Exposure to heavy metals disrupts respiratory and photosynthetic processes, damages cells, upsets ionic equilibrium, and produces more reactive oxygen. It also inhibits vital microelements, enzymes, and pigments (Reddy A S, 2007; Tchounwou P B, Yedjou C G, Patlolla A K and Sutton D J, 2012; Tepanosyan G, Sahakyan L, Belyaeva O, Asmaryan S and Saghatelyan A, 2018). Cd and Pb are considered nonessential elements for plants. However excess accumulation of such metals in plants severely harms plant growth and reproduction by damaging ion channels and disrupting metabolic reactions and absorption of essential elements (Shah F U R, Ahmad N, Masood K R, Peralta-Videa J R and Ahmad F u D, 2010).

IN HUMAN

Metals are absorbed by plants and animals from contaminated soil, water, and deposits on plant surfaces that are exposed to polluted air. An abundance of these metals in the diet is linked to the genesis of several illnesses (Al-Lami A M A, Khudhaier S R, Aswad O and Al-Lami A M A, 2020). Harmful heavy metals tend to accumulate in vital living organs (Baby Joseph B J, Jency George J G and Jeevitha M, 2012). Heavy metals impair the quality of natural waterways and may seriously damage human health in several ways, including the nervous, renal, liver, and respiratory systems (Tchounwou P B, Yedjou C G, Patlolla A K and Sutton D J, 2012). The phrase“metal trace elements” (MTEs) is often used rather than “heavy metals,” MTEs generalists generally carry a high risk of developing cancer (Sall M L, Diaw A K D, Gningue-Sall D, Efremova Aaron S and Aaron J-J, 2020). Additionally, MTEs can cause bio-regulatory system disturbance that results in functional or psychosomatic illnesses including chronic fatigue syndrome and neurodegenerative pathologies such as Parkinson's and Alzheimer's disease, as well as delays in human growth and development (Poëy J and Philibert C, 2000). Heavily due to agricultural and industrial activities in the soil, water, and air. Causing a wide range of illnesses, including bronchitis, asthma, pneumonia, emphysema, cancer, and heart problems (Singh J and Kalamdhad A S, 2011). When mined ores are poured on the ground surface for hand dressing, heavy metal contamination of surface and subsurface water causes

significant soil pollution and pollution grows. The dumping of metals exposed to the air also changed the air environment, and the cement companies discharged a variety of absorbing compounds that impacted the soil's outer surface (Pandey R et al., 2016).

BIOLOGICAL INDICATORS AS A WARNING SYSTEM FOR HMS

Heavy materials originated naturally at the beginning of the Earth and may be evenly or unevenly distributed on Earth, but have entered the environment as a result of human activities including rapid industrial growth, soil and water pollution due to heavy metal accumulation, especially in rapidly developing industrial areas Mines and disposal into other sources (Singh R, Gautam N, Mishra A and Gupta R, 2011; Verma R, Vijayalakshmy K and Chaudhry V, 2018). Typically, the amount of any pollutant that enters the human body in one of three ways inhalation, ingestion, or dermal contact (Cocârță D, Neamțu S and Reșetar Deac A, 2016). Eating contaminated food or water high in heavy metals can cause stomach upset as well as diarrhea and vomiting. Increased levels of lead (Pb) may decrease reaction times and cause anemia, a blood disorder in humans (Fay R and Mumtaz M, 1996). In addition to humans, animals and plants are often negatively affected by heavy metals, which negatively affect the amount of bacteria at the microscopic level, which affects the ability of ecosystems to function. In the case of mammals, birds, poultry, crustaceans, and fish (Ansari T, Marr I and Tariq N, 2004; LeFauve M K and Connaughton V P, 2017). These are some of the heavy metals that affect the human body and the harmful effects of heavy metals on human health are tabulated in Table 1.

Zink

Enzymes involved in gene expression are among the many biological processes that zinc is engaged in. Electron transport involves zinc as well. Because of its bioaccumulation, excessive use can have harmful effects such as mutagenesis, teratogenesis, and carcinogenesis (Baby Joseph B J, Jency George J G and Jeevitha M, 2012; Ojo A A, Osho I, Adewole S O and Olofintoye L K, 2017). Enzymes involved in gene expression are among the many biological processes in which zinc is engaged (Das K, Das S and Dhundasi S, 2008). Zinc is a mineral that may be toxic to the brain, but it has a role in controlling decisions about life and death at the cellular level. Consistent with the hypothesis that too much zinc may cause nerve cell death. Zinc probably has a role in neurodegenerative illnesses as well. For example, zinc and dysregulated zinc homeostasis may have a role in the development and course of Alzheimer's disease (Devirgiliis C, Zalewski P D, Perozzi G and Murgia C, 2007; Plum L M, Rink L and

Haase H, 2010). A zinc deficiency raises the risk of diabetes and can cause problems with reproduction (Jamshaid M, Khan A A, Ahmed K and Saleem M, 2018).

Arsenic

Another carcinogen, known as arsenic, causes bladder, liver, lung, and skin cancer. Decreased exposure levels can cause vascular damage, arrhythmias, diarrhea, and vomiting, and decreased red and white blood cell formation (Martin S and Griswold W, 2009). Humans can become toxically exposed to arsenic by unintentional intake of powders or solutions containing the element, suicide, homicide, or consumption of tainted food or water. High dosages of arsenic have been linked to liver impairment, significant effects on the cardiovascular system, and hypertension. In rats, it suppresses gonadotrophin and testosterone secretion as well as spermatogenesis. Diabetes mellitus (type II) and arsenic exposure are correlated. In addition, consuming inorganic arsenic causes several skin conditions, including hyperkeratosis, hyperpigmentation, and hypopigmentation; it can also cause orbital enlargement, spontaneous miscarriage, and nervous system damage. The most prevalent inorganic arsenic in the air is arsenic trioxide (As_2O_3), although arsenates (AsO_4)³⁻ or arsenites (AsO_2) can be found in food, water, or soil. Increased zinc can cause a variety of health issues, including arteriosclerosis, stomach pains, skin inflammation, nausea, vomiting, anemia, pancreatic root difficulties, and problems with protein metabolism (Chouhan B, Meena P and Poonar N, 2016; Singh J and Kalamdhad A S, 2011).

Mercury

Respiratory mercury poisoning initially appears in vapor form and can then dissolve in blood, plasma, and hemoglobin. It can damage the brain, nervous system, and kidneys. It can easily pass through the uterus and reach the fetus in pregnant women. Due to breast milk contamination, there is still a risk after delivery because mercury can accumulate in this way and poison the nerves, especially in young babies. Mercury poisoning affects all lifestyles and may inhibit growth (Sall, Diaw, Gningue-Sall, Efremova & Aaron, 2020). Mercury causes serious damage to developing fetuses, kidneys, and the brain. All forms of mercury are highly sensitive to the nervous system. Irritability, shyness, tremors, visual or hearing abnormalities, and memory problems can all be consequences of brain dysfunction. Increased blood pressure or heart rate, skin rashes, eye irritation, vomiting, diarrhea, and lung damage can all result from brief exposure to high concentrations of metallic mercury vapors (Agrawal, Singh, Sharma & Agrawal, 2007; Martin & Griswold, 2009). Human neural systems can be harmed by mercury

toxicity, particularly in young infants (Agrawal, Singh, Sharma & Agrawal, 2007; Sall, Diaw, Gningue-Sall, Efremova & Aaron, 2020).

Cobalt

Adults should take 3 micrograms of cobalt daily. Cobalt enters the body through one of the routes, as part of biomaterials (Czarnek K, Terpiłowska S and Siwicki A K, 2015). In addition, cobalt causes central nervous system abnormalities, lung illness, and asthma. Along with its genotoxic and carcinogenic properties, cobalt inhibits DNA repair, alters gene expression patterns, alters the shape of chromosomes, and causes abnormalities in the mitotic machinery (Dayan A and Paine A, 2001). Cobalt exposure may cause allergic dermatitis that resembles nickel dermatitis and causes scarlet cough with the usual form of hives. Those used in the manufacture of solid metals (tungsten carbide), printing, metalworking, ceramics, textiles, and leather are among the trades affected. Depending on its chemical form (particle, nanoparticle, ion, oxide, hydroxide), In humans, acute oral poisoning causes stomach discomfort, but continued absorption can cause abnormalities in the skin, heart, blood, or lungs. Known about allergies. As a result of further absorption cobalt becomes active, causing Cardiomyopathy characterized by fibrous damage, vacuoles, and interstitial edema with fibrous detachment (Payne L, 1977).

Chromium

It has a wide range of toxicity. For example, Cr⁶⁺ ions are around 1000 times more poisonous than Cr³⁺ ions. The subsequently reduced chromium species can mediate double-strand breaks in DNA and initiate DNA damage, potentially acting as an eventual genotoxic agent (Sall, Diaw, Gningue-Sall, Efremova & Aaron, 2020). Chronic chromium poisoning in humans can result in mucous membrane irritation, skin rashes, respiratory issues, and even broncho-pulmonary malignancies (Ahmad, Bhatti, Muneer, Iqbal & Iqbal, 2012). Chromium compounds are proven carcinogens to humans and are toxic. Breathing in chromium can irritate the nasal lining, causing nasal ulcers, a runny nose, and respiratory issues including wheezing, coughing, and shortness of breath (Martin & Griswold, 2009). Hexavalent (+6) chromium, which is produced by industrial contamination, is more harmful than trivalent (+3) chromium. Additionally, consuming too much of this form can lead to stomach issues, lung cancer, and skin discomfort (Jamshaid, Khan, Ahmed & Saleem, 2018). Chromium toxicity can cause low sperm count, lung problems, stomach and small intestinal lesions, anemia, and damage to the reproductive system in humans (World Health Organization [WHO], 2000). Chromium affects

blood by causing anemia, eosinophilia, lymphocytosis, and injury to the bronchi and kidneys (Sonone, Jadhav, Sankhla & Kumar, 2020).

Lead

One of the most dangerous heavy metals is lead. Lead poisoning is the most common form of poisoning and has severe consequences for the heart, hematopoietic system, and nervous system of humans. High-concentration lead poisoning can cause blood, kidney, and brain problems. Additionally, it can lead to abnormalities in brain development, including psychopathology and learning disabilities. Reduced fertility, fetal death, and spontaneous abortion are all results of lead exposure. It affects the stomach, intestines, heart, and nerves, and can cause cancer and mutations (Pandey, Singh & Kalamdhad, 2016; Singh & Kalamdhad, 2011). Inhibition of hemoglobin synthesis, cardiovascular system damage, and acute and long-term harm to the central and peripheral nervous systems are further effects of lead poisoning (PNS and CNS). This may lead to kidney, blood vessel, nerve, or joint diseases such as rheumatoid arthritis (Odum, 2016). The toxicity of lead and its detrimental effects on human health are widely recognized. Lead penetrates the body through the skin, food, and/or inhalation, damaging the body, particularly the kidneys, and can enter through the blood, soft tissues, and bones. Lead causes mutagenesis and carcinogenesis in human lesions of the immune system, endocrine system, gastrointestinal tract, and reproductive system (Al-Lami, Khudhaier, Aswad & Al-Lami, 2020; Kazemipour, Ansari, Tajrobehkar, Majdzadeh & Kermani, 2008).

Cadmium

One recognized human carcinogen is cadmium. High doses induce severe stomach irritation, which can result in vomiting and diarrhea. Long-term cadmium exposure can cause lung damage, bone fragility, and renal disease (Martin S and Griswold W, 2009). The kidney is the primary human organ affected by cadmium exposure in both the general population and those who are exposed at work (Chouhan B, Meena P and Poonar N, 2016). The gradual accumulation of cadmium in the body causes several adverse health consequences, mostly to the kidneys, liver, and vascular system (Al-Lami A M A, Khudhaier S R, Aswad O and Al-Lami A M A, 2020). The appearance of its effects is almost as dangerous as that of lead and mercury. Cadmium can raise blood pressure and cause kidney problems in humans. In addition, breathing it in can be harmful. Chronic exposure to cadmium causes "itai-itai" syndrome, a condition that results in irreversible kidney disease and may eventually lead to kidney failure (Sall M L, Diaw A K D, Gningue-Sall D, Efremova Aaron S and Aaron J-J, 2020). The earth's

crust naturally contains cadmium. Acute exposure to markedly elevated cadmium levels can cause a range of harmful health effects, such as vomiting, diarrhea, fever, lung damage, and muscle soreness. Chronic cadmium consumption can cause diseases like kidney and bone damage, reproductive issues, and potentially even cancer (Jamshaid M, Khan A A, Ahmed K and Saleem M, 2018).

Table 1. The harmful effects of heavy metals on human health (Jan A T et al., 2015; Sonone S S, Jadhav S, Sankhla M S and Kumar R, 2020).

Heavy metals	Hazards
Zn	Cramping, weariness, nausea, kidney damage, and dizziness.
As	Impacts several vital biological functions, including ATP production, oxidative phosphorylation, arsenicosis, carcinogen, and cancer.
Hg	Brain damage, lung and kidney failure, autoimmune illness, depression, sleepiness, tiredness, hair loss, insomnia, memory loss, restlessness, alteration of eyesight, tremors, and outbursts of rage.
Co	Paralysis, low blood pressure, and diarrhea.
Cr	Hair loss, ulcers, nephritis, and cancer.
Pb	Heart disease risk and neurotoxic effects.
Cd	Endocrine disruptors, carcinogens, carcinogenic substances, lung and kidney damage, and brittle bones all have an impact on how calcium is regulated in biological systems.
Ni	Lung cancer, allergies that cause itching, immunotoxicity, neurotoxicity, teratogenicity, carcinogenicity, genotoxicity, and mutagenicity, as well as issues with hair loss and fertility.

Nickel

Nickel has a special place among the heavy metals found in the crust of the earth. In air when can be exposed to the skin for a long time it can cause itching and sometimes sensitivity and inflammation. By entering the body, nickel salts can cause vomiting, diarrhea, and prolonged inhalation of nickel in the form of minerals or monoxide can cause some cases of asthma and bronchial dysfunction (Hayyat M S et al., 2020; Révész C et al., 2004). Red blood cells (RBCs) need nickel in small amounts to be assembled, but in large amounts, nickel becomes invisibly poisonous. Infants of women employed in a nickel hydrometallurgy refining factory showed an increase in anatomical abnormalities 89 Strong carcinogens, nickel compounds can cause neoplastic transformation in both human and rodent cells. There were additional observations of alveolar cell hyperplasia, bronchiole inflammation, and sometimes lumen congestion (Mishra S, Dwivedi S P and Singh R, 2010).

CONCLUSION

As a result of population growth, heavy discharges of agricultural wastewater containing chemical fertilizers, as well as industrial wastewater discharges from mining, chemical and electrical manufacturing, and soil degradation, lead to the formation of heavy substances. Given their widespread presence in the environment, through soil, plants, food, seawater, and air, heavy metals can cause several health problems, including cancer, growth problems,

cardiovascular disease, kidney damage, and more Loss of bone. Regarding the future of heavy materials, no physical, chemical, or biological process can break down heavy metals into a harmless by-product only plants and bacteria can convert it to a less harmful form. Environmental toxicity of heavy metals is a major concern due to possible effects on human and animal health. Removing these metals from the soil and water around industrial plants has been difficult for many years. Therefore, to conserve rare natural resources and biodiversity they need more efficient solutions.

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INVESTIGATION OF COVID-19 FEAR AND LIFE QUALITY AMONG BIPOLAR DISORDER PATIENTS FOLLOWED BY A COMMUNITY MENTAL HEALTH CENTER DURING THE COVID-19 PANDEMIC

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ABSTRACT

This study aims to determine and investigate COVID-19 fear level, quality of life, and follow-up-related data during the pandemic in patients with bipolar disorder in remission who were followed up at a Community Mental Health Center (CMHC). The study included 42 individuals who admitted to the CMHC unit between June and July 2022. Participants were assessed by using a sociodemographic data form, the COVID-19 Fear Scale, the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0), and the Clinical Global Impression Scale (CGI). The data were analyzed using independent groups T-test and Pearson correlation test. During the pandemic, no change was determined in the frequency of psychiatric hospitalizations in 95.2% (n=40), and manic and/or depressive episodes in 69% (n=29) of the patients. While 92.9% (n=39) of the patients reported no difficulty attending psychiatric follow-ups, 64.3% (n=27) stated that they did not experience COVID-19-related challenges accessing non-psychiatric services. The average COVID-19 fear score was 15.21 ± 7.57 , WHODAS 2.0 was 10.29 ± 7.27 , and CGI was 2.57 ± 0.77 . No significant relationships were found between the variables ($p > 0.05$). In conclusion, the stability in episode frequency and hospital follow-ups during the pandemic highlights the importance of CMHC monitoring, emphasizing the need to enhance such services, especially during crises.

INTRODUCTION

COVID-19, a novel coronavirus disease that emerged in November 2019 and rapidly spread across the globe, was declared as a pandemic by the World Health Organization (WHO) in March 2020 (CDC Covid-19 Response Team, 2020). The pandemic significantly impacted on health, economy, and social life worldwide, and led to substantial increases in uncertainty and stress levels (Yalçın et al., 2021). Individuals with chronic illnesses were among the most vulnerable groups to the physical and psychological burdens brought on by the pandemic.

Studies have consistently reported that individuals with chronic health conditions faced heightened vulnerability during the COVID-19 pandemic—not only due to their increased risk of infection and COVID-19-related mortality, but also because of the indirect psychological

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burden imposed by the pandemic (Melamed et al., 2020). Quarantine measures, fear of infection, and social distancing policies created substantial barriers to healthcare access for these individuals, affecting both their physical and mental health (Wang et al., 2020; Xiong et al., 2020). Additionally, chronic illnesses were shown to impact not only the physiological course of COVID-19 but also individuals' psychological resilience, making them more susceptible to adverse mental health outcomes during this period (Holmes et al., 2020).

From the perspective of psychiatric disorders, the impact of the pandemic was particularly striking. It was suggested that individuals diagnosed with mood disorders and anxiety disorders might have experienced a worsening of symptoms due to the isolation, uncertainty, and disruptions to daily routines brought about by the pandemic (Rajkumar, 2020). In addition, the traumatic effects of the pandemic increased the risk of emerging mental health issues such as depression, anxiety, post-traumatic stress disorder, and alcohol or substance use disorders (González-Sanguino et al., 2020; Goularte et al., 2021; Xiong et al., 2020).

This period became even more critical for individuals diagnosed with severe mental disorders (SMD) such as Bipolar Affective Disorder (BAD), schizophrenia, and other psychotic conditions. Due to increased social distancing and quarantine measures, individuals with SMD faced significant challenges in accessing social support systems, leading to heightened feelings of loneliness, disruptions in circadian rhythms, and irregular sleep and eating patterns (Murray, Gottlieb & Swartz, 2021; Stefana et al., 2020). In patients diagnosed with Bipolar Disorder, it was noted that the isolation and restricted access to healthcare services during the pandemic might have increased the risk of suicidal behavior, placed a greater burden on caregivers, and elevated the likelihood of mood episode relapses (Fornaro et al., 2021; Stefana et al., 2020).

According to cross-sectional studies, quarantine measures were associated with increased severity of depressive symptoms in individuals with BAD and led to more pronounced disruptions in biological rhythms compared to patients with major depression and healthy individuals (Carta et al., 2021; Van Rheenen et al., 2020). However, there were also studies reporting no significant deterioration in individuals with BAD during the pandemic period (Karantonis, Rossell, Berk & Van Rheenen, 2021; Tundo, Betro' & Necci, 2021).

The COVID-19 pandemic profoundly affected individuals' health, social lives, and psychological resilience across the globe, with particularly significant consequences for vulnerable groups such as those with chronic or psychiatric conditions. In this context, our study examined the levels of fear related to COVID-19, quality of life, and the impact of the pandemic on psychiatric follow-up processes among individuals diagnosed with Bipolar Affective

Disorder (BAD) who were in remission and were being followed up at a Community Mental Health Center (CMHC). By exploring the experiences of this patient group at both individual and systemic levels, our study aimed to assess the effectiveness of CMHC services during crisis periods like the pandemic and to offer recommendations for their improvement. The research questions were listed below:

- What was the level of fear related to COVID-19 among individuals diagnosed with BAD who were in remission?
- How did the COVID-19 pandemic affect the quality of life of individuals in remission from BAD?
- Was there a relationship between quality of life and the level of fear associated with COVID-19?
- During the COVID-19 pandemic, did individuals with BAD in remission experience difficulties in continuing their psychiatric follow-up appointments?
- Was there a change in the frequency of manic and/or depressive episodes in individuals diagnosed with BAD during the pandemic?
- What was the role of Community Mental Health Center (CMHC) services in helping individuals with BAD in remission maintain regular follow-ups and psychological stability during the pandemic?
- How did social distancing measures, quarantine, and restricted access to healthcare services during the pandemic affect the overall mental health status of individuals in remission from BAD?

MATERIAL AND METHOD

Aim and Type of the Study

The aim of this study was to assess the level of COVID-19-related fear, quality of life, and follow-up data during the pandemic among patients diagnosed with Bipolar Affective Disorder (BAD) who were in remission and were receiving health care at a Community Mental Health Center (CMHC). This study was designed as a cross-sectional research.

Population and the Sample of the Study

Forty-two euthymic patients diagnosed with Bipolar Affective Disorder (BAD), who presented to the Community Mental Health Center (CMHC) of Dışkapı Training and Research Hospital between June and July 2022, were included in the study. The minimum sample size

required to perform a correlation analysis with a large effect size ($r=0.5$), an alpha level of 0.05, and 80% power ($1-\beta=0.80$) was calculated as 29. Therefore, the inclusion of 42 participants was considered sufficient to detect large effects. At the time of the study, the CMHC functioned as an outpatient rehabilitation center affiliated with Dışkapı Training and Research Hospital, providing care for individuals with severe mental disorders, including schizophrenia, schizoaffective disorder, bipolar disorder, and other psychotic disorders. The center's professional team consisted of one faculty member, one nurse, one psychologist, one occupational therapist, one social worker, and two psychiatry residents. Of approximately 1,000 registered patients, 400 were being followed with a diagnosis of Bipolar Affective Disorder. Patients' mood states were assessed through clinical interviews conducted by case managers. These clinical evaluations were performed in accordance with the Structured Clinical Interview for DSM-5 (SCID-5). The case managers responsible for these assessments (residents, nurses, psychologists, and social workers) were professionals who had received training in and were authorized to administer the SCID-5 for severe mental disorders within the CMHC. The euthymic status of the patients was also supported by the Clinical Global Impression (CGI) Scale. During the study period, all literate individuals between the ages of 18 and 65, who were diagnosed with BAD, regularly attended their follow-up appointments at the CMHC, and were compliant with their medication regimens, were informed about the study. Written informed consent was obtained from those who agreed to participate. Patients who lacked of insight or who presented with psychotic symptoms were excluded from the study. No financial compensation was provided to the participants for their involvement in the study.

Data Collection and Analysis

Participants were assessed by a psychiatrist using a sociodemographic data form, and the severity of illness was evaluated using the Clinical Global Impression (CGI) Scale. Their quality of life was assessed by the clinician through the short form of the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0). Following this, participants were given the Fear of COVID-19 Scale to complete. The entire survey process took approximately 30 minutes. Evaluations of patients who were already being followed by the Community Mental Health Center (CMHC) and who continued to receive follow-up via telephone during the COVID-19 pandemic were conducted during the period when face-to-face appointments resumed and restrictions were lifted.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 22.0. The normality of data distribution was assessed through skewness and kurtosis values.

For categorical (qualitative) variables, frequency (n), percentage (%), and standard deviation (SD) statistics were reported. Data analysis was performed using independent samples t-tests and Pearson correlation tests. A p-value of less than 0.05 was considered statistically significant.

Measurements

The sociodemographic data form (SDF)

The Sociodemographic Data Form was used to gather personal information from participants, including age, gender, education level, marital status, employment status, psychiatric history, and medication use. Additionally, the form assessed the number of illness episodes during the COVID-19 pandemic, whether there were any changes in the frequency of hospitalizations compared to the pre-pandemic period, and whether participants experienced difficulties attending CMHC follow-ups or accessing other medical departments for non-psychiatric complaints due to the pandemic. The development of this form was informed by previous studies in the literature (Bakioğlu, Korkmaz & Ercan, 2021; Castelpietra et al., 2021; Clerici et al., 2020; Pinkham, Ackerman, Depp, Harvey & Moore, 2020).

Fear of COVID-19 scale (FCV-19S)

The Fear of COVID-19 Scale (FCV-19S) is a 7-item, 5-point Likert-type self-report scale developed by Ahorsu and colleagues to assess the intensity of individuals' fear of the coronavirus (Ahorsu et al., 2020a). Scores on the scale range from 7 to 35, with higher scores indicating a greater level of fear related to COVID-19. The scale has a validated Turkish version, with established reliability and validity (Bakioğlu et al., 2021). In the Turkish adaptation study, the reliability coefficient was reported as .82, while in the current study, it was calculated as .91.

World health organization disability assessment schedule 2.0 (WHODAS 2.0)

The World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) is a disability assessment tool developed by the World Health Organization. It includes 12- and 36-item versions and can be administered in three formats: interviewer-administered, proxy-administered, and self-administered (Üstün et al., 2010). A Turkish validity and reliability study of the scale has been conducted on individuals with psychiatric disorders (Aslan Kunt & Dereboy, 2018). In the present study, the 12-item interviewer-administered version of the scale was used. Higher scores on the scale indicate greater impairment in quality of life, and the total score ranges from 0 to 48. In the Turkish adaptation study, the internal consistency coefficient

for the 12-item interviewer-administered version was reported as .90, whereas in the present study, it was calculated as .75.

Clinical global impression scale (CGI)

The Clinical Global Impression Scale (CGI) was developed by Guy and colleagues to assess the severity of illness, degree of improvement, and intensity of side effects related to medications during follow-up (Guy, 1976). The scale is structured as a 7-point Likert-type instrument and does not include a specific cut-off score. The CGI comprises three subscales: severity of illness, global improvement, and side effects. In the present study, only the "severity of illness" subscale was used to assess the individual severity level of each patient. This subscale rates the patient's current condition on a scale from 1 to 7, where 1 = Normal, not at all ill; 2 = Borderline mentally ill; 3 = Mildly ill; 4 = Moderately ill; 5 = Markedly ill; 6 = Severely ill; and 7 = Among the most extremely ill patients. Although CGI is widely used in clinical practice in Turkey, a formal Turkish validation study has not yet been conducted.

Limitations of the Study

One of the main limitations of our study is that it was conducted in a single center, with a relatively small sample size, and relied on self-report data. Additionally, the study did not specify whether the participants were diagnosed with Bipolar I or Bipolar II Disorder. Although participants were clinically determined to be in a euthymic phase by their long-term case managers through clinical interviews, this status was not confirmed using a standardized rating scale, which can also be considered a limitation. However, considering that the participants were patients regularly followed at a single Community Mental Health Center (CMHC) over an extended period, the sample size and findings still provide valuable insights into the challenges faced by individuals with Bipolar Affective Disorder (BAD)—a severe mental illness—during the COVID-19 pandemic. Notably, much of the existing literature on the impact of COVID-19 in individuals with BAD focuses primarily on the early stages of the pandemic.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki, and ethical approval was obtained from the Ethics Committee of Dışkapı Training and Research Hospital (date: 06.06.2022, decision number: 139/19). Informed consent was obtained from all participants for both the administration of questionnaires and the publication of the study results.

RESULTS

Demographic and Clinical Characteristics of the Participants

More than half of the participants in our study were female (61.9%) and married (52.4%). Nearly half were high school (40.9%) or university (23.8%) graduates. Approximately 40.5% were housewives, and 50% reported having a physical illness. Detailed sociodemographic data are presented in Table 1 (Table 1).

When changes in psychiatric inpatient admissions over the past two years were evaluated, it was found that 95.2% (n=40) of participants reported no change, while 4.8% reported an increase. Regarding changes in the frequency of manic and/or depressive episodes, 69% (n=29) reported no change, 16.7% (n=7) reported an increase in episode frequency, and 14.3% (n=6) reported a decrease compared to previous years.

When, whether there was a difference in the severity of COVID-19 fear scores based on the presence or absence of a physical illness among participants were evaluated, no significant difference was found between the two groups ($t_{(42)} = -0.101$, $p > 0.05$).

In terms of access to psychiatric and other healthcare services during the COVID-19 pandemic, 7.1% of participants reported difficulties attending psychiatric follow-up appointments, while 35.7% experienced difficulties accessing other medical departments.

When the scores for COVID-19 fear severity and quality of life were evaluated, the mean fear score related to COVID-19 was determined to be 15.21 ± 7.57 , while the mean quality of life score was 10.29 ± 7.27 . According to the Clinical Global Impression (CGI) scale, the mean illness severity score of the patients was 2.57 ± 0.77 .

Information about the participants' sociodemographic and clinical characteristics is presented in Table 1 (Table 1).

Table 1. Demographic Information and Clinical Data of the Participants

Demographic information (N=42)	
Age ($\bar{X} \pm SD$)	46 \pm 10.58
Gender (%)	
Female (n=26)	61.9%
Male (n=16)	38.1%
Marital status (%)	
Married (n=22)	52.4%
Single (n=10)	23.8%
Divorced (n=5)	11.9%
Separated (n=1)	2.4%
Widowed (n=4)	9.5%
Education level (%)	
Primary school (n=12)	28.6%
Middle school (n=3)	7.1%

High school (n=17)	40.5%		
Collage/university (n=10)	23.8%		
Employment status (%)			
Unemployed (n=11)	26.2%		
Housewife (n=17)	40.5%		
Civil servant (n=7)	16.7%		
Retired (n=7)	16.7%		
Presence of physical illness (%)			
Yes (n=21)	50%		
No (n=21)	50%		
Change in number of hospitalizations (%)			
Increased (n=2)	4.8%		
No change (n=40)	95.2%		
Change in number of BAD episodes (%)			
Increased (n=7)	16.7%		
Decreased (n=6)	14.3%		
No change (n=29)	69.0%		
Difficulty attending psychiatric follow-up (%)			
Yes (n=3)	7.1%		
No (n=39)	92.9%		
Difficulty accessing other departments (%)			
Yes (n=15)	35.7%		
No (n=27)	64.3%		
Medication use (%)			
Depot antipsychotic (n=4)	9.5%		
Oral antipsychotic (n=38)	90.5%		
Mood stabilizer (n=38)	90.5%		
Antidepressant (n=6)	14.3%		
	Min-max	\bar{X}	SD
Fear of COVID-19 Scale	7-35	15.21	7.57
WHODAS 2.0	0-25	10.29	7.27
CGI	1-4	2.57	0.77

Note. BAD=Bipolar Affective Disorder; WHODAS 2.0=World Health Organization Disability Assessment Schedule 2.0; CGI=Clinical Global Impression Scale

Findings Related to Participants' Clinical Data

The correlations between illness severity, fear of COVID-19, and quality of life scores among participants are summarized in Table 2 (Table 2). No significant relationship was found between illness severity and fear of COVID-19 scores ($r=-0.097$, $p>0.05$). Similarly, no significant correlation was observed between illness severity and quality of life ($r=0.241$, $p>0.125$). In addition, there was no significant association between fear of COVID-19 and quality of life scores ($r=0.092$, $p>0.05$).

Table 2. Correlation between Quality of Life, Illness Severity, and Fear of COVID-19

		1	2	3
(1) WHODAS 2.0	r	1		
	p			
(2) Fear of COVID-19 Scale	r	0.092	1	
	p	0.564		
(3) CGI	r	0.241	-0.097	1
	p	0.125	0.542	

Note. WHODAS 2.0=World Health Organization Disability Assessment Schedule 2.0; CGI=Clinical Global Impression Scale

DISCUSSION

In our study, the level of fear related to COVID-19 and the quality of life of patients diagnosed with Bipolar Affective Disorder (BAD) who were being followed at our Community Mental Health Center (CMHC) were investigated. Additionally, changes in the frequency of illness episodes and hospital follow-ups during the COVID-19 pandemic were evaluated. Finally, the relationships between fear of COVID-19, illness severity, and quality of life were examined. The findings indicated that there were no significant changes in the frequency of mood episodes or psychiatric hospital admissions during the pandemic, and the majority of patients did not experience difficulties in continuing their follow-up appointments.

In our study, it was observed that half of the patients had comorbid physical illnesses. Additionally, the fact that nearly half of the individuals experienced difficulties in accessing other medical departments for the follow-up of their physical conditions highlighted an important issue that warranted attention during the pandemic. During the pandemic period, the follow-up of various conditions that require close monitoring—such as cardiovascular, endocrine, and neurological disorders—might have been disrupted (Keesara, Jonas & Schulman, 2020). Considering that, in addition to physical illnesses requiring follow-up, various psychiatric disorders—such as those examined in this study—also demand close monitoring, we believe that our findings might serve as a source of inspiration for future research. Contrary to previous studies, however, our study did not find a significant relationship between the presence of a physical illness and the severity of fear related to COVID-19 (Bakioğlu et al., 2021).

Psychopharmacological interventions played an essential role in the treatment of individuals diagnosed with severe mental disorders (SMD). However, there was also a critical need for community-based mental health practices that provided continuous psychosocial support, the development of individualized treatment and care plans, and the reintegration of individuals into society. At Community Mental Health Centers (CMHCs), which were established for this purpose, not only the individuals diagnosed with a disorder but also their social support networks were included in the treatment system, and a multidisciplinary approach was adopted. Given that our study was conducted within a CMHC, where patients were followed using a multidisciplinary approach, it was possible that the majority of participants did not experience significant difficulty in accessing non-psychiatric medical

services. However, the fact that a noteworthy proportion of patients reported experiencing such difficulties outside the CMHC setting was significant in terms of case management and highlighted an area that warranted further attention. In a longitudinal study conducted by Dickerson et al., which compared patients diagnosed with schizophrenia and bipolar disorder to a control group, it was found that individuals with SMD had higher levels of stress and were more likely to neglect their hospital follow-up appointments compared to the control group (Dickerson et al., 2022). Although our study was cross-sectional, 92.9% of the participants reported that they did not experience difficulties in continuing their psychiatric follow-up appointments. The fact that psychiatric monitoring during the COVID-19 pandemic was carried out not only through in-person visits but also via telephone and, when necessary, home visits (in urgent cases and compliance with social distancing measures) might have contributed to the low rate of reported difficulties among patients.

Moreover, during the pandemic, it was found that there was no change in psychiatric hospitalization frequency for nearly all participants, and more than half reported no change in the frequency of manic and/or depressive episodes. A certain proportion reported a decrease in the number of episodes compared to previous years. The effective utilization of community-based mental health systems—particularly during challenging conditions such as the COVID-19 pandemic—may play a protective role by reducing patients' feelings of isolation and loneliness, thereby lowering the risk of relapse (Castelpietra et al., 2021; Clerici et al., 2020). In a study involving a total of 56 patients diagnosed with either BAD or Major Depressive Disorder, symptom severity, and mood changes were examined during the early phase of the pandemic in individuals with serious mental illness. The study found no significant differences compared to the pre-pandemic period. Surprisingly, participants reported a significant increase in their sense of well-being during the early phase of the pandemic (Pinkham et al., 2020). The finding that individuals with greater social resources before the pandemic reported increased well-being at the onset of the pandemic is consistent with the results observed in our study (Pinkham et al., 2020).

A higher level of social support appears to be associated with greater psychological resilience (Liu, Zhang, Wong & Hyun, 2020). In a comprehensive study conducted by Tundo et al., which included 194 patients diagnosed with BAD, participants were evaluated over a period that included the post-pandemic quarantine phase. The findings indicated that patients adapted well to the pandemic, and the negative impact of the pandemic on psychopathology was found to be low (Tundo et al., 2021). In 50% of the patients, the psychological responses

observed were found to be similar to those of close friends and relatives without psychiatric disorders. Notably, one in three patients reported perceiving the quarantine period in a positive light (Tundo et al., 2021). In a study conducted during the early phase of the pandemic with 70 patients diagnosed with BAD, which evaluated fear of COVID-19, positive coping, and the severity of psychopathology, it was found that manic symptoms and fear of COVID-19 were higher during the early phase but decreased over time. Similarly, the use of positive coping strategies was also more prominent in the early phase and declined as time progressed (Koenders et al., 2021). In another study conducted with patients over the age of 50 diagnosed with BAD, no worsening of BAD symptoms was observed following the pandemic; on the contrary, a decrease in symptom levels was reported. However, feelings of loneliness and the use of passive coping strategies were found to be associated with symptom worsening (Orhan et al., 2021).

When examining the participants' COVID-19 fear scores, it was noted that no cut-off point had been established in either the original development study or the Turkish validity and reliability study of the scale (Ahorsu et al., 2020a; Bakioğlu et al., 2021). However, in the Turkish validity and reliability study of the scale conducted on a community sample, the mean score was reported as 19.44 ± 6.07 (Bakioğlu et al., 2021). In a study involving 43 patients with BAD and 24 healthy controls, the mean fear of COVID-19 scores were reported as 14.81 ± 6.37 and 15.83 ± 5.94 , respectively. No significant difference was found between the two groups (Karantonis et al., 2021). Although the absence of a control group in our study prevented statistical comparisons in terms of significance, the fear of COVID-19 levels observed in our participants appeared to be lower than the community average. While it could have been speculated that this lower level was due to a lack of information about COVID-19, we did not consider lack of knowledge to be a primary factor, as patients with BAD regularly received information about COVID-19 during their follow-up at the CMHC, including in-person visits, phone calls, and/or home visits. However, it should be noted that the participants' level of knowledge was not measured before or after these informational interventions. Additionally, the passage of time might have led participants to recall their fear levels as lower than they actually were at the time. While there was limited literature examining the relationship between fear of COVID-19 and quality of life in individuals with psychiatric disorders, community-based studies had shown that fear of COVID-19 was related to mental health. Therefore, this issue should be explored in greater detail to better understand how individuals diagnosed with

BAD experienced the pandemic and to plan the types of support they might require (Ahorsu, Lin & Pakpour, 2020b; Fofana et al., 2020; Şimşir, Koç, Seki & Griffiths, 2022).

In line with the objectives of our study, the results regarding quality of life as measured by the WHODAS 2.0 revealed that the participants had a mean impairment score of 10.29 (SD=7.27). In the literature, there are varying opinions regarding the cut-off score for WHODAS. However, in the Turkish validity and reliability study of WHODAS 2.0, a cut-off point of approximately 1.5 was determined using ROC analysis (Aslan Kunt & Dereboy, 2018). In a study by Andrews et al., the mean impairment score on the quality of life among individuals with any mental disorder (including mood disorders, anxiety disorders, and substance use disorders) was found to be 6.3. Based on this, a cut-off score of 10 was proposed, suggesting that individuals scoring 10 or above may be experiencing clinically significant impairment in quality of life (Andrews, Kemp, Sunderland, Von Korff & Ustun, 2009). The fact that the mean score in our sample was considered borderline according to some studies and was above the cut-off point according to others might be interpreted as an indication that further research is still needed regarding quality-of-life assessments in individuals with psychiatric disorders.

In a study conducted on a community sample examining the relationship between fear of COVID-19 and quality of life as measured by the Short Form-12 (SF-12), increased fear was found to be associated with lower quality of life (Öztürk Çopur & Karasu, 2021). However, in another study where the quality of life in patients with BAD was assessed using the "Quality of Life in Bipolar Disorder Scale–Short Form," it was found that subjective quality of life was not associated with fear of COVID-19, changes in social rhythm, mood lability, or lifestyle changes. (Karantonis et al., 2021). Considering the conflicting findings in the literature on this topic, the results of our study—which did not find a relationship between fear of COVID-19 and quality of life—can be regarded as valuable. The relatively small sample size might have contributed to this outcome. Taking into account that no increase in the number of episodes or hospitalizations was observed among patients with BAD during the pandemic, the lack of a significant relationship between fear of COVID-19 and quality of life might be the result of stable and regular follow-up provided by healthcare professionals. Future studies are recommended to compare these findings with those of patients diagnosed with BAD who are not being followed at CMHCs (Karantonis et al., 2021).

CONCLUSION

In conclusion, this study aimed to evaluate the levels of COVID-19-related fear, quality of life, and follow-up processes during the pandemic among individuals diagnosed with BAD in remission and receiving care at a CMHC. The findings provided preliminary data supporting the potential protective role of CMHCs. Our study was among the limited number of studies offering data on fear of COVID-19 and quality of life in individuals with BAD followed at CMHCs in the post-pandemic period. To better understand how individuals with BAD were affected by the COVID-19 pandemic, further research that includes pre-pandemic data was deemed essential. Identifying the mental health needs of individuals with BAD was considered important not only for developing emergency strategies to respond to global stressors such as pandemics, but also for improving preparedness for similar situations in the future.

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HEALTHCARE PROFESSIONALS' PREPAREDNESS STATUS AND PERCEPTIONS IN DISASTER MANAGEMENT: THE CASE OF THRACE REGION PRIVATE MEDICAL CENTERS

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ABSTRACT

This descriptive study aimed to determine the disaster preparedness and perceptions of the personnel in private medical centers in the Thrace region from May to July 2024, with a sample size of 205 participants. Data were collected using “Demographic Data Form” and “Disaster Preparedness Perception Scale”. Parametric test techniques were applied using the SPSS 26.0 program. Among participants, 36.6% were aged 35 to 44 years, with 30.2% being high school graduates and 30.7% holding an associate degree. The roles included 31.7% paramedics and 32.7% emergency medical technicians. 125 participants (61.0%), associated disasters with events like earthquakes and floods. Additionally, 141 participants (68.8%) reported receiving disaster preparedness training, with 44% receiving theoretical training only and 56% engaging in both theoretical and practical training. 52 participants (25.4%) had previously participated in a drill, 135 (65.9%) believed their workplaces were somewhat prepared for a disaster. Significant differences were noted in the scale and preparation and intervention phases based on disaster training and drill participation ($p<.05$). The study concluded that personnel who received disaster training and participated in drills scored higher in both disaster preparation and intervention phases, underscoring the need for enhanced and more frequent training initiatives.

INTRODUCTION

Natural phenomena occur incessantly across the globe. For a natural event to be classified as a disaster, it must result in detrimental effects on public health. These effects encompass injuries, disabilities, and fatalities among individuals, as well as the insufficiency of existing resources to address the crisis. Numerous studies have delineated a wide array of consequences stemming from disasters. These may encompass considerable loss of life, enduring financial strains (Pearson & Sommer, 2011), profound economic and political ramifications (Rodríguez, Vitoriano, and Montero, 2011), and social and psychological challenges. Additionally, disasters can lead to the destruction of infrastructure, damage to residential properties, loss of assets, and a pervasive disruption of social cohesion within communities (Malgarejo & Lakes, 2014). Given that the foremost concern is the considerable loss of life and the significant long-term

costs (Pearson & Sommer, 2011), health services emerge as a pivotal element in disaster management when viewed through this lens. Effective disaster preparedness, response, and recovery require a coordinated effort from adept professionals, as some may lack the requisite knowledge and experience to navigate high-pressure situations effectively (Walsh et al., 2012). Disasters severely impede the provision of health services by compromising the infrastructure of healthcare facilities in the affected areas. Integrating business continuity planning and management into emergency preparedness is essential to ensure the uninterrupted delivery of health services. Prior to disasters, initiatives are undertaken to enhance and expand the capacity of health systems. These efforts involve strengthening infrastructures, providing specialized training for healthcare personnel in disaster response, conducting planning and simulation exercises. In the aftermath of disasters, healthcare remains the most critical service, both during the acute phase and in the long term. It is imperative for all healthcare professionals to comprehend the principles of disaster medicine to respond accurately and effectively. Understanding their specific roles is crucial for health staff, particularly in relation to medical interventions across various disaster scenarios (Kocak, Kinik, Caliskan & Aciksari, 2021; Pourhosseini, Ardalan & Mehrolhassani, 2011). In this context, the preparedness and perception of preparedness among healthcare workers are of paramount importance. Effective disaster management facilitates quicker access to disaster victims, thereby enabling efficient and rapid recovery efforts (Sabharwal & Swarup, 2012). However, managing the response process during disaster situations presents challenges, particularly in addressing immediate needs and fulfilling the health requirements of the affected population (National Disaster Management Authority [NDMA], 2013). In this context, the disaster preparedness of healthcare providers is vital at local, regional, and national levels (Khirekar, Badge, Bandre & Shahu, 2023). Healthcare organizations must be equipped to effectively manage potential crises that may arise at any given moment. Healthcare professionals, including physicians, nurses, and support staff, are indispensable assets during a disaster. The continuity of medical facilities and the efficacy of response efforts are heavily contingent upon the safety and well-being of these individuals. To safeguard their health and enhance their capacity to deliver care, healthcare workers must undergo training in emergency protocols, be provided with necessary protective equipment, and have access to reliable communication systems. This comprehensive strategy is encapsulated in the concept of disaster preparedness (Khirekar et al., 2023). For disaster plans to be effective within healthcare organizations, personnel must possess a thorough understanding of their specific roles and responsibilities. Consequently, disaster training is essential for all healthcare facilities to ensure readiness for potential disasters (Bistaraki, Waddington & Galanis, 2011).

In disaster scenarios, medical institutions play a crucial role in delivering health services to affected populations. Without adequate preparation and planning, it becomes exceedingly challenging to provide these vital services effectively and promptly. Thus, all healthcare institutions, particularly hospitals, occupy a pivotal position during disaster situations (Kavari & Mobaraki, 2012). Both disaster preparedness and the perception of readiness among personnel in all healthcare institutions are critical for public health and safety. Regular training for staff, strategic planning for disaster scenarios, and coordinated action are essential for delivering effective interventions during emergencies. This approach is vital for the sustainability of public health and healthcare services. This study aims to assess the levels of disaster preparedness and the perception of preparedness among personnel working in private health institutions that provide outpatient diagnosis and treatment in the Thrace Region, to examine these factors in relation to specific variables. Research questions: Accordingly, the following research questions were raised:

1. What is the level of preparedness among personnel employed in private healthcare centers that offer outpatient diagnosis and treatment with respect to the concept of disaster?
2. How does the preparedness of healthcare personnel for disaster management vary based on their training in disaster response, participation in simulation drills, and professional experience?

MATERIAL AND METHOD

Research Type and Data Collection

This descriptive study was carried out from May 2024 to July 2024, involving personnel from four outpatient diagnosis and treatment centers in Edirne, nineteen in Tekirdağ, and five in Kırklareli within the Thrace Region. To enhance the effectiveness of data collection, preliminary interviews were conducted with senior managers of the facilities, and a suitable time frame was established based on the operational hours of the organizations. Subsequently, the study was conducted with personnel were present at their workplaces on the day of the visit and who provided informed consent to participate (n=205).

Study Population and Sample

In this study, no sampling method was employed. Instead, the entire population of 28 outpatient diagnosis and treatment services across the three provinces in the Thrace Region was considered be sample (231). However, the research sample was composed of all personnel who were not on leave during the scheduled visit days and who voluntarily consented to participate

after receiving adequate information about the study. Ultimately, the research sample consisted of 205 personnel who agreed to participate and were actively engaged in their duties on the day of the visit.

Data Collection Tools

In the study, a 16-item “Demographic Data Form” and a 20-item “Disaster Preparedness Perception Scale” were used as data collection tools.

Demographic Data Form:

The first part of the questionnaire included 16 questions about the introductory characteristics of the employees working in private medical centres where outpatient diagnosis and treatment are provided (questions about age, gender, education level and disaster preparedness).

Disaster Preparedness Perception Scale:

The scale used in the study was developed by utilizing the scales created for nurses by Fung, Loke, and Lai (2008) and Bond and Tichy (2007), Özcan (2013) determined in his master's thesis that there was no measurement tool to determine the level of preparedness of nurses serving in our country against disasters as a result of the literature review. The Nurses' Disaster Preparedness Perception Scale (DPS) was developed by Özcan (2013) measure nurses' perceptions of preparedness regarding disaster management. Initially, a 35-question draft of DPS was created by Özcan (2013). The scale was reduced to 30 questions based on the opinions of 10 nurses. Then, a 24-question scale was created based on the opinion of a Turkish language expert. The draft scale was sent to 6 experts for content validity. Some questions were changed in line with the opinions of the experts. Later, the scale was surveyed with 500 nurses where 4 questions were removed during the validity and reliability tests. Thus, the scale was reduced to 20 questions. The scale was created as the Preparation phase (questions 1-6), the Intervention phase (questions 7-15), and the Post-disaster phase (questions 16-20). The items of the scale were arranged as a five-point Likert type (1-Strongly disagree, 2-Disagree, 3-Partially agree, 4-Agree, 5-Strongly agree) scale and as the score obtained from the scale increases, the perception of disaster preparedness also increases. The Cronbach's alpha value was 0.907 and the test-retest reliability coefficient was 98%. Özcan (2013) stated in his study that the scale could be used provided that reference was made. However, it was necessary to make contact via e-mail to provide information. The Cronbach Alpha coefficient calculated for the entire scale used in this study is 0.789 (Table 1). In this study, the independent variables of the research are age,

gender, educational status, occupation, working period, definition of disaster and the level of preparedness for disasters. The dependent variables are the disaster preparedness perception scale and its score averages. The ranges within which the alpha coefficient can be found and, accordingly, the reliability status of the scale are given below. Accordingly; • If $0.00 \leq \alpha < 0.40$, the scale is not reliable, • If $0.40 \leq \alpha < 0.60$, the scale has low reliability, • If $0.60 \leq \alpha < 0.80$, the scale is highly reliable, • If $0.80 \leq \alpha < 1.00$, the scale is a highly reliable. As a matter of fact, the alpha coefficient of the scale used in the study which ranges between 0.80 and 1 shows that the survey is quite reliable (Kalaycı, 2008; Özdamar, 1997).

Ethical Consideration

For the study, a sample of private health institutions in the Thrace Region was selected and the personnel in the health institutions were intended to participate in the study on a voluntary basis. Private medical centers are among private health institutions that provide outpatient diagnosis and treatment (Official Gazette No. 26788, 2008; Social Security Institution Health Implementation Communiqué, 2022). A one-to-one preliminary interview was conducted with the senior managers of these institutions and the existence of the ethics committee approval document was deemed sufficient for the conduct of the study. Ethical committee approval for this study was obtained from Trakya University (Date: January 24, 2024, Decision No: 01/38). The participating personnel were informed before the data form provided to them.

Data Analysis

The SPSS (Statistical Package for the Social Sciences) 26.0 statistical program was used for data analysis. In the evaluation of the data, frequency, percentage, arithmetic mean, and standard deviation were used to assess the demographic characteristics of the participants. To evaluate the relationship between the demographic characteristics of the personnel and the disaster preparedness perception scale independent sample t-test, ANOVA, and post hoc Tukey tests were employed.

Limitation

The study was conducted on personnel working in private medical centres in the Thrace region which is a limitation of the study. Therefore, the study results cannot be generalized to all regions in Türkiye.

RESULTS

In this section of the study, the reliability analysis of the scale, the frequency distributions and percentages of the demographic and other characteristics of the participants evaluated within the scope of the study were examined. When more than one study or application is conducted on a scale, the consistency of the results obtained is an indicator of the reliability of that scale. Therefore, it is necessary to examine the Cronbach's alpha Coefficient in order to test the reliability of the scale used in the study (Hamarat, 2017). For the current study, the Cronbach Alpha internal consistency coefficient of the Disaster Preparedness Perception scale was calculated as 0.789, the coefficient of the preparation phase sub-dimension as 0.823; the coefficient of the intervention phase sub-dimension as 0.729, and the coefficient of the post-disaster phase sub-dimension as 0.883 (Table 1).

Table 1. Descriptive Statistics for the Disaster Preparedness Perception Scale

Scale	Min.	Max.	\bar{X}	s	Skewness	Kurtosis	Cronbach Alfa
Disaster Preparedness Perception	54.00	76.00	65.7317	4.94789	-.243	-.548	0.789
Preparation phase	20.00	27.00	23.7707	1.70671	-.557	.025	0.823
Intervention phase	20.00	36.00	27.6927	3.56703	-.038	-.836	0.729
Post-disaster phase	12.00	16.00	14.2683	.97076	-.269	-.474	0.883

Findings on Participants' Demographic Information

According to Table 2, which examines the demographic characteristics of the participants; The largest age group is 35-44 years (36.6%), indicating a predominance of middle-aged participants. Younger participants (18-24 years) represent only 17.0%, suggesting that the workforce may be skewed towards more experienced individuals. In addition, 97 participants (47.3%) were female and 108 (52.7%) were male. The gender distribution is relatively balanced, with a slight male majority (52.7%). This suggests a diverse representation in terms of gender among participants. The majority of participants hold either a high school (30.2%) or associate degree (30.8%). Higher education levels (Master's and Doctorate) are less represented, indicating a workforce that may be more focused on practical skills rather than advanced academic qualifications. The largest professional groups are Emergency Medical Technicians (32.7%) and Paramedics (31.7%), highlighting a strong representation of frontline emergency responders. The majority of participants have between 6-20 years of experience, with the highest group being 11-15 years (31.7%). This indicates a workforce that is relatively experienced, which may contribute to their understanding of disaster preparedness. When asked what came to their mind when disaster was mentioned, the predominant concept associated with

disasters is natural disasters (61.0%), indicating a strong awareness of environmental risks. A significant majority (68.8%) of participants have received disaster-related training, indicating a well-prepared workforce. However, 31.2% have not received training, highlighting an area for improvement in ensuring all personnel are adequately trained. Most participants received training that includes both theory and practice (56.0%), which is essential for effective disaster preparedness. A large majority (74.6%) did not participate in demonstrations, which may limit their practical experience in disaster scenarios. Encouraging participation in demonstrations could enhance hands-on skills and confidence. Most participants perceive their workplace as partially prepared (65.9%), indicating a need for further improvements in disaster readiness. Only 34.1% feel their workplace is fully prepared, suggesting areas for development in policies and resources. The demographic analysis reveals a workforce that is predominantly experienced and trained in disaster preparedness, with a strong representation of emergency responders. However, there are notable areas for improvement, particularly in practical training, participation in demonstrations, and enhancing workplace preparedness. Future training initiatives should focus on increasing engagement in practical exercises, addressing gaps in training for those without disaster-related education, and fostering a more comprehensive understanding of various disaster types beyond natural disasters (Table 2).

Table 2. Findings on Participants' Demographic Information (n: 205)

Age	n	%
18-24 Years	35	17.0
25-34 Years	45	22.0
35-44 Years	75	36.6
45-54 Years	30	14.6
55+ Years	20	9.8
Total	205	100.0
Gender		
Female	97	47.3
Male	108	52.7
Total	205	100.0
Educational status		
High school	62	30.2
Associate degree	63	30.8
Bachelor's degree	55	26.8
Master's degree	10	4.9
Doctor of philosophy	15	7.3
Total	205	100.0
Profession		
Doctor	15	7.3
Paramedic	65	31.7
Emergency Medical Technician	67	32.7
Driver	10	4.9
Other	48	23.4
Total	205	100.0
Experience		

1-5 years	10	4.9
6-10 years	62	30.2
11-15 years	65	31.7
16-20 years	58	28.3
21+	10	4.9
Total	205	100.0
The concepts that come to mind when disaster is mentioned.		
Earthquake, flood, landslide, avalanche, storm	125	61.0
Flu, dysentery and epidemics	37	18.0
Explosion, forest fire	33	16.1
Accidents such as traffic, ship, airplane etc.	10	4.9
Total	205	100.0
Receiving disaster-related training		
Yes	141	68.8
No	64	31.2
Total	205	100.0
Content of the training		
Theory	62	44.0
Theory+Practice	79	56.0
Total	141	100.0
Taking part in the demonstration		
No	153	74.6
Yes	52	25.4
Total	205	100.0
Disaster preparedness status of the workplace		
Partially prepared	135	65.9
Fully prepared	70	34.1
Total	205	100.0

Comparison of the Total Scores Obtained by Participants on the Disaster Preparedness Perception Scale and Its Sub-Dimensions with Their Disaster Training Status

When comparing the total scores obtained by participants on the Disaster Preparedness Perception Scale and its sub-dimensions with their disaster training status, statistically significant differences were found in the Disaster Preparedness Perception Scale itself as well as in the preparation phase and intervention phase sub-dimensions ($p < .05$). The significant differences stem from the higher average scores of participants who had received prior training. The results clearly indicate that receiving disaster-related training significantly enhances participants' perceptions of their preparedness, particularly: the Disaster Preparedness Perception, Preparation Phase, and Intervention Phase. The statistically significant differences ($p < .05$) in these areas highlight the importance of training in equipping healthcare personnel with the confidence and skills necessary for effective disaster response. However, the lack of significant difference in the Post-Disaster Phase suggests that other factors may influence perceptions of preparedness in the aftermath of a disaster. This could imply that while training is essential for preparation and intervention, additional strategies may be needed to improve perceptions of readiness for post-disaster scenarios. The findings in Table 3, underscore the

critical need for ongoing disaster training programs to enhance preparedness across various phases of disaster management, particularly in preparation and intervention (Table 3).

Table 3. Comparison of Total Scores from the Disaster Preparedness Perception Scale and Its Sub-Dimensions with The Status of Receiving Disaster Education

	Situation	n	\bar{X}	s	t	sd	p
Disaster Preparedness Perception	No	141	65.1560	4.89939	-2.540	203	.013
	Yes	64	67.0000	4.85341			
Preparation phase	No	141	23.5745	1.71645	-2.474	203	.014
	Yes	64	24.2031	1.61520			
Intervention phase	No	141	27.2979	3.46564	-2.379	203	.018
	Yes	64	28.5625	3.65963			
Post-disaster phase	No	141	14.2837	.98072	.336	203	.737
	Yes	64	14.2344	.95522			

Comparison of the Total Scores Obtained from the Disaster Preparedness Perception Scale and Its Sub-Dimensions with The Participants' Involvement in Drills

According to the results of the independent samples t-test conducted to examine whether the scores obtained from the Disaster Preparedness Perception Scale and its sub-dimensions significantly vary based on the participants' prior involvement in drills, statistically significant differences were found. These differences were found in the scale itself as well as in the preparation phase and intervention phase sub-dimensions ($p < .05$). The significant differences stem from the higher average scores of participants who had previously participated in drills. These findings highlight the critical role of disaster drills in improving overall preparedness among healthcare personnel. Regular participation in drills should be emphasized as part of a comprehensive disaster management training program to ensure that personnel feel equipped to handle various phases of disaster response effectively. Future training initiatives might also need to focus on enhancing perceptions of readiness in the post-disaster context, potentially through additional training or support systems (Table 4).

Table 4. Comparison of Total Scores from The Disaster Preparedness Perception Scale and Its Sub-Dimensions with The Status of Taking Part in the Drill (Independent Sample T-Test)

	Situation	n	\bar{X}	s	t	sd	p
Disaster Preparedness Perception	No	153	65.1634	4.97422	-2.871	203	.005
	Yes	52	67.4038	4.51255			
Preparation phase	No	153	23.5948	1.73371	-2.567	203	.011
	Yes	52	24.2885	1.52543			
Intervention phase	No	153	27.2941	3.50354	-2.789	203	.006
	Yes	52	28.8654	3.52598			
Post-disaster phase	No	153	14.2745	.97492	.157	203	.875
	Yes	52	14.2500	.96761			

Comparison of the Total Scores Obtained from the Disaster Preparedness Perception Scale and Its Sub-Dimensions with Professional Experience (ANOVA).

According to the results of the ANOVA conducted to examine whether the scores obtained from the Disaster Preparedness Perception Scale and its sub-dimensions significantly vary among professional experience groups, statistically significant differences were found in the scale itself as well as in the preparation phase and intervention phase sub-dimensions ($p < .05$). Post-hoc analyses using Tukey's test indicated which options the significant differences stemmed from, showing that the 6-10 years and 16-20 years groups were significant across all three dimensions. The significant differences observed in the comparisons among the options were due to the higher average scores of participants with 16-20 years of experience. The post-disaster phase scores remain relatively stable across all experience levels, with no significant variation. This suggests that perceptions of preparedness for post-disaster situations are less influenced by years of experience compared to other phases. These findings underscore the importance of ongoing training and experience in disaster preparedness. While increased experience correlates with improved perceptions of preparedness, particularly in intervention, there may be a need for targeted training to enhance readiness in the preparation and post-disaster phases. Future training programs should consider incorporating elements that address these specific areas to further improve overall disaster preparedness (Table 5).

Table 5. Comparison of Total Scores from The Disaster Preparedness Perception Scale and Its Sub- Dimensions with Professional Experience (ANOVA)

	Years	N	\bar{X}	s
Disaster Preparedness Perception	1-5	10	64.5000	4.06202
	6-10 ^b	61	64.1311	5.00158
	11-15	65	66.0154	5.28113
	16-20 ^d	58	67.4483	4.04003
	21+	10	65.3000	5.43752
Preparation phase	1-5	10	23.7000	1.33749
	6-10 ^b	61	23.2623	1.78794
	11-15	65	23.7846	1.79837
	16-20 ^d	58	24.3276	1.36867
	21+	10	23.9000	1.85293
Intervention phase	1-5	10	26.5000	3.30824
	6-10 ^b	61	26.5410	3.60820
	11-15	65	27.9692	3.73317
	16-20 ^d	58	28.8966	2.94207
	21+	10	27.3000	3.97352
Post-disaster phase	1-5	10	14.3000	.82327
	6-10	61	14.3279	.74658
	11-15	65	14.2615	.95651
	16-20	58	14.2241	1.18534
	21+	10	14.1000	1.19722

DISCUSSION

Disaster preparedness encompasses a comprehensive array of actions designed to ensure readiness prior to the occurrence of a disaster. This includes the identification of risks, the formulation of plans and policies, the development of educational and training programs—such as drills and exercises aimed at enhancing preparedness—the preparation of the healthcare system for effective disaster response, and fostering disaster knowledge and awareness among healthcare providers (Al Harthi, Al Thobaity, Al Ahmari & Almalki, 2020). Consequently, hospitals and all healthcare institutions occupy a critical role during disaster situations (Kavari & Mobaraki, 2012). Advanced educational qualifications have been reported to significantly influence healthcare workers' willingness to engage in disaster and emergency response efforts (Al-Hunaishi, Hoe & Chinna, 2019). A study conducted by Sultan et al. (2020) corroborated these findings, demonstrating that participants felt theoretically well-prepared. Those with more extensive educational backgrounds exhibited heightened confidence in their ability to act during emergencies and disasters (Sultan et al., 2020). Notably, a majority of participants in this study (68.8%) reported having received disaster-related training. However, several studies have indicated that receiving training does not necessarily equate to a willingness to take action; rather, staff readiness to manage a situation appears to be closely linked to their knowledge and experience in disaster management (Cotanda et al., 2016; Diakakis, 2020). Nevertheless, numerous studies have shown that disaster preparedness training positively impacts healthcare personnel's responses to disasters and emergencies, helps identify gaps in their knowledge and preparedness (Patel et al., 2017; Veenema et al., 2016). Given that knowledge and experience can enhance willingness to participate in the care of victims during hazardous events, it is imperative to provide disaster-specific training to healthcare personnel. Such training can bolster their disaster-related knowledge, increase their self-confidence, and mitigate their fears. Furthermore, there should be a greater emphasis on multi-agency and multi-professional training for all personnel, particularly healthcare workers, regardless of their roles or involvement in direct patient care. This approach will better prepare them to respond collectively to disasters and emergencies (Sultan et al., 2020). The objective of this study is to assess the disaster preparedness of employees working in private outpatient diagnosis and treatment centers and to evaluate their perceived readiness. By implementing the necessary precautions and intervention strategies, the adverse effects of disasters can be significantly minimized (Bahçebaşı, 2013). It has been observed that 61% of participants working in private outpatient diagnosis and treatment centers associate the term "disaster" primarily with natural

calamities such as earthquakes, floods, and landslides. Similarly, other studies have demonstrated that nearly all participants categorize situations deemed as "disasters" within the realm of nature-based events, including earthquakes, floods, and hurricanes (Göktekin, 2018; Tercan & Şahinöz, 2015). This underscores the significance of participating in disaster drills and acquiring experience in this domain as essential components of disaster preparedness.

Moreover, employees who took part in drills at outpatient diagnosis and treatment centers achieved notably high average scores on the Disaster Preparedness Perception Scale and its sub-dimensions. Findings from related studies further corroborate this outcome (Kocaman & Şahinöz, 2019; Sevinç, Güner & Til, 2017). The research revealed that participants with 16 to 20 years of experience in outpatient diagnosis and treatment centers scored higher on the scale, indicating that their perceptions of disaster preparedness were more favorable compared to those with less professional experience. The existing literature also includes studies that report a positive correlation between longer durations of employment and increased disaster preparedness perception scores (Basal & Ahmed, 2018; Dinçer & Kumru, 2021; Nofal et al., 2018; Tassew et al., 2022). This finding suggests that as personnel accumulate professional experience, they develop a deeper understanding of the critical importance of disaster preparedness.

CONCLUSION

Historically, disaster management in our country has predominantly adopted a response-based approach. However, in recent years, a paradigm shift has occurred with the implementation of a risk management framework designed to mitigate vulnerabilities, placing it at the core of modern disaster management processes. This holistic approach has positioned health services as a crucial stakeholder in national disaster management, influencing both risk management and crisis management strategies. In this context, it is imperative to prepare all healthcare institutions and personnel for disaster scenarios to facilitate the effective coordination of emergency medical interventions. Furthermore, enhancing the resilience of the health system and ensuring the continuous delivery of health services during emergencies are essential objectives. The capacity of healthcare workers to communicate effectively coordinate, and collaborate with one another and other rescue teams during disasters significantly enhances the efficacy of interventions. According to the findings of the study, 68.8% of employees at private outpatient diagnosis and treatment centers have received disaster-related training. A comparative analysis of total scores from the Disaster Preparedness Perception Scale and its sub-dimensions revealed that trained personnel achieved higher scores across these dimensions.

These findings underscore the critical need for an increased rate of disaster-related training among all healthcare workers within a comprehensive disaster management framework to bolster overall preparedness.

Furthermore, statistically significant differences were identified in the Disaster Preparedness Perception Scale and its sub-dimensions among employees who had previously participated in drills at private outpatient clinics. It is anticipated that regular disaster drills will enhance personnel preparedness. Additionally, only 34% of the participating staff expressed confidence that their organizations were fully prepared for disasters. This study has illuminated the current state of disaster management among personnel working in private outpatient diagnosis and treatment centers and offers recommendations for enhancement. Development of Educational Curriculum: It is recommended that both formal and continuing education curricula be established for the training of personnel in outpatient diagnosis and treatment centers. Decision-makers and leaders should prioritize training activities that enhance the knowledge and skills necessary for personnel to respond effectively to all types of disasters. Improvement of Health Service Programs: Health service programs must be refined to enable personnel to operate effectively within the health system without encountering confusion arising from poor coordination or systemic deficiencies among organizations involved in disaster response. Effectiveness of Disaster Management Plans: Increasing the effectiveness of existing disaster management plans is crucial to ensure that all health service providers operate cohesively and understand one another during interventions. To enhance this area, it is advisable for all stakeholders, particularly those working in outpatient diagnosis and treatment centers, to be actively involved in the development of the disaster plan. The objectives and components of the plan should be grounded in the needs identified through comprehensive risk assessments and vulnerability analyses. Improvement of Policies and Procedures: Enhancing policies and procedures related to disaster management is vital to prevent conflicts of interest, including ethical dilemmas. It is recommended that experts in the field ensure that these policies and procedures are current and well-communicated to all personnel and other healthcare providers.

In conclusion, this study has determined the current status of personnel working in outpatient diagnosis and treatment private healthcare centres regarding disaster management and emphasized the need for further research and systematic reviews. Additionally, the findings of this study are crucial for ensuring the sustainability of health services and public health during disaster situations in our country.

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SELF-CARE BEHAVIOURS: A RESEARCH ON CASES OF HEART FAILURE

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ABSTRACT

The aim of the study was to evaluate the self-care behaviors of patients with heart failure (HF) and associated factors. This descriptive and cross-sectional study was conducted with 151 HF patients. Data were collected using the “Patient Information Form”, which included the descriptive characteristics of the patients, and the “European Heart Failure Self-Care Behavior Scale (EHFScBS)” to assess self-care behaviors. Descriptive statistics, Student's t-test and ANOVA test were used in statistical evaluation. Bonferroni test was used for post-hoc analyses. It was found that the total EHFScBS score of the participants was 35.07 ± 8.03 and 61.6% of the participants had inadequate self-care behaviors. It was determined that age, educational status, presence of additional disease and duration of diagnosis were significant determinants of self-care behaviors ($p < 0.05$). However, no significant difference was found between gender and marital status variables and EHFScBS ($p > 0.05$). As a result of the study, it has been determined that the self-care behaviors of HF patients are at a moderate level, and the majority of them have inadequate self-care behaviors. Accordingly, it is thought that it would be beneficial to develop strategies to increase self-care skills in HF patients and to inform health professionals on this issue.

INTRODUCTION

Despite all the advancements in healthcare, cardiovascular diseases (CVD) are still among the most common diseases today (Rajan et al., 2020). CVD causes approximately 20 million deaths each year. Reports indicate that approximately 29 million Americans, independent of hypertension, have CVD (Martin et al., 2024). Heart failure (HF), which has a significant place among CVD, is an important public health problem that affects approximately 64.3 million people worldwide and has high mortality rates. HF is a significant burden for the health economy (Bowen, Graetz, Emmert & Avidan, 2020; Savarese et al., 2023).

Heart failure is a multifactorial syndrome characterized by decreased ventricular filling capacity due to structural and functional cardiac dysfunction, with many cardiac and non-cardiac etiologies (Bozkurt et al., 2021; Savarese et al., 2023). Common symptoms in HF include shortness of breath, fatigue, and weakness. Additionally, rales, jugular venous engorgement and peripheral edema are associated with HF (McDonagh et al., 2021).

Although a decrease in the incidence of HF due to age has been reported in developed countries in recent years, a significant increase in the prevalence of HF is observed with age due to factors such as the prolonged life expectancy of the World's population in general and an increase in the prevalence chronic diseases (McDonagh et al., 2021). It is estimated that the prevalence of HF, which affects 64.3 million people globally, will increase by 25% as of 2030 (Savarese et al., 2023; Martin et al., 2024). In 2018, approximately 380,000 people in the USA died due to HF, while more than six million adults continue to live with HF (Virani et al., 2020). In 2030, this rate is estimated to exceed eight million (Khan et al., 2019). The prevalence of HF is reported to be increasing in the USA, Europe and Asian countries due to the aging population (Timmis et al., 2022). The economic burden of HF is heavy due to its intensive treatment process and the rates of rehospitalization (Tsao et al., 2023). It was reported that the prevalence of HF in adults in Türkiye was 2.9%. This means there were approximately three million adults diagnosed with HF in Türkiye, and this rate was reported to be quite high compared to European countries (Yilmaz et al., 2019).

The mortality rates in HF cases are high and the average life expectancy is five years for more than half of the patients (Shahim, Kapelios, Savarese & Lund, 2023). HF is one of the most significant causes of hospitalization in people aged 65 years and older. It causes a severe symptom burden in patients and negatively affects their quality of life. In addition to well-known symptoms such as dyspnea, edema, fluid retention and pulmonary congestion, patients with HF frequently experience pain, depression, gastrointestinal stress and fatigue. Self-care is thought to play a key role in providing symptom management, optimizing treatment compliance, preventing rehospitalizations, and increasing quality of life in patients with HF (Zhao, Chen, Zhang, Ye & Fan, 2020; Sahlin et al., 2022).

Although there are different definitions in the literature, the concept of self-care is generally described as "the ability of a person to decide what to do to cope when symptoms related to a disease occur and to take responsibility for their own health without being dependent on others" (Bayrak et al., 2019). The main goal of self-care is to enable the individual to take responsibility for their own health (Jiang et al., 2021). Therefore, self-care in HF is considered an important component of the success of treatment (Dogu Kokcu & Tiryaki, 2020).

Understanding self-care behaviors and affecting factors can help HF patients achieve better symptom management, increase their compliance with treatment, and reduce rehospitalization rates (Zhao et al., 2020; Sahlin et al., 2022). Based on this consideration, the aim of this study is to examine the self-care levels of individuals with HF and the determining factors. It is expected that the results of this study will guide health professionals, direct

strategies to be developed to increase self-care skills in these patients, and contribute to the literature.

Research Questions:

- Are the self-care behaviors of HF patients sufficient?
- What are the determinants of self-care behaviors in HF patients?

MATERIALS AND METHODS

Objective and Design

This study had a descriptive-cross-sectional design. The aim of the study was to evaluate the self-care behaviors of patients with HF and associated factors (Akbiyik, Kocak & Oksel, 2016; Ermis, Kasar, Karaman & Yildirim, 2018).

Population and Sample of the Study

The data of the study was collected in the cardiology clinic of a university hospital in western Türkiye between January and June 2024. The study population consisted of all HF patients who visited the aforementioned outpatient clinic on the dates of the study. The sample size of the study was calculated using the G*Power program (Version 3.1). In the calculation made based on the study conducted by Bayrak et al. (2019), the minimum required sample size of the study was determined as 128 patients with 95% power, 5% Type I error, 0.8 effect size and 95% confidence interval. The study was completed with 151 HF patients who met the inclusion criteria and filled out the data collection forms completely.

Inclusion Criteria:

- Being between the ages of 18 and 65,
- Having been diagnosed with HF at least six months ago,
- Receiving outpatient treatment in the outpatient clinic,
- Volunteering to participate in the study.

Exclusion Criteria:

- Being diagnosed with chronic kidney failure and on dialysis,
- Being diagnosed with cancer and receiving chemotherapy/radiotherapy,
- Having cognitive or communication barriers,
- Not wanting to participate in the study.

Data Collection Tools

Patient Information Form

The form included a total of seven questions regarding the characteristics of the participants, including their marital status, gender, age, diagnosis period, education level, and presence of comorbidities of the participants.

European Heart Failure Self-Care Behavior Scale (EHFScBS)

The scale was developed by Jaarasma et al (2003). It was later adapted to the Turkish society by Baydemir et al. (2013). EHFScBS is a five-point Likert-type scale and consists of 12 items. The scores obtained from the scale range from 12 to 60. Higher scale scores indicate poorer self-care behaviors. Scores at or below 36 indicate adequate self-care behaviors, while scores at or above 37 indicate inadequate self-care behaviors. The alpha reliability value of the scale was reported as 0.69 (Baydemir, Ozdamar & Unalir, 2013). The alpha reliability value was found to be 0.82 in our study.

Statistical Analysis

The Statistical Package for the Social Sciences (IBM SPSS Version 25) program was used to analyze the collected data. Normal distribution assumptions were tested using skewness and kurtosis values. The analyses included descriptive statistics (frequency, percentage, standard deviation, min-max values), Student's t-test, and ANOVA as parametric tests. In post hoc analyses, the Bonferroni test was applied for the pairwise comparisons of variables showing significant differences among three or more groups.

Limitations

This study was conducted in a single center. Additionally, due to the limited sample size, the results cannot be generalized to all HF patients. It is recommended that the study be repeated in multiple centers with larger samples and that regional differences be revealed by including HF patients from different regions of Türkiye in the sample.

Ethical Consideration

Before starting the study, ethics committee approval (Date: 20/12/2023; Number: 20.478.486-2082 - 2131), necessary institutional permissions, and permission to use EHFScBS in the study were obtained. The study was conducted in accordance with the principles of the Declaration of Helsinki. The participants were informed about the study, and their consent was obtained.

RESULTS

The mean age of the participants was 55.50 ± 7.19 years, and their mean duration of diagnosis was 4.64 ± 3.46 years. It was determined that 52.3% of the participants were female, 74.2% were married, 58.3% had primary school or lower levels of education, and 74.2% had comorbidities. Among those with comorbidities, 45.6% had hypertension, 57.1% had diabetes, 24.7% had respiratory tract diseases, 2.7% had renal diseases, and 10.7% had other diseases (Table 1).

Table 1. Descriptive Characteristics of Participants (n=151)

Descriptive Features	N	%
Gender		
Female	79	52.3
Male	72	47.7
Marital Status		
Married	112	74.2
Single	39	25.8
Education Status		
Primary school and below	88	58.3
High School	45	29.8
Bachelor's degree and above	18	11.9
Presence of Comorbidities		
Yes	112	74.2
No	39	25.8
Comorbidity*		
Hypertension	51	45.6
Diabetes	64	57.1
Respiratory system diseases	27	24.7
Kidney diseases	3	2.7
Other	12	10.7
	X±S.D.	Min-Max
Age	55.50 ± 7.19	37-65
Duration of Diagnosis	4.64 ± 3.46	1-13

* More than one option is selected; X: mean; S.D.: standard deviation; Min: minimum; Max: maximum

The mean total EHFScBS score of the participants was 35.07 ± 8.03 . Among the EHFScBS items, the participants had the lowest mean score in item 6 (1.45 ± 0.85), which is about limiting alcohol intake, and they had the highest mean score in item 12 (4.18 ± 1.05), which is about doing regular exercise (Table 2).

Table 2. Mean of Participants' Responses to EHFScBS Questions (n=151)

Scale Items	X±S.D.	Min-Max
I1	3.94 ± 0.98	1-5
I2	2.37 ± 1.08	1-5
I3	2.70 ± 1.15	1-5
I4	2.76 ± 1.11	1-5
I5	2.92 ± 1.72	1-5
I6	1.45 ± 0.85	1-5
I7	2.36 ± 1.01	1-5

I8	2.63±1.07	1-5
I9	3.03±1.23	1-5
I10	2.66±1.38	1-5
I11	4.01±1.24	1-5
I12	4.18±1.05	1-5
EHFScBS Total Score	35.07±8.03	16-50

EHFScBS: European Heart Failure Self-Care Behavior Scale; X: mean; S.D.: standard deviation; Min: minimum; Max: maximum

According to their EHFScBS scores, the majority of the participants (61.6%) had inadequate self-care behaviors (Table 3).

Table 3. Self-Care Behavior Levels of Participants According to EHFScBS Scores (n=151)

Scale	n	%
Self-care behaviors are appropriate	58	61.6
Inadequate self-care behaviors	93	38.4

EHFScBS: European Heart Failure Self-Care Behavior Scale

Age, education level, presence of comorbidities, and duration of diagnosis were significant determinants of the self-care behaviors of the participants ($p < 0.05$). The post hoc analyses (Bonferroni) showed that the participants aged 45-55 had higher scores than those aged under 45 and those aged over 55, and those with bachelor's or higher degrees had higher scores than those with high school degrees and those with primary school or lower levels of education. On the other hand, gender and marital status did not create a significant difference in self-care behaviors ($p > 0.05$). The differences in the total EHFScBS scores of the participants associated with their descriptive characteristics are shown in Table 4.

Table 4. Participants' Scores on the EHFScBS According to Descriptive Characteristics (n=151)

Descriptive Characteristics	n	%	X±S.D.	Significant
Age				
Under 45 years old	18	11.9	34.66±10.53	F=16.947
45-55 years	42	27.8	29.71±6.39	p=0.000**
Over 55 years old	91	60.3	37.62±6.91	
Gender				
Female	79	52.3	34.79±6.69	t=-0.440
Male	72	47.7	35.37±9.31	p=0.66
Marital Status				
Married	112	74.2	34.88±7.39	t=-0.489
Single	39	25.8	35.61±9.70	p=0.62
Education Status				
Primary school and below	88	58.3	36.82±7.44	F=8.648
High School	45	29.8	34.13±7.07	p=0.000**
Bachelor's degree and above	18	11.9	28.83±9.82	
Presence of Comorbidities				
Yes	112	74.2	36.81±7.43	t=4.836
No	39	25.8	30.07±7.6	p=0.000**
Duration of Diagnosis				
4 years and below	93	61.6	33.77±8.16	t=-2.563
5 years and above	58	38.4	37.15±7.40	p=0.011*

EHFScBS: European Heart Failure Self-Care Behavior Scale; X: mean; S.D.: standard deviation; t=Student's t test, F= One Way ANOVA, * $p<0.05$; ** $p<0.01$

DISCUSSION

Heart failure is a multifactorial syndrome that occurs when the heart cannot pump enough blood to the tissues, has a heavy symptom burden and causes rehospitalizations. Despite all advancements in treatment, HF continues to be a global public health problem (Meng, Wang, Tang, Gu & Fu, 2021). It is thought that self-care may be an important key in the effective management of HF, which affects more than 64 million people worldwide and has a high financial burden due to rehospitalizations (Shahim, Kapelios, Savarese & Lund, 2023; Savarese et al., 2023). In this study, which was conducted to determine self-care behaviors and related factors in HF patients, the mean EHFScBS scores of the participants were found to be 35.07 ± 8.03 . In the study conducted by Bayrak et al. (2019), a mean self-care behaviors score of 30.58 ± 7.1 was found. Dogu Kokcu and Tiryaki (2020) reported a mean self-care behaviors score of 33.14 ± 9.41 in HF patients. In another study involving HF patients, performed by Pobrotyn, Mazur, Kałużna-Oleksy, Uchmanowicz and Lomper (2021), the mean self-care behaviors score of the patients was reported as 49.55 ± 22.07 . It is observed that different outcomes of self-care behavior have been reported in the literature. These differences may have been due to the differences in the geographical regions where these studies have been conducted and their samples. Moreover, studies in the literature have emphasized that the self-care in HF patients is not yet at the desired level. It is believed that planning individualized, multidisciplinary interventions to increase the self-care agency of HF patients will be beneficial.

The results of this study revealed a significant relationship between age and self-care behaviors. In the post-hoc analyses, it was determined that the difference originated from the 45-55 age group. Bayrak et al. (2019) reported that the self-care scores of their participants were inversely proportional to their age. This situation was similar to the one in our study. However, there are also studies in the literature reporting no significant relationship between age and self-care (Pobrotyn et al., 2021; Nur Guzel & Koc, 2024; Karagoz & Sayin Kasar, 2024). Therefore, studies examining the age variable and its relationships to self-care in larger care in larger samples are needed.

In this study, it was seen that the female patients had lower self-care behavior scores than male patients, but this difference was not significant. Other studies have provided different results on this issue. While the results of some studies indicated that gender was not a determinant of self-care behaviors (Bayrak et al., 2019; Nur Güzel and Koç, 2024; Karagöz and Sayın Kasar, 2024), some showed that male gender was a negative predictor of self-care levels

(Pobrotyn et al., 2021). In this respect, it is thought that more studies examining the relationship between the gender variable and self-care are needed.

The marital statuses of the participants of this study were not associated with a significant difference in their EHFSBS scores. In other studies in the literature, it has been similarly reported that marital status is not a significant determinant of self-care behaviors (Bayrak et al., 2019; Nur Guzel & Koc, 2024; Karagoz & Sayin Kasar, 2024). In this respect, our findings supported the literature.

It was determined that the EHFSBS scores of participants in this study decreased as their education levels increased. The post-hoc analyses showed that those with a bachelor's or higher degrees had better levels of self-care than those with high school degrees and those with primary school or lower levels of education. Some previous studies have revealed that self-care behaviors improve education levels (Bayrak et al., 2019). In this respect, our findings supported the information in the literature. This result may have been associated with an increase in health literacy as the education level of a person increases, and these individuals can understand the education provided by health professionals more easily. However, there are also studies in the literature reporting that education levels do not affect self-care behaviors (Nur Guzel & Koc, 2024; Karagoz & Sayin Kasar, 2024). It is thought that further studies examining the relationship between education levels and self-care would be beneficial.

In this study, it was observed that the participants without comorbidities had better self-care behaviors than those with comorbidities. This result may be explained by the possibility that those without comorbidities had less symptom burden, higher motivation, and more optimistic beliefs about recovery.

Furthermore, it was determined that the study participants with a diagnosis period of four years or less had significantly lower scale scores than others. Different results have been obtained in the literature on this topic. In a study conducted with HF patients by Ermis et al. (2018), it was reported that the diagnosis period was not a significant determinant of self-care agency. Pobrotyn et al. (2021) reported that those with a diagnosis period of more than 10 years had better self-care behaviors. In this respect, it can be stated that more studies are needed to examine the diagnosis period variable and its relationship to self-care levels. In our study, the better self-care scores of those with a shorter diagnosis period may have been associated with their potentially higher motivation to recover as newly diagnosed patients.

CONCLUSION




Our findings showed that the majority of HF patients had had inadequate self-care behaviors. Additionally, age, education level, presence of comorbidities, and duration of diagnosis were found to be significant determinants of self-care behaviors. According to these results, it is recommended that the study be repeated in larger samples and different regions, strategies be developed to increase self-care skills in HF patients, and training programs be organized for health professionals on this subject.

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EXAMINATION OF CARE PLANS OF STUDENTS TAKING SURGICAL NURSING COURSE IN TERMS OF DIAGNOSIS OF PAIN

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ABSTRACT

The aim of this study is to determine whether or not students include diagnosis of acute pain in their nursing care plans and evaluate it appropriately. The population of this retrospective descriptive study consisted of 161 students who completed the clinical practice of the surgical diseases nursing course at a university's nursing faculty. When the nursing care planes of the students were examined, it was determined that 61.5% were female and their average age was 21.56±1.43 years. When the diagnosis of acute pain was examined in terms of the nursing process steps, it was determined that 60.2% of the students were competent in taking medical history of patients and 49% in physical assessment in the data collection stage. However, 56.1% of the students used a pain assessment scale and 45.9% indicated the pain area in the diagnosis step. After the nursing practices they planned for the patients whose pain diagnosis they determined, 19.4% of the students stated that they reached the goal, while 38.8% did not evaluate the effectiveness of the nursing practices. It is recommended that students' training should be planned in the context of their deficiencies in the nursing process and they should prepare more care plans to gain experience in preparing care plans.

INTRODUCTION

The nursing process is a planned and dynamic approach in which critical thinking method and problem-solving steps are applied to identify problems of patients and solve them and nursing practices are based on scientific basis (Ardahan et al., 2019; Avşar, Ögünç, Taşkın & Burkay, 2014; Zaybak, İsmailoğlu & Özdemir, 2016). The nursing process, which brings a scientific quality to nursing practices, is important in terms of providing individual-centered quality nursing care by nurses and student nurses in line with a certain plan, using time more effectively, improving communication between team members, creating written resources and evidence for nursing education and research, and making nursing services visible (Hakverdioğlu Yönt, Korhan, Erdemir & Müller-Staub, 2014; Tasdemir & Kizilkaya, 2013).

The use of the nursing process in patient care enables nurses to increase job satisfaction, to secure care, to transfer scientific knowledge to practice, to contribute to the development of the profession by evaluating the results of practice, and to recognize the authority and duty areas of nurses by the society (Avşar et al., 2014). It is known that students, who comprehend

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planning of nursing care by using a care plan during the vocational education process and apply the plan of nursing care, continue to use the care plan when they graduate (Ardahan et al., 2019; Tasdemir & Kizilkaya, 2013).

The related previous studies reported that students could not sufficiently comprehend the nursing process and the importance of the use of nursing diagnoses during clinical practice, and students were incompetent in using the stages of data collection, identifying nursing diagnoses, determining descriptive features, related factors, and outcome criteria, planning and evaluation (Ardahan et al., 2019; Aykin, Alptekin & Akyüz, 2022; Keski & Karadağ, 2010; Uysal, Gürol Arslan, Yılmaz & Yelkin Alp, 2016).

Surgical interventions are an important cause of pain. Pain is one of the most common complications in patients in the postoperative period. Worldwide, it is known that more than 47% of patients undergoing surgery experience postoperative pain (Gao, Mu, Lin, Wen & Gao, 2023; Paladini et al., 2023). Postoperative pain needs to be managed multidimensionally because it affects the patient's quality of life and recovery process. When postoperative pain is managed effectively, the patient is discharged early, thus resulting in reduced health costs and higher patient satisfaction (Gürarslan Baş et al., 2016; Karadağ Arlı, 2017). The aim of postoperative pain control is to minimize or prevent the patients' discomfort, to protect them from possible side effects, to shorten the duration of hospitalization and to ensure that complaints about pain do not recur (Sidar, Dedeli & İşkesen, 2013).

Some reasons such as guiding the patient in coping with pain, spending more time with patients compared to other health team members, monitoring the results of the practices and using empathy skills enable nurses to take an active role in pain control (Karadağ Arlı, 2017; Şenyüz & Koçalışlı, 2017; Olimat et al., 2021). In this context, it is important for nursing students to learn surgical pain management during their education. However, it is known that students encounter difficulties in learning and adopting the nursing process concerning the diagnosis of pain, evaluating the diagnosis of pain using a pain scale, and determining appropriate nursing interventions (Ardahan et al., 2019; Dirimeşe, Özdemir & Şahin, 2016; Erden, Deniz, Arslan & Yurtseven, 2018; Hakverdioğlu Yönt et al., 2014).

MATERIAL AND METHOD

Purpose and Type of the Study

This study was designed as a retrospective descriptive study to determine whether or not students include acute pain diagnosis and manage appropriate acute pain while preparing a care plan.

Population and Sample

The population consisted of 173 students who completed the clinical practice of the Surgical Diseases Nursing course between April and May 2022 in the nursing faculty of a private university. The care plans of 161 students who agreed to participate in the study were examined without sample selection and the data were obtained from 98 care plans with diagnosis of acute pain.

Data Collection and Analysis

Students in clinical practice used the data collection and evaluation form for patient care to record information about the patient. This form was prepared based on Gordon's Functional Health Patterns (FHP) Model and consists of 11 functional areas: health perception-health management, nutritional-metabolic, elimination, activity-exercise, cognitive-perceptual, self-perception, role-relationship, sexuality-productive, coping/stress tolerance, values-beliefs, and sleep-rest (Gordon, 2016). This model facilitates the accurate, objective and complete data collection and analysis by examining the needs of patients (Yılmaz & Atay, 2014).

During the theoretical lecture of the Surgical Diseases Nursing course, nursing interventions were taught in the last part of each subject by associating with the North American Nursing Diagnosis Association (NANDA) diagnoses in order to comprehend the nursing process and care plans. After completing the theoretical course hours, the students completed their clinical practice period in the surgical clinics of hospitals in the Turkish Republic of Northern Cyprus and Türkiye. The students prepared a care plan including the nursing process for each patient they cared for during clinical practice. The data were obtained from the data collection forms and the final nursing care plans prepared by the students according to the FSS Model used in clinical practice.

In order to obtain data from the care plans, a form was prepared by the researchers as a collection tool and the data were classified. This form included descriptive information of the participants such as the city, hospital, and clinic they made practices, medical diagnosis of the patient, and the nursing diagnoses included by them in the nursing processes, their status of determining the diagnosis of pain, the interventions they planned for the diagnosis, and their evaluations.

In clinical practice, the students were recommended to use NANDA diagnostic criteria for pain diagnosis as in all diagnoses in the diagnosis stage of the care plans they would prepare. The acute pain diagnosis determined by the students for the patients was evaluated. The information related to the diagnosis of acute pain was grouped as “competent”, “partially

competent”, and “incompetent” considering all stages of the nursing process. Especially in the care plans examined, it was evaluated whether the descriptive characteristics, the determined acute pain diagnosis and related factors were written in accordance with the nursing diagnosis of the patient, whether the expected patient outcomes were related to the nursing diagnosis, whether the nursing interventions were related to the nursing diagnosis and patient outcomes, and whether the evaluation section was associated with the expected patient outcomes. In addition, descriptive characteristics, related factors, outcome criteria, planning/implementation and evaluation stages related to each diagnosis were grouped as competent, partially competent, and incompetent according to the above criteria.

The care plans prepared by the students, who completed the clinical practice, after the practice were evaluated between August and November 2022. The data were analyzed by percentage and frequency analysis using the Statistical Package for Social Sciences (SPSS) 18.00 software.

Limitations

The study has several limitations. The first one is that the patient circulation is high in surgical clinics and the student cannot provide care to the same patient for more than two days in hospital practice. Another limitation is that the study was conducted with second-year students. Students have not yet acquired some professional competences that will enable them to evaluate the patient holistically.

Ethical Considerations

Approval (no: YDU/2017/48-436) from the Scientific Research Evaluation Ethics Committee of a University, permission from the Dean’s Office of the Faculty of Nursing and consent from the participants were obtained to collect the data of the study.

RESULTS

When the care plans were analyzed, it was found that 61.5% of the students were female and their average age was 21.56 ± 1.43 years. While 32.3% of the students completed their clinical practice in the Mediterranean Region in Türkiye, 23.6% in the Turkish Republic of Northern Cyprus (TRNC), 19.3% in the Southeastern Anatolia Region in Türkiye, 53.4% of the patients whose nursing process was planned received treatment in a state hospital. Of the patients whose care plans were evaluated, 32.3% underwent lower abdominal surgery, 14.9% extremity surgery, and 10.6% spinal surgery.

When 161 care plans prepared by the students were analyzed, it was found that they identified a total of 67 different nursing diagnoses. Of these diagnoses, 19 were excluded from the study because they were not nursing diagnoses. The students made a total of 487 diagnoses with 48 NANDA nursing diagnoses. Some of the medical conditions that students evaluated as nursing diagnoses while preparing a care plan but were not nursing diagnoses were hypertension, hematoma, kidney stones, and the risk of complications related to drug treatment. It was determined that the most frequently used NANDA nursing diagnoses by the students were acute pain (60.9%), risk of infection (50.3%), anxiety (34.7%), lack of information (18%) and risk of falls (16.1%). 52% (n=51) of the students (n=98) who included the nursing diagnosis of acute pain ranked it first when preparing nursing processes.

When the diagnosis of acute pain was examined in terms of nursing process steps, it was found that students were competent mostly in taking medical history of patients (60.2%) and physical assessment (49%) in the data collection step. However, 56.1% of them used the pain assessment scale appropriately. In the diagnosis stage, 45.9% of the students indicated the pain site appropriately, 37.8% indicated the etiological factors of acute pain diagnosis and 34.7% indicated the factors associated with acute pain. In the planning stage, 50% of the students stated the aim, 30.6% stated the expected outcome appropriately, and only 19.4% stated the appropriate nursing interventions adequately. In the implementation stage, 41.8% of the students recorded the interventions, 37.8% included the individual and his/her family in the care at a partially competent level, and 39.8% implemented the planned interventions at a partially competent level. In the evaluation stage, while 36.7% of the students used the pain scale, it was observed that the evaluation of non-pharmacological methods (56.1%) and nursing intervention results (42.8%) were not performed competently. After the nursing interventions planned by the students in patients with a diagnosis of acute pain, 19.4% of them stated that they reached the target, while 41.8% partially evaluated the effectiveness of the nursing interventions (Table 1).

Table 1. Evaluation of Acute Pain Diagnosis According to the Nursing Process Stages (n=98)

Nursing Process	Competent n (%)	Partially competent n (%)	Incompetent n (%)	Total n (%)
Data Collection				
History of acute pain	59 (60.2)	30 (30.6)	9 (9.2)	98 (100)
Use of pain scale	55 (56.1)	26 (26.5)	17 (17.4)	
Physical assessment	48 (49)	35 (35.7)	15 (15.3)	
Psychosocial assessment	35 (35.7)	39 (39.8)	24 (24.5)	
Laboratory findings	28 (28.6)	43 (43.9)	27 (27.5)	
Diagnosis				
Determination of the pain zone	45 (45.9)	19 (19.4)	34 (34.7)	98 (100)

Determination of etiological factors	37 (37.8)	30 (30.6)	31 (31.6)	
Determination of factors associated with the diagnosis	34 (34.7)	28 (28.6)	36 (36.7)	
Planning				
Statement of purpose	29 (29.6)	49 (50)	20 (20.4)	
Correct expression of the expected result	30 (30.6)	36 (36.7)	32 (32.7)	
Indication of appropriate interventions	19 (19.4)	43 (43.9)	36 (36.7)	
Planning of non-pharmacological methods	22 (22.5)	30 (30.6)	46 (46.9)	98 (100)
Planning of pharmacological methods to be applied with the medical advice	26 (26.5)	35 (35.7)	37 (37.8)	
Implementation				
Involvement of the individual and his/her family in care	26 (26.5)	37 (37.8)	35 (35.7)	
Implementation of planned interventions	37 (37.8)	39 (39.8)	22 (22.4)	98 (100)
Recording the interventions performed	41 (41.8)	34 (34.7)	23 (23.5)	
Evaluation				
Assessment with pain scale	36 (36.7)	23 (23.5)	39 (39.8)	
Evaluation of the results of nursing interventions	18 (18.4)	38 (38.8)	42 (42.8)	
Evaluation of non-pharmacological methods	17 (17.4)	26 (26.5)	55 (56.1)	98 (100)
Evaluation of pharmacological methods applied with medical advice	20 (20.4)	32 (32.7)	46 (46.9)	
accomplishment of goals	19 (19.4)	41 (41.8)	38 (38.8)	

DISCUSSION

The nursing process, a model that finds solutions to nursing problems, is an important element of nursing education that bases nursing on scientific knowledge, organizes care and makes nursing visible (Ardahan et al., 2019; Bölükbaş, Irmak, Bulut, Özdemir & Bayrak, 2020; Şen Atasayar & İşeri, 2023). In addition, it has benefits such as determining nursing practices, evaluating nursing care, improving the knowledge of the nurse and the quality of care, and preventing loss of labor and time (Zaybak et al., 2016). Student nurses should use the nursing process correctly and effectively in clinical practice from undergraduate education in order to use the nursing process effectively and correctly in professional life (Bölükbaş et al., 2020; Ramanzadeh et al., 2023).

In the data collection stage, the importance of using various data collection models that provide comprehensive data is known (Şen Atasayar & İşeri, 2023). Therefore, an appropriate model should be used for data collection. Various models have been developed by theorists to collect data from patients and their families (Yılmaz & Atay, 2014). The FHP Model is one of

the models that evaluate individuals in a holistic way (Gordon, 2016). In the data collection stage, our students collected data systematically and comprehensively using a questionnaire prepared in accordance with the FHP Model.

Management of acute postoperative pain is among the important surgical nursing interventions. Since it affects the patient's physiological and psychological status, quality of life and recovery process, it should be handled multidimensionally. In addition, an effective pain management is one of the important factors determining patients' satisfaction with care. Therefore, nursing practices used in the preoperative and postoperative periods have an important place in pain management (Birimoğlu & Ayaz, 2015; Gürarslan Baş et al., 2016; Tasdemir & Kizilkaya, 2013). At the planning stage of the nursing process, the nurse, who collects data by taking medical history of patients and adequate observation, should be able to choose appropriate methods to control pain based on the data to be obtained, teach these methods to the patient, apply them together and evaluate their effect on pain (Yılmaz & Atay, 2014). During their education, nursing students are taught the concept of pain, the types of scales that can be used to evaluate pain, and pharmacological and non-pharmacological methods that can be applied in pain control. During clinical practice, the students evaluate patients and transfer what they learned into practice (Ünver, Kızılcık Özkan, Avcıbaşı & Babacan Dığın, 2016).

It was determined that the students mostly used the nursing diagnosis of acute pain while preparing the nursing process of surgical patients. Approximately half of the students who planned the nursing process ranked acute pain as the first nursing diagnosis. Likewise, some related studies reported that students and clinical nurses frequently diagnosed acute pain (Avşar et al., 2014; Taskin Yilmaz, Sabanciogullari & Aldemir, 2015). However, the related studies revealed that in the nursing processes prepared by the students, they often included diagnoses such as risk of infection, disruption of skin integrity and unbalanced nutrition, which they can easily recognize, in the first place, and diagnoses such as acute pain and anxiety expressed by the patient in the second place (Ardahan et al., 2019; Aydin & Akansel, 2013; Aykin et al., 2022; Gök Özer & Kuzu, 2006; Uysal et al., 2016). It is stated that students cannot analyze physical problems that require systemic evaluation of the patient, such as tissue perfusion disorder, impaired gas exchange, excess fluid volume, risk of decreased cardiac tissue perfusion, and risk of delay in postoperative recovery (Erden et al., 2018). The present study is compatible with the literature.

The results of the studies indicate that nursing students are incompetent in pain assessment, thus the level of determining appropriate nursing diagnoses is low (Ardahan et al.,

2019; Tasdemir & Kizilkaya, 2013; Yılmaz & Atay, 2014; Taskin Yilmaz et al., 2015). However, in the present study, it was determined that more than half of the students diagnosed acute pain. Taskin Yilmaz et al., (2015) conducted a study with students taking Internal Medicine Nursing course and found that 10% of the students diagnosed acute pain (Taskin Yilmaz et al., 2015). In their study with third- and fourth-year students, Ardahan et al., (2019), observed that 61% of the students identified the diagnosis of acute pain (Ardahan et al., 2019). According to other studies, it was observed that students addressed the diagnosis of acute pain more during and after the period when they took the surgical diseases nursing course while preparing a care plan (Ardahan et al., 2019; Gök Özer & Kuzu, 2006; Karadağ Arlı, 2017). This is thought to be associated with the fact that one of the most common problems experienced by patients in the postoperative period is acute pain and the students experienced the presence of pain in patients.

It is known that identifying the nursing diagnosis is the area where students have the most difficulty in preparing a care plan (Şen Atasayar & İşeri, 2023). Identifying the nursing diagnosis requires appropriate data collection and systematic and critical thinking (Aykin et al., 2022; Basit, 2020; Şen Atasayar & İşeri, 2023). Executing properly the stages of the nursing process after diagnosis and ensuring the effectiveness of care are closely associated with the correct identification of the nursing diagnosis (Şen Atasayar & İşeri, 2023). The present study revealed that while more than half of the students took the medical history of patients and used the pain scale, less than half of the students performed the physical assessment appropriately. According to the results of the study, it can be asserted that students were not competent at the data collection stage.

In the literature, it is seen that nurses are significantly dependent on physician order and nursing students think that pharmacological methods are sufficient for pain management (Basit, 2020; Gürarslan Baş et al., 2016; Yılmaz & Atay, 2014). Based on findings of the study, it can be asserted that nearly half of the students were incompetent in planning the application of non-pharmacological methods and tended to apply pharmacological methods at a higher rate.

CONCLUSION

Critical thinking is a nurse-specific reflective thinking process that enables the nurse to produce ideas in patient care, contributes to coping with professional concerns, and guides the transfer of the nursing process to the care environment. Therefore, the appropriate use of critical thinking skills by nursing students affects the correct identification of the nursing diagnosis, which is an important step in the nursing process.

While preparing the care plans of surgical patients, it was observed that the students mostly focused on the diagnosis of pain, and also included diagnoses such as risk of infection, anxiety, lack of information and risk of falls. Moreover, a few students focused on medical diagnoses instead of nursing diagnoses.


It is recommended to plan trainings in the context of students' deficiencies in terms of nursing process, to prepare more care plans in terms of gaining experience in preparing care plans, to communicate with patients more, to make pain assessment appropriately, to use scales in pain assessment, and to review the missing information about non-pharmacological methods applied in pain management.

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COMPARISON OF FOOT BIOMECHANICS AND FUNCTIONS IN UNIVERSITY STUDENTS WITH AND WITHOUT REGULAR EXERCISE HABITS

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Students

ABSTRACT

The foot, a complex structure for the human skeleton, plays a crucial role in providing contact with the ground and facilitating walking. The impact of regular exercise on foot biomechanics and function in young adults remains unclear. This study aims to compare foot biomechanics and function in university students who engage in regular exercise habits with those who do not. A total of 102 students were divided into two groups: having exercise habits (n=51), defined as engaging in moderate-intensity exercise at least three times per week, and not having exercise habits (n=51). Foot biomechanics were assessed using navicular drop (ND), metatarsal width, hallux valgus angle, and subtalar angle. Foot function was evaluated using the Foot Function Index (FFI). Demographic characteristics were similar between the groups ($p>0.05$). The right-side ND was significantly lower in the regular exercise group ($p=0.030$). No significant differences were observed in other biomechanical measurements or FFI scores ($p>0.05$). The ND is lower in university students with exercise habits; however, no difference was found between the groups in other foot biomechanical measurements and foot function. Regular exercise promotes navicular height in young individuals, but further studies are needed to demonstrate its effects on foot biomechanics.

INTRODUCTION

The foot, one of the most complex structures of the human skeleton, is very important. It provides contact with the ground and allows walking (Earls, 2021). It serves two primary functions: supporting body weight and transferring it to the ground, and acting as a lever to facilitate forward movement during walking (Earls, 2021). Comprising 26 bones, the foot's complexity is further enhanced by ligaments, muscles, and tendons that enable movement and stability (Gülçimen & Ülkü, 2008). Any anatomical, physiological, or kinesiological changes in these structures can significantly impact foot biomechanics and function (Card & Bordoni, 2023).

Foot problems are frequently encountered in society and significantly affect daily life activities (Budiman-Mak, Conrad, Mazza & Stuck, 2013). The incidence of foot problems can reach up to 80%, leading to reduced independence, lower quality of life, and mental health

challenges, particularly among young individuals (Menz, Jordan, Roddy & Croft, 2010; Yaliman, Şen, Eskiuyurt & Budiman-Mak, 2014). Moreover, an injury or deformity occurring in the foot may also cause problems in structures located in the upper segments, such as the knee, hip, and spine (Eldemir et al., 2025; Sarı, Otman, & Akman, 1995).

Previous evidence has reported that pes planus deformity reduces balance and physical performance in young individuals (Kızılcı & Erbahçeci, 2016; Şahin et al., 2022) and negatively affects walking parameters and quality of life in children (Kothari, Dixon, Stebbins, Zavatsky & Theologis, 2015). Similar findings were reported that foot posture affects postural stability (Cote, Brunet, Gansneder & Shultz, 2005). In another study, the navicular drop test measurement is associated with static balance and physical function, social function, and general health from the sub-dimensions of the quality of life in sedentary young adults (Aktan & Kutlay, 2022).

Physical inactivity, a major concern in the 21st century, is increasingly common among young populations (Park, Moon, Kim, Kong & Oh, 2020). Most individuals spend most of their time sitting, especially at home, work, and transportation. With increasing technological developments, the time spent in front of screens is increasing in all segments of society, and, accordingly, the rate of sedentary life is also increasing (Can, 2019). It is known that problems in musculoskeletal system development will occur over time in a physically inactive population, especially in young individuals.

Research on the effects of physical activity, exercise, and sports on foot biomechanics reveals inconsistent and limited evidence. While some studies suggest that sports (e.g., volleyball) may alter foot structure (Ekanem et al., 2024; Sirgo Rodríguez & Aguado Jodar, 1991), others report normal changes in athletes from sports like football (López et al., 2005). The divergent findings across these studies can be attributed to differences in the types of sports examined. Repetitive loading in high-impact sports may lead to biomechanical impairments, such as an increased prevalence of pes cavus among athletes, likely due to prolonged stress on the foot arch (Ekanem et al., 2024). Short-term changes were observed in metatarsal width in volleyball players, which can be linked to the sport's high-intensity jumping and landing movements that place significant stress on the forefoot (Sirgo Rodríguez & Aguado Jodar, 1991). In contrast, football players exhibited near-normal foot biomechanical properties, possibly due to the sport's specific demands, such as running and kicking, which may promote adaptive changes without causing significant structural alterations (López et al., 2005). These variations suggest that sport-specific loading patterns and training adaptations are critical in shaping foot biomechanics.

These conflicting results suggest that more research is needed. To the best of our knowledge, no studies investigate foot biomechanical properties and function in young adults who do or do not exercise regularly. We hypothesize that young adults who exercise regularly exhibit different foot biomechanical properties compared to their sedentary counterparts, suggesting that physical activity enhances foot biomechanics and functions. This study compares foot biomechanics and function in university students with or without regular exercise habits. Our research questions are as follows:

Research question 1. Are the biomechanical properties of the foot different in university students with and without regular exercise habits?

Research question 2. Are the foot functions different in university students with and without regular exercise habits?

MATERIAL AND METHOD

Aim and Type of the Research

This study was designed as a cross-sectional and comparative analysis.

Population and Sample of the Research

Participants who met the inclusion criteria were invited to the Department of Physiotherapy and Rehabilitation of the University. One hundred and two students were included in the study. They were recruited into two groups: regular exercise participants (Group 1, n = 51) and non-exercise participants (Group 2, n = 51). The inclusion criteria were (1) 18-36 years of age and (2) not having foot or ankle surgery. The exclusion criteria were (1) any history of deformity or injury that may affect lower extremity evaluations, and (2) refusing to participate in tests and surveys.

Sample size calculation was calculated using the left side subtalar angle scores in a similar comparative study (López, Alburquerque, Santos, Sánchez & Domínguez, 2005). For this purpose, the G*power software (version 3.1.9.7; Heinrich Heine Universitaet, Dusseldorf, Germany) was used (Faul, Erdfelder, Lang & Buchner, 2007). Accordingly, in the power analysis performed to determine the sample size, Cohen's d effect size was found to be 0.692, and the number of individuals to be included in the study was determined as at least 92 with a 5% type 1 error and 95% power. It was decided to include at least 102 people in the study, assuming a 10% dropout rate.

Data Collection and Data Analysis

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 23.0 (SPSS, Chicago, IL). The normality of data was assessed by the Shapiro–Wilk test. Assessment statistics were reported as mean±SD for normally distributed scale variables, median (interquartile range [IQR]) for non-parametric variables, and frequency (%) for categorical variables. The Chi-square test or Fisher test was used to compare categorical variables between the groups. The Samples t-test or Mann–Whitney U test was used to analyze the differences between the groups. All the tests were conducted at the 5% significance level.

Assessments

As demographic information, data for age, height, height, body mass index, sex, dominant side, and exercise frequency were collected. Regular exercise habits, navicular drop, metatarsal width, hallux valgus angle, subtalar angle, and foot function were assessed for all participants.

Navicular drop (ND): The ND test was measured in a sitting position without weight on the foot and in a standing position with weight on the foot. During the measurement, the navicular tubercle was marked by palpation, and the distance between it and the ground was recorded in millimeters. The amount of navicular drop was determined by taking the difference between the two measurements. Pronation of the foot will indicate a tendency towards pes planus, and supination will indicate a tendency towards pes cavus. For the ND test, 5-9 mm is considered normal, 10 mm and above is considered pronation, and 4 mm and below is considered supination (Cote et al., 2005).

Metatarsal width: In this evaluation used to select forefoot width, the distance between the medial surface of the first metatarsal head and the lateral surface of the fifth metatarsal head was measured and recorded. Measurements were repeated in a sitting position without weight bearing on the foot and in a standing position with weight on the foot. The distance between the two malleoli was recorded in millimeters (Morrison, Durward, Watt & Donaldson, 2005).

Hallux valgus (HV) angle: It is the angle between the longitudinal axis of the proximal phalanx of the big toe and the longitudinal axis of the first metatarsal. First, the pivot point of the goniometer was placed at the first metatarsophalangeal joint, with one arm parallel to the first metatarsal bone and the other arm parallel to the proximal phalanx (Nix, Russell, Vicenzino, and Smith, 2012). Then, the angle between the two axes was measured and recorded in degrees while the subject put weight on the foot. An angulation of 5-15 degrees is normal (Gentili, Masih, Yao & Seeger, 1996).

Subtalar angle: It is the angle between the longitudinal axis of the hindfoot (calcaneus) and the vertical midline of the distal third of the lower leg. The midline of the calcaneus and the midline of the lower leg were marked with a pencil while the individual was lying in the prone position. The angle between these two lines was measured with a goniometer in the prone and standing position and recorded in degrees (Cho, Park & Nam, 2019). Angular valgus of up to four degrees is normal (Ahn, Bok, Kim & Park, 2017).

Foot Function Index (FFI): The FFI consists of three sub-parameters. These are pain, disability, and activity limitations and have 23 items. The pain subtitle contains nine items and measures the severity of foot pain in different situations. The disability subtitle contains nine items and evaluates a person's difficulty performing functional activities due to foot problems. The activity limitation subtitle contains five items and measures the person's activity limitation due to foot problems. Participants are asked to mark the appropriate place for each question on a visual analog scale ranging from 0 to 10 (no pain - the most severe pain possible), considering their condition in the last week. After the scores of all questions are added, the total index score is calculated by dividing it by the maximum score that these questions can receive and multiplying the obtained number by 100. The total score varies between 0 and 100, while high scores on the scale indicate increased foot disability (Budiman-Mak, Conrad, Mazza & Stuck, 2013; Yagci, Erel & Okunakol, 2020).

Limitations of the Research

This study has some limitations. Firstly, parameters related to the foot, such as muscular strength, endurance, and flexibility, could not be evaluated. These parameters may affect foot function and biomechanics. Secondly, functional assessments such as balance, walking, and physical fitness were not examined. Thirdly, although our study included sufficient participants, it is based on the measurement results of students from only one university. Therefore, this situation limits its generalizability. Fourthly, this study is cross-sectional. Since cross-sectional studies collect data at a single point, they cannot track changes over time or establish the temporal sequence required to infer causal relationships. Finally, regular exercise habits were questioned verbally, requiring trust in the participants' statements. In future studies, studies that include individuals whose regular exercise habits are monitored may help to better demonstrate the effectiveness of the exercise. Future studies can be conducted considering all these limitations.

Ethical Considerations

This study was approved by the Ethics Committee of Sivas Cumhuriyet University (approval number: 2024-12/31) and conducted according to the Declaration of Helsinki.

RESULTS

One hundred and two individuals (Group 1; 51 and Group 2; 51) were included in the study. There was no significant difference between the groups regarding demographic information ($p>0.05$). Additionally, a group of participants were exercising regularly at least three days a week (3.58 ± 1.45 days), and the non-exercising group did not exercise regularly (Table 1).

Table 1. Demographic characteristics of participants

	Regularly Exercising Participants (n=51) Mean±SD	Non-Exercising Participants (n=51) Mean±SD	p
Age (years)	21.76±2.70	21.31±1.72	0.318
Height (cm)	169.96±8.79	171.11±9.49	0.525
Weight (kg)	68.52±12.04	68.65±16.59	0.965
BMI (kg/m ²)	23.56±2.63	23.23±4.25	0.636
Sex, Female/Male (Female %)	26/25 (49%)	25/26 (51%)	0.843
Dominant side, right/left (right %)	45/6 (88.2%)	47/4 (92.2%)	0.505
Exercise frequency (day/ hours, in a week)	3.58±1.45/1.56±0.72	-	-

BMI: Body mass index. Values are presented as mean ± SD or percent, $p<0.05$.

ND right-side was lower in the regular exercise group ($p=0.030$) (Figure 1). There was no significant difference in other foot evaluations and FFI ($p>0.05$) (Table 2). It was observed that the ND scores of all individuals were within normal values (Nielsen et al., 2009).

Table 2. Comparison of Regularly Exercising Participants and Non-Exercising Participants

		Regularly Exercising Participants (n=51) Mean±SD Median (IQR)	Non-Exercising Participants (n=51) Mean±SD Median (IQR)	p	Test Statics
ND (cm)	Right	5.00 (3.40-6.90)	6.00 (4.40-7.80)	0.030*	U: 975.0
	Left	6.40 (4.40-8.30)	6.50 (4.90-8.40)	0.825	U: 1264.5
Metatarsal width- non weight bearing (mm)	Right	93.30 ± 7.20	92.53±7.85	0.606	t: 0.517
	Left	91.60 (87.00-96.40)	91.10 (87.00-94.90)	0.700	U: 1243.0
Metatarsal width- weight bearing (mm)	Right	96.60 (91.70-101.90)	94.10 (91.20-99.20)	0.478	U: 1194.5
	Left	94.80 (92.20-100.40)	94.40 (90.40-98.60)	0.574	U: 1216.5
Metatarsal width- difference (mm)	Right	3.90 (2.40-5.20)	3.60 (2.60-4.60)	0.468	U: 1192.0
	Left	3.60 (2.40-4.90)	3.30 (2.00-5.10)	0.486	U: 1196.0
HV angle (°)	Right	15 (10-18)	15 (10-19)	0.952	U: 1291.5
	Left	12 (10-18)	12 (10-16)	0.778	U: 1258.5
Subtalar angle (°)	Right	7 (5-9)	7 (5-10)	0.869	U: 1276.0

	Left	11 (9-15)	10 (9-15)	0.861	U:1239.5
FFI (0-100)	Right	15 (5-33)	11 (2-23)	0.283	U: 1140.5
	Left	9 (2-31)	12 (1-24)	0.957	U: 1292.5

FFI: Foot Function Index, HV: Hallux Valgus, ND: Navicular drop. The variables are presented as Mean \pm Standard deviation (SD) or Median (Interquartile range- IQR) accordingly normality. *: $p < 0.05$. t: The student's t-test, U: Mann-Whitney U test

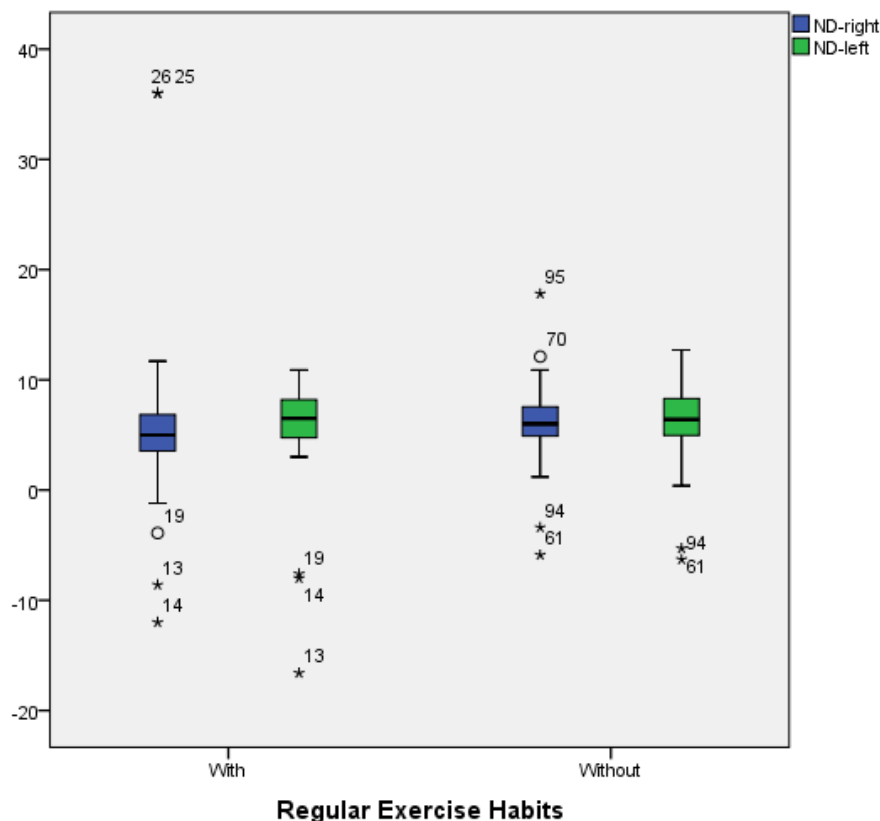


Figure 1. Box and Plot Chart for ND values

DISCUSSION

This study aimed to compare the foot biomechanics and function of university students with or without regular exercise habits. Our results showed that foot biomechanics evaluations, except right-side ND, and foot functions were similar between groups.

The excessive arch deformation was assessed using ND. ND right-side was statistically lower in the regular exercise group in this study. The foot exercises correct the foot alignment and prevent injuries (Okamura et al., 2020). A previous study reported that a 4-week foot exercise training improved foot alignment as assessed by the ND test (Mulligan & Cook, 2013). Although participants in the regular exercise group did not do any specific exercises for the feet, they generally did exercises for aerobic capacity, muscle strength, and endurance. These exercises can improve foot muscle strength, so the ND score was lower in the regular exercise on both dominant and non-dominant sides. To support our thought, a biomechanical assessment study can be performed in which muscle strengths, especially the tibialis posterior, will be

evaluated. Previous studies have determined that ND is linked to several lower-extremity overuse injuries, such as medial tibial stress syndrome and patellofemoral pain syndrome (Haun, Brown, Hannigan & Johnson, 2020). Neither group in our study had lower extremity injuries, and the test results were among the normal values (Nielsen et al., 2009). Another study investigated the risk factors of injury among people with or without doing active sports (Komisak, 2021). Researchers determined that their ND scores increased as the participants' foot functionality decreased. It has been reported that as the ND test score increased, the foot biomechanics were negatively affected. The ND score of the non-exercising group was higher than that of the regularly exercising group. As a result, the ND scores in our study are consistent with all these studies, and a smaller ND change was seen in regularly exercising individuals. Based on this, regular exercise may significantly contribute to maintaining navicular height.

Metatarsal width shows the response of the forefoot structures to loading (Barroco et al., 2011). A norm value for metatarsal width has not yet been investigated in the literature. In rehabilitation, the symptomatic foot is often compared with the asymptomatic foot (Deben & Pomeroy, 2014). There was no pathology among the participants recruited for the study. Therefore, there may not have been a difference between the groups. On the other hand, it is stated that metatarsal width is directly correlated with body weight. (Altuntaş & Uzun, 2022). However, in this study, body weight was similar in both groups ($p=0.965$). In this respect, our results seem to be consistent with the literature. This is the first study to compare metatarsal width in individuals with and without regular exercise habits. On the other hand, to better understand the effects of exercise habits, long-term studies investigating different exercise approaches in more detail are needed in future studies.

The HV is a foot deformity involving lateral deviation of the hallux and medial deviation of the first metatarsal head. The HV angle, defined as the angle between the longitudinal axis of the big toe's proximal phalanx and the first metatarsal's longitudinal axis, normally ranges from 5° to 15° (Cavalheiro, Arcuri, Guil & Gali, 2020). Accordingly, our study observed that the HV angles in the groups that did regular exercise and those that did not were between normal values. Since HV was within normal values, there may have been no difference between the groups. Although the exact cause of HV remains unclear, several factors have been proposed as potential contributors. These include extrinsic factors such as inappropriate footwear (e.g., high heels, narrow shoes, etc.), excessive body weight, and intrinsic factors like sex, age, hypermobility, and bony abnormalities (Perera, Mason & Stephens, 2011). Previous studies have shown that HV is more common among women, and its prevalence increases with age (Akinbo, Aiyegbusi, Owioye & Ogunsola, 2011; Bayar, Erel, Şimşek, Sümer & Bayar, 2011;

Tutuş, Polat, Işık & Göker, 2024). Furthermore, body mass index (BMI) is associated with HV (Tutuş et al., 2024). In the study conducted by Bortone et al. (2021), it was reported that as body weight increases, the hallux valgus angles also increase (Bortone et al., 2021). On the other hand, one study found that as height increases, HV decreases (Albo et al., 2021). Since both groups in our study have similar demographic characteristics regarding sex, age, and BMI, it can be considered normal that no significant difference was found in the HV.

The subtalar angle is important for both the flexibility of the foot and maintaining optimum stiffness. Subtalar joint pronation is associated with decreased medial arch, producing the clinically described pes planus deformity (Sahan et al., 2022). A previous study reported that the subtalar angle may be greater in the dominant extremity (Oskouei, Malliaras, Hill, Clark & Perraton, 2022). Our study showed no difference between the groups regarding the dominant extremity. The lack of difference between the two groups may be because the dominant extremity of both groups is the same.

Another important evaluation in this study was foot function using the FFI. Our results show that the FFI score was similar between the groups. However, the right FFI scores of the non-exercise group were lower than those of the left and right sides of the exercise group. It has been shown that regular foot exercises decrease pronation pathology in the foot and provide functional improvement, according to FFI (Gupta et al., 2023). No pathology was detected in the individuals participating in our study. Therefore, there may not have been a difference between the groups. In future studies, comparing individuals with foot problems with those without foot problems may provide a better understanding of the effects of regular exercise.

This is the first study investigating foot biomechanics and function in university students with and without regular exercise habits. Previous studies have generally focused on athletes (Ekanem et al., 2024; Lopez et al., 2005; Sirgo Rodríguez & Aguado Jodar, 1991). These studies have reported that athletes' foot biomechanics may be impaired due to repetitive loading. It has been reported that the incidence of pes cavus is increased in professional athletes and that metatarsal width increases in volleyball players (Ekanem et al., 2024; Sirgo Rodríguez & Aguado Jodar, 1991). Unlike these studies, the participants in our study were not athletes, and they were exercising. Exercise consists of repetitive movements targeting one or more physical fitness parameters and aims to preserve body biomechanics (Dasso, 2019). Therefore, no pathology may have occurred in the group that regularly exercises.

CONCLUSION

Our study is the first to investigate foot biomechanics and function in university students with and without regular exercise habits. Our results showed that foot biomechanics evaluations, except right-side ND, and foot functions were similar between groups. This study showed that regular exercise promotes navicular height in young individuals, but more comprehensive studies are needed to demonstrate its general effects on foot biomechanics.

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Declarations

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Competing interests

The authors declare that they have no competing interests.

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PREOPERATIVE AND POSTOPERATIVE RADIOLOGIC EVALUATION IN HALLUX VALGUS SURGERY

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ABSTRACT

In this research radiological outcomes of hallux valgus surgeries which involved osteotomies of the first metatarsal has been retrospectively analyzed. A total of 25 patients who underwent surgery between 2020 and 2024 were evaluated. Preoperative and postoperative weight-bearing X-rays were analyzed to measure hallux valgus angle (HVA), intermetatarsal angle (IMA), and the first and second metatarsal length ratio (D1/D2). The results showed significant reductions in HVA and IMA after surgery, alongside a shortening of first metatarsal, indicating enhanced metatarsal alignment. The study concluded that surgical interventions effectively reduce hallux valgus deformity and improve both radiological and clinical outcomes. However, there exists limitations such as small sample size and short follow-up periods. Further studies are recommended to validate these findings and explore long-term effects.

INTRODUCTION

Hallux valgus (HV) as the most common forefoot deformity is marked by the outward displacement of the hallux and the inward displacement of the first metatarsal. In a meta-analysis involving 45 researches, the results showed the prevalence to be 23.74% in females and the overall prevalence 19% (Cai et al., 2023). Alkhalifah et al. have determined the prevalence as 25%, but also have pointed on widely varying reports about the topic (Alkhalifah et al., 2023). Besides gender; increasing age (the prevalence increases to 35.7% after the age of 60), body mass index, constricting footwear and family history are considered to be risk factors for HV (Alkhalifah et al., 2023; Kwan, Yick, Yip & Tse, 2021; Ray et al., 2019).

HV often causes pain, but also leads to functional limitations, joint mechanics alterations, decreased mobility, and cosmetic concerns (Ray et al., 2019; Schmeichel & Krähenbühl, 2022; Zirngibl, Grifka, Baier & Götz, 2017). Some of the kinematic changes obtained in HV are reduction in coronal plane motion of the hindfoot-shank during preswing, reduced force in the hallux region, reduced peak pressure at the medial and lateral hindfoot (Rosemberg et al., 2023). All these complications prompt many patients to seek surgical intervention when conservative treatment fails (Schmeichel & Krähenbühl, 2022). Surgical correction aims to restore proper

alignment and function, alleviate symptoms and improve the patient's life quality (Dias, Godoy-Santos, Ferrari, Ferretti & Lenza, 2024).

Radiological evaluation plays a crucial role in determining pathoanatomical concepts and assessing the effectiveness of surgical interventions for HV (Motta et al., 2022; Soares, Gomes, Garibaldi, Monteverde & Oliva, 2023). By this aspect, key parameters such as the hallux valgus angle (HVA), the intermetatarsal angle (IMA) measured by using radiological imaging are frequently used to quantify the deformity and monitor postoperative outcomes (Motta et al., 2022). HVA and IMA are evaluated to be the best in correlating the magnitude of HV deformity (Canella, 2020). The studies have demonstrated that successful surgical correction results in significant improvements in HVA and IMA radiographic measures, suggesting that the deformity is effectively addressed (Dias et al., 2024). The metatarsal length change and the ratio of the first to second metatarsal lengths (D1/D2) are the other parameters that have been investigated and shown to be valuable parameters in assessing the results previously (Lee, Lee, Song & Choi, 2015; Sovilj, Baljović & Bašćarević, 2021).

The objective of this study was to assess the radiological outcomes of patients who underwent surgical treatment for HV by comparing preoperative and postoperative X-rays. Specifically, the HVA, IMA and D1/D2 ratio were analyzed on weight-bearing anterior-posterior foot X-rays.

MATERIAL AND METHOD

This retrospective study was performed at a training hospital after obtaining the ethics committee approval (18.09.2024/04). Patients with HV who were treated surgically in our clinic between March 2020 and July 2024 were screened in this study.

Inclusion criteria were; 1) osteotomy with a diagnosis of HV, 2) accessibility of data in patient files.

Exclusion criteria were; 1) Those who underwent arthrodesis techniques usage in the treatment, 2) Those who underwent double osteotomy, 3) Those who underwent phalangeal osteotomy, 4) Those who underwent only soft tissue procedures.

The age, sex, side, follow-up time, American Orthopaedic Foot and Ankle Society Metatarsophalangeal-Interphalangeal Scale (AOFAS MTP-IF) scores at the last follow-up were noted. HVA, IMA, first and second metatarsal lengths were calculated separately in the preoperative and postoperative standing anteroposterior foot X-rays. The metatarsal lengths were not compared due to the error potential caused by the magnification that could be observed in the X-rays (Figure 1 A, B). Instead of comparing the preoperative and postoperative first

metatarsal lengths, the first and second metatarsal lengths were measured separately on each X-rays and then compared to each other (D1/D2 ratio). Since a change in the length of the first metatarsal after osteotomy is predicted, the second metatarsal, which remains constant, does not change in the denominator. It was investigated whether there was a change in the first metatarsal length before and after surgery due to the change in the D1/D2 ratio. Preoperative and postoperative HVA, IMA and D1/D2 ratios were compared in all patients. The locations of the metatarsal osteotomies were noted by proximal osteotomy, shaft osteotomy or distal osteotomy.

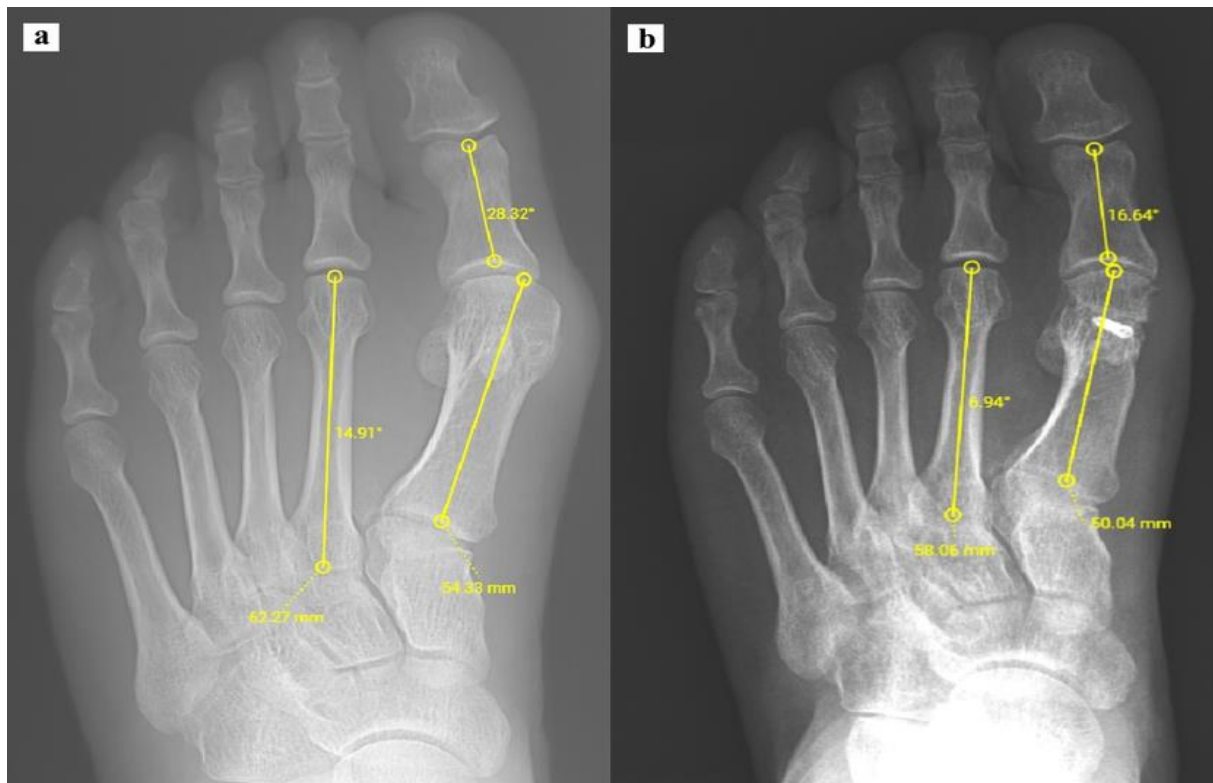


Figure 1: The weight-bearing anteroposterior foot X-rays a) Shows the preoperatively measurement of hallux valgus angle: 27.25° , intermetatarsal angle: 14.62° , and the lengths of the first metatarsal: 60.76 mm, and second metatarsal: 69.09 mm. b) Shows the postoperatively measurement of hallux valgus angle: 8.96° , intermetatarsal angle: 3.59° , and the lengths of the first metatarsal: 55.39 mm, and second metatarsal: 65.73 mm.

Statistics

Data for continuous variables were given as mean and standard deviation. Data for qualitative variables were given as frequency and percentage. Shapiro-Wilk test was used to evaluate the normality of the data. Paired samples t test was used to compare before and after measurement means. Analyses were performed by using SPSS 27 (IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp).

RESULTS

In the research 25 patients, 20 female and 5 male, who met the study criteria were included (Table 1). With mean follow-up time of 28.08 ± 13.87 months, the average age of the patients at the end of their follow-up was determined to be 49.92 ± 13.18 . Of the 25 hallux valgus osteotomy operations, 14 were performed on the left foot and 11 was done to right foot. When osteotomy sites were considered; 3 (12%) were proximal, 7 (28%) were shaft and 15 (60%) were distal site operations (Table 1).

Table 1. Gender, Direction and Osteotomy Site Variables. Data are Shown as n and %.

Variable		N	%
Gender	Male	5	20
	Female	20	80
Direction	Left	14	56
	Right	11	44
Osteotomy site	Proximal	3	12
	Shaft	7	28
	Distal	15	60

AOFAS MTP-IF mean score was determined to be 93.36 ± 8.97 . Preoperative and Postoperative D1/D2 Ratio mean scores were 0.9 ± 0.06 and 0.89 ± 0.06 respectively and showed statistically significant difference ($p < 0.001$). When HVA scores were considered, postoperative mean HVA score 14.52 ± 8 was determined to be statistically significantly different from preoperative HVA score of 33.83 ± 8.61 ($p < 0.001$). Likewise statistically significant difference was obtained among preoperative 14.36 ± 2.54 and postoperative 7.74 ± 2.87 IMA values ($p < 0.001$) (Table 2).

Table 2. AOFAS MTP-IF, Preoperative and Postoperative D1/D2 Ratio, Preoperative and Postoperative HVA, Preoperative and Postoperative IMA Values. Data are Shown as Mean±Standard Deviation. Paired Samples t Test was Used, $p < 0.001$. AOFAS MTP-IF: American Orthopaedic Foot and Ankle Society Metatarsophalangeal-Interphalangeal Scale, HVA: Hallux Valgus Angle, IMA: Intermetatarsal Angle.

Variables	Mean±Standard Deviation	p
AOFAS MTP-IF	93.36 ± 8.97	
Preoperative D1/D2 ratio	0.9 ± 0.06	< 0.001
Postoperative D1/D2 ratio	0.89 ± 0.06	
Preoperative HVA	33.83 ± 8.61	< 0.001
Postoperative HVA	14.52 ± 8	
Preoperative IMA	14.36 ± 2.54	< 0.001
Postoperative IMA	7.74 ± 2.87	

DISCUSSION

HV is a common deformity that significantly impacts patients' life quality by the pain and anatomical deformities, and cosmetic concerns it causes. Surgical interventions are frequently assessed when conservative treatments fail (Schmeichel & Krähenbühl, 2022; Zirngibl et al.,

2017). The results of this study confirm that surgical correction effectively improves both radiological and clinical outcomes, as evidenced by significant reductions in the HVA, IMA, and D1/D2 ratio, alongside improved patient-reported outcomes.

The reduction in HVA and IMA observed postoperatively in our study aligns with previous literature, which consistently shows that correction of these angles leads to improved alignment and symptom relief (Canella, 2020; Dias et al., 2024). These findings suggest that the surgical procedures employed were successful in realigning the hallux and reducing the deformity severity, consistent with other studies that emphasize the importance of these radiological measures (Motta et al., 2022). The D1/D2 ratio, which reflects the metatarsal length distribution, also demonstrated a significant improvement, and these findings are similar to the findings of Sovilj et al. (Sovilj et al., 2021). This improvement in the D1/D2 ratio may indicate a better metatarsal alignment, which could contribute to better foot biomechanics and potentially reduce the risk of postoperative complications. The first metatarsal shortening can lead to metatarsalgia, particularly when the shortening exceeds 4 mm (Justiniano et al., 2022). Due to magnification-related technical errors on X-ray, in the current study the preoperative and postoperative lengths of first metatarsal could not be compared (Shigematsu et al., 2013). Therefore, metatarsal length could not be presented in mm, but was evaluated as a ratio. Although there is statistical significance according to the change between the D1/D2 ratios, the small mean difference between the preoperative and postoperative ratios suggests that the shortening of the first metatarsal is too minor to cause pain.

Additionally, the AOFAS HV-IF score observed in our study underscores the positive correlation between radiological corrections and functional outcomes, as also reported by Dias et al. (Dias et al., 2024). This suggests that the surgical interventions not only corrected the deformity but also enhanced the patients' overall foot function and quality of life. The results of current study confirm that surgical correction of HV results in significant improvements in radiological measurements and clinical outcomes, supporting the efficacy of surgical intervention for this condition (Dabelea et al., 2017; Dias et al., 2024).

The comparison of osteotomy locations for HV reveals varying outcomes based on the specific techniques employed. Different osteotomy sites, such as proximal, shaft, and distal have been evaluated for their effectiveness in correcting HV deformities. Studies usually indicate no significant differences in outcomes between the locations of osteotomies (Fukushi et al., 2022; Santos, Roseiro, Cortesão Seïça & Amaro, 2024). Although the small sample size in the study does not allow us to make comparisons according to the location of the osteotomy,

the observation of adequate radiologic improvement in the patients was consistent with the literature.

However, this study has some limitations. The sample size was relatively small, and the follow-up period was short, which may affect the long-term applicability of our results. Another limitation is that subgroups could not be compared according to the localization of the osteotomy due to the small sample size. The absence of the first metatarsal length in mm is another limitation. The lack of sesamoid x-rays, owing to technical constraints, also constitutes a limitation. Further studies with larger cohorts and longer follow-up are needed to confirm the durability of the observed improvements and assess the role of other factors, such as metatarsal length changes, in postoperative outcomes.

CONCLUSION

This study demonstrates that osteotomy-based surgical interventions for hallux valgus deformity significantly improve radiological parameters, such as the hallux valgus angle and intermetatarsal angle, indicating effective correction of the deformity. A statistically significant decrease in D1/D2 metatarsal ratios may not always have clinical significance, as it may be more meaningful to demonstrate the change in metatarsal length with mm measurement. Despite these promising results, the study's limitations, including a small sample size and short follow-up period, warrant caution in generalizing the findings. Further large-scale studies with extended follow-up, measuring the length in mm are necessary to confirm the long-term efficacy and safety of these surgical techniques in the management of hallux valgus.

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Cu, Fe, Mn AND Zn CONTENTS IN PROPOLIS SAMPLES FROM MALATYA, TÜRKİYE AND HEALTH RISK ASSESSMENT

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ABSTRACT

In this study, copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) contents of propolis samples obtained from five different districts of Malatya, Türkiye were investigated. Element contents were determined using flame atomic absorption spectrometry (FAAS). The concentration ranges of propolis samples taken from five different districts of Malatya province varied between 1.24 ± 0.06 mg/kg and 6.28 ± 0.02 mg/kg for Cu, 206.28 ± 21.50 mg/kg and 663.08 ± 55.24 mg/kg for Fe, 15.40 ± 0.17 mg/kg and 27.11 ± 1.83 for Mn, 39.36 ± 1.82 mg/kg and 52.57 ± 2.13 mg/kg for Zn. The results obtained for each district and element were evaluated in detail considering the estimated daily intake (EDI), recommended dietary allowance (RDA), provisional maximum tolerable daily intake (PMTDI) of these elements for adults. Moreover, hazard coefficient (HQ) was calculated for risk assessment and it was determined that HQ values for the studied elements in bee propolis from all districts were below 1.

INTRODUCTION

Elements that play an important role in maintaining vital functions in the human body (Ca, Mg, K, Cu, Zn, Fe, etc.) are involved in many functions in the body, such as physiological functions, metabolic mechanisms, and enzyme functions (Stacewicz-Sapuntzakis, Bowen, Hussain, Damayanti-Wood & Farnsworth, 2001; Mezzaroba, Alfieri, Simao & Reiche, 2019; Vatansever, Ozyigit & Filiz, 2017). For these functions to be maintained in the body, it is very important to take nutritious foods rich in mineral elements into the body through nutrition. However, taking too little or too many of these elements into the body can negatively affect body functions. In recent years, bee products (such as propolis, royal jelly and pollen) have begun to be consumed by humans due to their high nutritional value. Propolis, a natural mixture of these products, is a wax resin and is collected by honeybees from shoots, plant resin, leaves, and flowers. Propolis has antioxidant, anti-inflammatory, antitumor, antibacterial, antifungal and antiviral properties (Zulhendri et al., 2021; Aboulghazi et al., 2024; Chan, Cheung & Sze, 2013; Kalogeropoulos, Konteles, Troullidou, Mourtzinis & Karathanos, 2009; Nainu et al., 2021; Tumbarski et al., 2023; Keskin & Cetin, 2020; Silva, Rodrigues, Feas & Estevinho, 2012;

Wozniak et al., 2020). It has been reported that propolis is rich in many bioactive components such as flavonoids, phenolic acids, vitamins, essential minerals and oils (Di Capua, Bejarano, Adami & Reverchon, 2018; Jansen-Alves et al., 2018; Yesiltas et al., 2014). These bioactive components vary depending on the vegetation, geographical and climatic characteristics of the region where bees live and feed, and the chemical composition of each propolis species found in different regions of the world is different (Di Capua, Bejarano, Adami & Reverchon, 2018; Ozdal et al., 2019; Yen et al., 2017). Today, because of human activities (such as urbanization, mining, industrialization and agricultural activities), the damage caused by chemical pollutants to the environment is increasing (Tutun et al., 2022). In addition to essential trace elements that have a toxic effect when taken excessively, it is very important to monitor toxic elements. The accumulation of toxic and essential trace elements in food products and the consumption of these foods by humans can pose a risk to human health (Tutun et al., 2022; Mititelu et al., 2022).

The contents of essential trace elements such as Cu, Fe, Mn and Zn in propolis samples collected from five different districts of Malatya/Türkiye were determined by FAAS (flame atomic absorption spectrometry), and the obtained elemental results were evaluated statistically. Considering the elemental contents, the daily contribution of the studied elements to human nutrition and the risk factors for health were evaluated in detail.

MATERIAL AND METHOD

Reagents and Standards

Standard solutions of Cu, Fe, Mn, Zn (1000 mg/L), HNO₃ and H₂O₂ were purchased from Merck (Merck & Co., Inc., Whitehouse Station, NJ, USA). All chemicals and solvents used in all experimental studies were analytically pure. Ultrapure water (Milli-Q, Millipore 18.2 µΩ cm⁻¹ resistivity) was used in all experiments. Standard solutions of the elements were prepared by diluting the stock solutions of the studied elements. Standard solutions prepared at different concentrations were used to obtain the calibration graph of each element. All glassware was cleaned with a 10% HNO₃ solution before use and then rinsed with deionized water.

Instrumentation

Cu, Fe, Mn and Zn analyses were performed using Perkin Elmer AAnalyst 800 FAAS (Perkin Elmer, Inc., Shelton, CT, USA). The system is equipped with a hollow cathode lamp, air-acetylene flame, and a single slot-burner head. The operation conditions used for FAAS are given in Table 1.

Table 1. Instrumentation operation condition for FAAS*

Element	Cu	Fe	Mn	Zn
Wavelength (nm)	324.8	248.3	279.5	213.9
Slit Wight (nm)	0.7	0.2	0.2	0.7

*Flow of air: 17.0 L min⁻¹, Flow of acetylene: 2.0 L min⁻¹.

Sampling and Sample Preparation

Propolis samples were supplied from different honey producers from five different districts (Arapgir, Arguvan, Hekimhan, Kale, Puturge) of Malatya province in the Eastern Anatolia Region of Türkiye in 2022. These samples were cleaned, ground into small pieces, and stored at +4 °C until analysis time. The propolis samples obtained from Arapgir, Arguvan, Hekimhan, Kale and Puturge districts were called *Propolis I*, *Propolis II*, *Propolis III*, *Propolis IV* and *Propolis V*, respectively.

About 0.5 g of propolis samples obtained from different districts of Malatya were weighed in 3 parallel samples for each district. They were digested with 2 mL of a mixture of concentrated HNO₃ and H₂O₂ prepared in a one-to-one ratio on a hot plate. The samples were evaporated until almost dry, and 2 mL of a mixture of the same concentration was added to the samples again and evaporated until dry. After the samples were cooled, the final volume was taken with 15 mL of 1.0 M HNO₃ and filtered with Whatman filter paper. Cu, Fe, Mn and Zn analyses were performed with FAAS in clear solutions. Blank samples were prepared in the same way as the samples. The results obtained for different districts are the average of three values, and the results were given as the average value ± standard deviation on a dry weight basis. The accuracy of the method was tested with the standard reference material NIST-1547 peach leaves and all the procedures applied to the samples were applied to the standard reference material. Experimental results were statistically evaluated using one-way analysis of variance (ANOVA) and Tukey's multiple comparison tests. The differences were considered statistically significant when $p < 0.05$.

Estimation of Daily Intake (EDI) and Hazard Quotient

In human nutrition, adequate intake of Cu, Fe, Mn and Zn elements varies according to age and gender. In this study, the intake values of these elements over the age of 19 were evaluated considering females and males (Institute of Medicine, 2006). The calculation of estimated daily intakes (EDI, mg/kg bw/day) is expressed as element concentration (mg/kg) and meal size (kg/day) divided by adult body weights (kg) (Tutun et al., 2022; Mititelu et al., 2022).

Hazard quotient (HQ) was calculated to evaluate the non-carcinogenic risks for Cu, Fe, Mn, and Zn with propolis consumption, and hazard index (HI), which is the sum of the hazard quotients, was calculated to assess the potential risk of elements in food. Systemic effects may occur when the risk of HQ is above 1, which is an indicator higher than the reference dose of HQ (US-EPA, 2007). The calculation of HQ is expressed in the equation below (Tutun et al., 2022; Mititelu et al., 2022):

$$HQ = C \times EF \times ED \times IR/RfD \times BW \times AT$$

C: Element content in propolis, mg/kg

MS or IR: Meal size or Ingestion rate, 0.00315 kg/day propolis for adults (Tutun et al., 2022)

BW: Body weight, 70 kg for adults (US-EPA, 2000)

EF: Exposure frequency, 52 days/year for people who eat propolis one time a week

ED: Exposure duration, 70 years for adults

AT: Averaging time, $ED \times 365$ days/year

RfD: Oral reference dose, 0.04 mg/kg bw/day for Cu, 0.7 mg/kg bw/day for Fe, 0.14 mg/kg bw/day for Mn, 0.3 mg/kg bw/day for Zn (US-EPA, 2007).

RESULTS AND DISCUSSIONS

Limit of detection (LOD) and limit of quantification (LOQ) values were determined for Cu, Fe, Mn and Zn. For this purpose, calculations were made with a formula defined as $3 \times SD/b$ for LOD and $10 \times SD/b$ for LOQ, where SD is the standard deviation of the blank and b is the slope of the analytical curve. Repeatability was calculated as the relative standard deviation (RSD%) and was found to be less than 10% for the studied elements. LOD and LOQ values for Cu, Fe, Mn and Zn elements are presented in Table 2. The essential trace element (Cu, Fe, Mn, Zn) contents of propolis samples collected from five districts including Arapgir (*Propolis I*), Arguvan (*Propolis II*), Hekimhan (*Propolis III*), Kale (*Propolis IV*), Puturge (*Propolis V*) of Malatya, Türkiye were determined, and these results were evaluated considering EDI, RDA, PMTDI, HQ values calculated for each element. As seen in Table 2, the concentration ranges of propolis samples taken from five different districts of Malatya province varied between 1.24 ± 0.06 mg/kg and 6.28 ± 0.02 mg/kg for Cu, 206.28 ± 21.50 mg/kg and 663.08 ± 55.24 mg/kg for Fe, 15.40 ± 0.17 mg/kg and 27.11 ± 1.83 for Mn, 39.36 ± 1.82 mg/kg and 52.57 ± 2.13 mg/kg for Zn. When the element contents of each district are evaluated separately, the highest Fe and Zn contents were determined in *Propolis V*, and the results were

found to be 663.08 ± 55.24 mg/kg and 52.57 ± 2.13 mg/kg. The highest Cu and Mn contents were determined in *Propolis III* and *Propolis IV*, and the results were found to be 6.28 ± 0.02 mg/kg and 27.11 ± 1.83 mg/kg. When the lowest essential element contents were evaluated, it was found that the lowest Mn (15.40 ± 0.17 mg/kg) and Zn (39.36 ± 1.82 mg/kg) contents were determined in *Propolis III*. Similarly, when Cu and Fe contents were evaluated, the lowest results were observed in *Propolis IV*, and the results were found to be 1.24 ± 0.06 mg/kg for Cu and 206.28 ± 21.50 mg/kg for Fe. The results obtained for the studied element were also evaluated statistically. When the statistical results of the Cu contents of propolis samples were evaluated, significant differences were found between both propolis samples except *Propolis II* and *Propolis V* ($p < 0.05$). According to the statistical results, the Fe contents of propolis samples showed significant differences between both propolis samples except *Propolis I* and *Propolis III*, *Propolis I* and *Propolis IV*, *Propolis III* and *Propolis IV* ($p < 0.05$). The Mn contents of propolis samples were evaluated statistically, and no significant difference was found between both propolis samples except *Propolis I* and *Propolis IV*, *Propolis II* and *Propolis IV*, *Propolis III* and *Propolis IV*, *Propolis IV* and *Propolis V* ($p < 0.05$). When the statistical results of the Zn contents of propolis samples were evaluated, no significant differences were found between both propolis samples except *Propolis III* and *Propolis IV*, *Propolis III* and *Propolis V* ($p < 0.05$). The accuracy of the method was verified using NIST-1547 peach leaves standard reference material. The recoveries of the elements were found to be 95% for Cu, Mn and 98% for Fe, Zn.

Table 2. The element contents of propolis belonging to five different districts of Malatya, Türkiye (n=3).

Propolis samples	Cu, mg/kg	Fe, mg/kg	Mn, mg/kg	Zn, mg/kg
<i>Propolis I</i>	4.98 ± 0.26^a	313.41 ± 1.76^a	19.49 ± 1.72^a	46.88 ± 2.87^a
<i>Propolis II</i>	3.25 ± 0.34^b	452.50 ± 26.16^b	16.15 ± 1.45^a	44.89 ± 3.38^a
<i>Propolis III</i>	6.28 ± 0.02^c	259.54 ± 10.93^a	15.40 ± 0.17^a	39.36 ± 1.82^a
<i>Propolis IV</i>	1.24 ± 0.06^d	206.28 ± 21.50^a	27.11 ± 1.83^b	$50.24 \pm 0.06^{a,b}$
<i>Propolis V</i>	2.67 ± 0.03^b	663.08 ± 55.24^c	19.63 ± 1.52^a	$52.57 \pm 2.13^{a,b}$

Average values of different letters were significantly different from each other ($p < 0.05$).

LOD: 0.03 mg/kg for Cu and Fe, 0.04 mg/kg for Mn, 0.02 mg/kg for Zn; LOQ: 0.09 mg/kg for Cu, 0.10 mg/kg for Fe, 0.11 mg/kg for Mn, 0.06 mg/kg for Zn.

Estimated daily intakes (EDI) values for females and males over 19 years of age were evaluated separately for each element. When examined in Table 3, EDI in propolis samples varied between 0.0001 and 0.0003 mg/kg bw/day for Cu, 0.0093 and 0.0298 mg/kg bw/day for Fe, 0.0007 and 0.0012 mg/kg bw/day for Mn, and 0.0018 and 0.0024 mg/kg bw/day for Zn. Recommended daily allowance (RDA) values in propolis samples were evaluated considering the recommended values for females and males (Table 3). The RDA values for Cu varied

between 0.006% and 0.031% in females and males, the RDA values for Fe varied between 0.052% and 0.373% in females and 0.116% and 0.373% in males, the RDA values for Mn varied between 0.038% and 0.068% in females and 0.030% and 0.053% in males, the RDA values for Zn varied between 0.022% and 0.030% in females and 0.016% and 0.022% in males (Table 3). PMTDI values were calculated considering the element contents for propolis samples in Table 3, and the results are presented as %. PMTDI values varied between 0.01% and 0.03% for Cu, 0.93% and 2.98% for Fe, 0.07% and 0.12% for Mn, and 0.18% and 0.24% for Zn. Additionally, HQ values were calculated for health risk assessment; the highest HQ values were found for *Propolis III* (0.0011) for Cu, *Propolis V* (0.0061) for Fe, *Propolis IV* (0.0012) for Mn and *Propolis IV and V* (0.0011) for Zn. The lowest HQ values were found for *Propolis IV* (0.0002) for Cu, *Propolis IV* (0.0019) for Fe, *Propolis II and III* (0.0007) for Mn and *Propolis III* (0.0008) for Zn. HQ values below 1 indicate that there is no health risk.

Table 3. EDI, RDA, PMTDI, and HQ values calculated considering the studied contents of propolis samples of Malatya, Türkiye.

		Propolis samples				
Element		<i>Propolis I</i>	<i>Propolis II</i>	<i>Propolis III</i>	<i>Propolis IV</i>	<i>Propolis V</i>
Cu	EDI (mg/kg bw/day)	0.0002	0.0001	0.0003	0.0001	0.0001
	RDA (%)	0.025(F,M)	0.016(F,M)	0.031(F,M)	0.006(F,M)	0.013(F,M)
	PMTDI (%)	0.02	0.02	0.03	0.01	0.01
	HQ	0.0008	0.0005	0.0011	0.0002	0.0004
		<i>Propolis I</i>	<i>Propolis II</i>	<i>Propolis III</i>	<i>Propolis IV</i>	<i>Propolis V</i>
Fe	EDI (mg/kg bw/day)	0.0141	0.0204	0.0117	0.0093	0.0298
	RDA (%)	0.078-	0.113-	0.065-	0.052-	0.166-
		0.176(F)	0.255(F)	0.146(F)	0.116(F)	0.373(F)
		0.176(M)	0.255(M)	0.146(M)	0.116(M)	0.373(M)
	PMTDI (%)	1.41	2.04	1.17	0.93	2.98
	HQ	0.0029	0.0041	0.0024	0.0019	0.0061
		<i>Propolis I</i>	<i>Propolis II</i>	<i>Propolis III</i>	<i>Propolis IV</i>	<i>Propolis V</i>
Mn	EDI (mg/kg bw/day)	0.0009	0.0007	0.0007	0.0012	0.0009
	RDA (%)	0.049(F)	0.040(F)	0.038(F)	0.068(F)	0.049(F)
		0.038(M)	0.032(M)	0.030(M)	0.053(M)	0.038(M)
	PMTDI (%)	0.09	0.07	0.07	0.12	0.09
	HQ	0.0009	0.0007	0.0007	0.0012	0.0009
		<i>Propolis I</i>	<i>Propolis II</i>	<i>Propolis III</i>	<i>Propolis IV</i>	<i>Propolis V</i>
Zn	EDI (mg/kg bw/day)	0.0021	0.0020	0.0018	0.0023	0.0024
	RDA (%)	0.026(F)	0.025(F)	0.022(F)	0.028(F)	0.030(F)
		0.019(M)	0.018(M)	0.016(M)	0.021(M)	0.022(M)
	PMTDI (%)	0.21	0.20	0.18	0.23	0.24
	HO	0.0010	0.0010	0.0008	0.0011	0.0011

Adequate intakes (AIs) for >19 years of age: for F and M 0.9 mg/day for Cu, for 8-18 mg/day F and 8 mg/day M for Fe, for 1.8 mg/day F and 2.3 mg/day M for Mn, for 8 mg/day F and 11 mg/day M for Zn (Institute of Medicine, 2006). Tolerable upper intake levels (UL) for adults: for 10 mg/day for Cu, 45 mg/day for Fe, 11 mg/day for Mn, and 40 mg/day for Zn (Institute of Medicine, 2001). Provisional maximum tolerable daily intakes (PMTDIs): 0.5

mg/kg bw/day for Cu, 0.8 mg/kg bw/day for Fe, 0.36 mg/kg bw/day for Mn and 1.0 mg/kg bw/day for Zn (FAO/WHO, 2007).

Mutlu et al. (2023) examined the element contents of propolis samples obtained from different parts of Türkiye, including Malatya province. They determined the average element contents for the provinces including Malatya province as the Eastern Anatolia Region, and the propolis contents of this region were found to be 627 ± 122 mg/kg for Fe, 9.43 ± 3.75 mg/kg for Mn, and 5.46 ± 3.84 mg/kg for Zn (Mutlu, Ozer-Atakoglu, Erbas & Yalcin, 2023). Tutun et al. (2022) investigated the element contents of bee pollen and propolis in Türkiye and evaluated their effects on health risk. In propolis samples obtained from different provinces, Cu, Fe, Mn and Zn contents were determined as 2.76 ± 1.46 mg/kg on average in the range of 0.61 to 6.08 mg/kg, 390 ± 181 mg/kg on average in the range of 69 to 658 mg/kg, 10.6 ± 5.88 mg/kg on average in the range of 1.61 to 28.0 mg/kg and 36.3 ± 18 mg/kg on average in the range of 7.98 to 102 mg/kg, respectively, and the results were reported to have no health risk (Tutun et al., 2022). Arslan et al. (2021) investigated the chemical and biological properties of propolis obtained from *Apis mellifera caucasica* from Ardahan and Erzurum provinces of Türkiye. The element contents in propolis samples for Ardahan province was found as 2.45 ± 0.16 mg/kg for Cu, 428.51 ± 77.75 mg/kg for Fe, 5.297 ± 0.71 mg/kg for Mn, 30.05 ± 7.30 mg/kg for Zn and the element contents in propolis samples for Erzurum province 2.01 ± 0.79 mg/kg for Cu, 507.62 ± 287.13 mg/kg for Fe, 7.47 ± 3.27 mg/kg for Mn, 41.77 ± 19.65 mg/kg for Zn (Arslan et al., 2021). The elemental contents of propolis samples from different provinces in Türkiye were found to be compatible with the propolis samples from Malatya province. However, the element contents of propolis samples may differ depending on the region due to the environmental conditions in which bees live. Risk assessment can be carried out with element analyses in different provinces and regions to monitor environmental health and contamination levels of pollutants in bee products (Tutun et al., 2022).

CONCLUSION

The elements Cu, Fe, Mn and Zn were determined in propolis samples obtained from five different districts of Malatya, Türkiye. The Cu, Fe, Mn and Zn contents of propolis samples were determined by FAAS, and the obtained results were also evaluated statistically. In addition, the element contents were calculated by considering adult females and males as the estimated daily intake (EDI), recommended dietary allowance (RDA) and provisional maximum tolerable daily intakes (PMTDIs). It was found that there was no risk according to the tolerable limits allowed in the intake of the estimated elements studied in the propolis

samples. In addition, HQ values were calculated for each element and propolis sample for health risk assessment. Since the HQ value was below 1 for all propolis samples and elements, no health risk was found.

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DEEP LEARNING IN NEUROLOGICAL IMAGING: A NOVEL CNN-BASED MODEL FOR BRAIN TUMOR CLASSIFICATION TÜRKİYE AND HEALTH RISK ASSESSMENT

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ABSTRACT

Brain tumors can cause serious neurological damage and death by putting pressure on critical brain regions that manage vital functions. Given the complex structures in the brain, human error in the evaluation of radiological images can create difficulties in the detection of these tumors. Convolutional neural networks (CNNs) are type of deep learning (DL) and are widely used, especially for analyzing visual data. The advantage of CNNs in detecting brain tumors is that they can automatically learn features from images and minimize human error by increasing the classification accuracy. In this study, a unique CNN-based model is proposed for brain tumor diagnosis using magnetic resonance imaging (MRI) images. A high classification score was obtained using a dataset consisting of 3096 MRI images divided into four categories: glioma, meningioma, normal brain, and pituitary tumor. The model achieved an overall 93% accuracy rate in tumor detection. In particular, great success was seen for the detection of pituitary tumors with 96% precision and a 95% F1 score. This study demonstrates that DL has significant potential in medical image analysis. The novelty of our approach lies in designing a lightweight CNN architecture from scratch that achieves high accuracy without relying on transfer learning, while requiring significantly fewer computational resources than traditional deep architectures.

INTRODUCTION

Intracranial neoplasms, commonly referred to as brain tumors, pose a considerable challenge in the fields of neurology and oncology due to their complex pathophysiology and potential to cause severe neurological disorders. Characterized by abnormal proliferation of cells within the cranial cavity, these neoplasms can be categorized as either benign or malignant with varying invasiveness and growth rates. Accurate and timely diagnosis of brain tumors is of paramount importance for optimal patient outcomes as it directly affects treatment strategies and prognosis (Louis et al., 2016).

Traditional diagnostic methods based primarily on radiological interpretation and histopathological examination are often time-consuming and subject to inter-observer variability. This limitation has prompted the search for advanced computational methods to

support the diagnostic process. In recent years, the emergence of artificial intelligence (AI) and especially deep learning (DL) techniques has revolutionized medical image analysis (Litjens et al., 2017).

Machine learning (ML) approaches are widely used in various fields, such as medical diagnosis and preventive medicine (Adlung, Cohen, Mor & Elinav, 2021). However, the challenges of limited medical imaging data pose a major challenge for these approaches. The limited data is usually trained and tested on magnetic resonance imaging (MRI) data using traditional ML algorithms. Recently, some approaches have started to use DL methods for brain disease diagnosis. Convolutional neural networks (CNNs), a class of DL algorithms, have shown exceptional effectiveness in image classification and object detection tasks (Zhao, Zheng, Xu & Wu, 2019). Their ability to automatically learn hierarchical feature representations from raw image data makes them particularly well suited for analyzing complex medical images such as MRI scans (Hammernik et al., 2019).

CNN-based methods have been successful in detecting many brain diseases, such as epilepsy (Dutta, Manohar & Krishnappa, 2024), Alzheimer's disease (Çelebi & Emiroğlu, 2023), and stroke (Zhang, Xu, Tan, Wang & Meng, 2021). Rehman et al. (Rehman, Naz, Razzak, Akram & Imran, 2020) proposed a framework for the classification of different types of tumors using a model called triple architecture CNN. As a result of their research, they achieved an accuracy of 98.69% using the VGG16 architecture to improve classification and diagnosis. Çınar and Yildirim (2020) introduced a hybrid CNN architecture aimed at computed tomography detection via the adaptation of a deep learning model. Their integrated ResNet50 architecture attained an accuracy of 97.2%, in contrast to the standalone ResNet50 model, which recorded an accuracy of 92.53%. Banerjee et al. (Banerjee, Mitra, Masulli & Rovetta, 2019) proposed new ConvNet models to improve MRI image classification using multiple MRI images. By combining existing ConvNet and VGGNet models, the study achieved 97% accuracy of the proposed models. Furthermore, a multi-level feature extraction method was developed to overcome the differences between medical images and natural images. Pashaei et al. (Pashaei, Sajedi & Jazayeri, 2018) introduced two distinct methodologies: the first methodology used a CNN model for the classification task, while the subsequent methodology used the features derived from the CNN as inputs for a kernel extreme learning machine approach. The methodology represents a learning algorithm that is composed of multiple layers of hidden nodes. Abiwinanda et al. (Abiwinanda, Hanif, Hesaputra, Handayani & Mengko, 2019) introduced a CNN architecture characterized by a dual-layer configuration. Hashemzahi et al. (Hashemzahi, Mahdavi, Kheirabadi & Kamel, 2020) proposed a hybrid CNN-NADE

model that effectively detected brain tumors from MRI images, even with limited medical image availability. Pereira et al. (Pereira, Meier, Alves, Reyes & Silva, 2018) suggested a 3D CNN that automatically grades glioma using MRI in conventional multiple sequences. The proposed system provides two functionalities, which are automatically extracting regions of interest and predicting glioma grade. Evaluated on the BRATS 2017 training set, the system achieved 89.5% accuracy, and tumor prediction based on regions of interest was performed with 92.98% accuracy. In another study, Tiwari et al. (Tiwari et al., 2022) used a CNN to classify brain tumors into four different classes (ie, non-tumor, glioma, meningioma, and pituitary tumor) and achieved 99% accuracy. Ozdemir (2023) developed a novel CNN architecture for classifying three types of brain tumors (meningioma, glioma, and pituitary) from brain MR images that is simple, fast, and computationally efficient, achieving a high accuracy rate of 98.69%. This model presented an architecture requiring less computational power, with greater flexibility and reduced complexity, particularly by utilizing high kernel size and stride values in the first convolutional layers.

This study aimed to investigate the effectiveness of CNNs in detecting and classifying brain tumors using a comprehensive dataset of MRI scans. Our research focused on four different categories: gliomas, meningiomas, pituitary tumors, and normal brain tissue. By the end of the study, we aimed to develop a highly accurate classification model to help clinicians in the diagnostic process with DL. The performance of the model was evaluated using various metrics, including precision, sensitivity, and F1-score, with special attention paid to its ability to discriminate between different tumor types.

The success of published studies in detecting brain tumor types inspired us to select a DL-based approach to improve its accuracy and performance. We evaluated our proposed approach on a publicly available dataset. The research contributes to the burgeoning literature on DL-assisted medical image analysis and explores the potential of DL techniques in improving the speed and accuracy of brain tumor diagnosis. By demonstrating the capabilities of CNNs in this context, we aimed to lay the groundwork for the development of more efficient and reliable diagnostic tools that can complement traditional clinical methods. Furthermore, with our proposed work, we aimed to answer the following research question: To what extent does the DL algorithm demonstrate efficiency and precision in the identification and classification of various tumor types?

The study provided three main contributions. (1) We presented an innovative DL model designed for the classification of four distinct categories of MRI scans. The introduced DL classification methodology demonstrated superior performance compared with prevailing state-

of-the-art techniques by attaining the highest accuracy on the MRI dataset. (2) Especially limited datasets pose a major problem in medical image processing. For this reason, high-accuracy studies in the literature are usually based on transfer learning (Ozdemir, 2024) models. However, in this paper, we showed that our proposed novel CNN-based method can achieve as high accuracy as transfer learning. (3) Traditional ML methods require feature extraction. However, DL-based methods eliminate this need thanks to their ability to automatically learn features. Therefore, the superior classification performance of our CNN-based method becomes more evident when compared with traditional ML methods. In this paper, we evaluated the effectiveness of a CNN-based architecture.

The novelty of the CNN architecture proposed in this work lies in several key aspects. First, unlike many recent approaches, our model is designed from scratch to specifically adapt to the unique characteristics of brain tumor MRI images, rather than using pre-trained architectures. Second, our model achieves high accuracy (93%) with only 1.8 million parameters, using significantly less computational resources compared to complex deep architectures (e.g., VGG, ResNet). Third, the proposed architecture has shown superior performance, especially in the detection of pituitary tumors (96% accuracy), thanks to its layer configuration specifically designed to capture the morphological features of different tumor types. In these aspects, our work provides the literature with a lightweight and effective brain tumor classification model that can be used in clinical applications. Although existing studies have achieved high accuracy, they typically rely on transfer learning and large-scale pretrained models that require substantial computational resources. Our work addresses this gap by developing a lightweight CNN architecture from scratch that achieves comparable accuracy with significantly fewer parameters, making it more suitable for deployment in resource-constrained clinical settings.

With this work, we aimed to advance the field of neuro-oncology and contribute to the ongoing efforts to improve patient care with innovative technological solutions.

MATERIAL AND METHOD

In this study, a novel CNN architecture was developed to detect and classify brain tumors.

Dataset

The dataset used in the study provides a large collection of MRIs for brain tumor classification (Chitnis, Hosseini & Xie, 2022). The dataset consists of a total of 3096 images and was divided into four categories: glioma tumor, meningioma tumor, pituitary tumor, and

normal brain scans. The dataset includes images acquired in the axial, coronal, and sagittal planes. Each image was labelled for medical image processing and DL model development. Figure 1 shows example images of the dataset from four different classes.

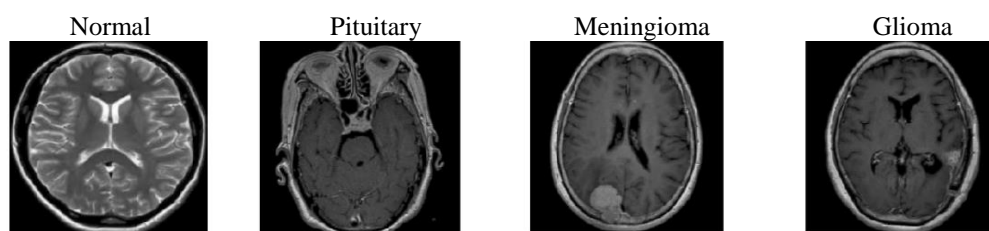


Figure 1: Dataset sample images

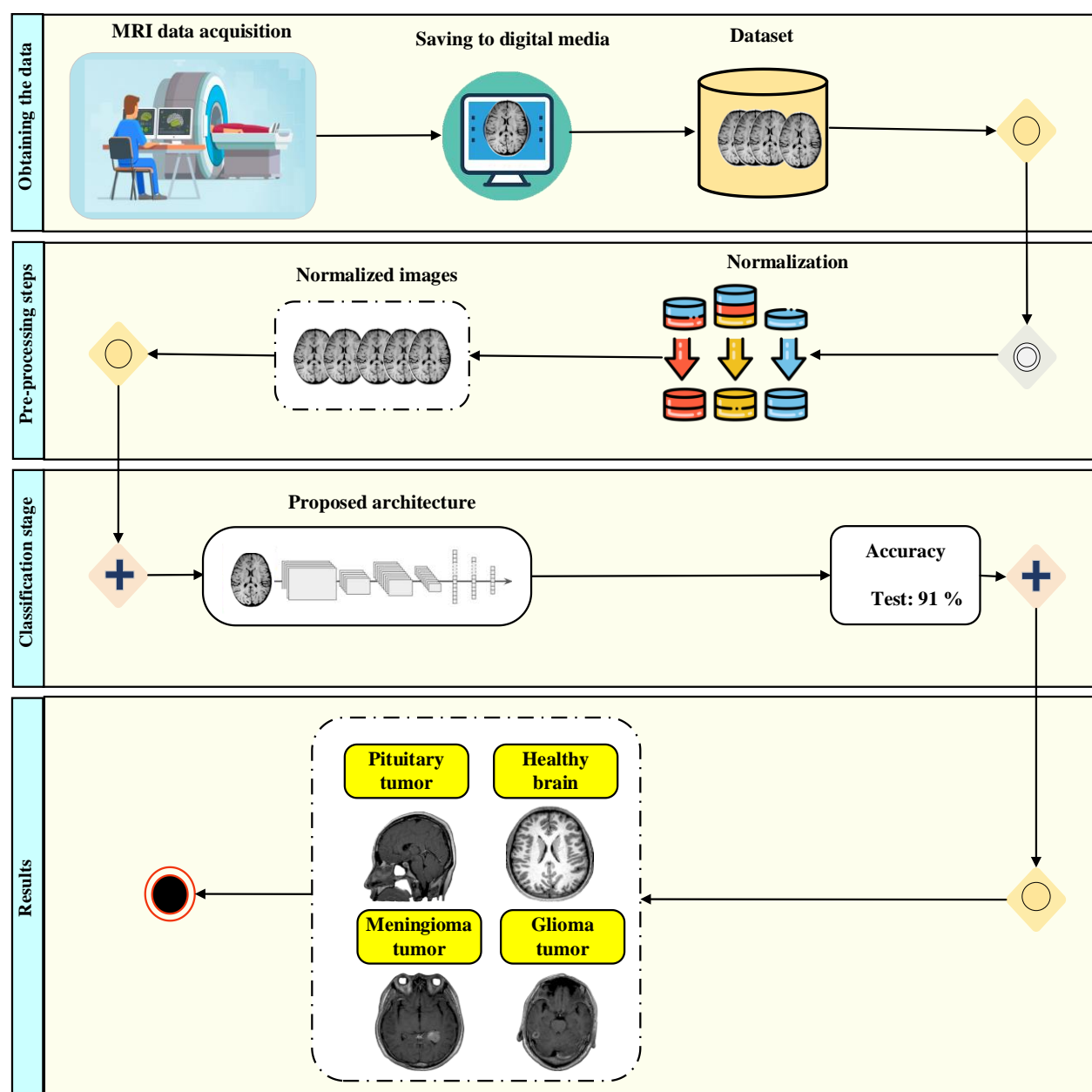
The images were standardized to 224x224 pixels and RGB format. The dataset was divided into groups with approximately 70% for training, 10% for validation, and 20% for model training and testing. The pixel intensity values were adjusted by the min–max normalization method and measured as a value between 0 and 1. The distribution of the dataset is shown in Table 1.

Table 1: Dataset classes

Class name	Train (n)	Validation (n)	Test (n)	Total images (n)
Glioma tumors	633	90	178	901
Meningioma tumors	640	92	182	913
Normal brain images	305	44	89	438
Pituitary tumors	588	85	171	844

Model architecture

The DL model used in the study was developed for the classification of brain tumors and was built using the Keras library. The model was specifically designed and structured for brain tumor classification. Figure 2 shows the process of the proposed method for brain tumor diagnosis. For model training, categorical_crossentropy was used as the loss function as it is suitable for multi-class classification problems. Adam Optimizer was selected as the optimization algorithm.

**Figure 2:** Proposed DL model

Adam is a gradient-based stochastic optimization method and is widely used in large-scale DL models. In our study, the accuracy metric was used to evaluate the performance of the model. The hyperparameters used for the architecture of the model designed in this study are given in Table 2.

Table 2: Model architecture details

Parameters	Value
Learning rate	1e-3
Batch size	128
Optimizer	Adam
Loss function	Categorical Crossentropy
Number of epochs	30

Rescaling	1/255
Metrics	Accuracy

The model consists of a series of convolutional (Conv2D) and maximum pooling (MaxPooling2D) layers and followed by flattening (flatten), fully connected (dense), and dropout layers. The final layer is dense and consists of four neurons. The total number of parameters in the model was 1,846,916, which suggests that the model was sufficiently complex and has the potential to discriminate various types of brain tumors. The architecture of the proposed CNN-based classifier is detailed in Table 3.

Table 3: CNN architecture

Layer	Output shape	Parameter
Conv2D	(,222, 222,64)	1,792
MaxPooling2D	(,111, 111, 64)	0
Conv2D	(,111, 111, 128)	204,928
MaxPooling2D	(,37, 37, 128)	0
Conv2D	(,37, 37, 128)	802,944
MaxPooling2D	(,18, 18, 128)	0
Conv2D	(,18, 18, 128)	409,728
MaxPooling2D	(,9, 9, 128)	0
Conv2D	(,9, 9, 128)	147,584
MaxPooling2D	(,4, 4, 128)	0
Conv2D	(,4, 4, 128)	147,584
MaxPooling2D	(,2, 2, 128)	0
Flatten	(,512)	0
Dense	(,256)	131,328
Dropout	(,256)	0
Dense	(,4)	1,028
Total parameters		1,846,916

Deep learning

Artificial neural networks (ANNs) are used to model learning processes in computer systems (Göçmen, Çıbuk & Akin, 2024). These networks have the potential to provide effective solutions in complex problem domains where traditional methods fall short. ANNs have important applications in various fields, such as for financial transactions (Havishya, Lakshmi & Aishwarya, 2024), marketing (Aslan & Çelebi, 2022), forecasting (Birecikli, Karaman, Çelebi & Turgut, 2020), and health applications (Yaşar, 2025). ANNs are used for processing and analyzing complex datasets (Aslan & Çelebi, 2024).

ANNs are a subclass of ML, and deep neural networks (DNNs) are a subclass of ANN. DNNs can process complex data structures more efficiently due to the inclusion of more layers and neurons. Following this development, CNNs emerged with the addition of the convolution process. CNNs have led to significant advances, especially in the field of image processing (Hayıt & Çınarar, 2022; Özcan & Acar, 2024). DL, thanks to its multilayer structure, has been

used for image processing, natural language processing, and voice recognition. This technology offers effective applications in the healthcare, computer vision, and finance sectors. The processing and analysis of complex datasets in these fields is made more efficient with DL techniques (Shlezinger, Whang, Eldar & Dimakis, 2020).

ANN and DL techniques play a crucial role in modern AI applications, given their success in data analysis and modeling processes. These technologies offer new opportunities for future research and applications and bring innovative solutions to problems in various disciplines. As a result, ANNs and DL are leading revolutionary developments in computer science and AI and shaping the future of these fields.

Development environment

Google Colaboratory (Colab) is a widely used platform for cloud-based scientific computing and ML applications. Built on Google's infrastructure, Colab allows users to work with the Python programming language and facilitates project management with Google Drive integration. The platform is specially optimized for training DL models with high-performance computing resources, such as the Tesla K80 GPU and Tensor Processing Unit (TPU), which are available for free. Due to its web-based interface, Colab allows users access from a variety of devices without requiring any local installation, which allows researchers and developers to continue their work from different platforms, including mobile devices. The platform offers a comprehensive ecosystem for researchers working with data science, ML, and DL. Users can easily upload shared scientific and ML libraries and collaborate on their projects. Colab provides a powerful, flexible, and accessible platform for researchers and developers working in scientific computing and ML. With its free computational resources, user-friendly interface, and extensive library support, Colab plays an important role in the development of academic and industrial research projects (Sukhdeve & Sukhdeve, 2023).

Performance metrics

The key metrics used for the performance evaluation of classification models are crucial for analyzing various aspects of the model. Accuracy (ACC) is a performance metric that expresses the ratio of a model's correct predictions to total predictions. Accuracy is calculated by the equation:

$$ACC = \frac{TP + TN}{TP + TN + FP + FN} \quad (1)$$

True positive (TP) refers to the number of samples correctly predicted as positive and true negative (TN) indicates the number of samples correctly predicted as negative. False positive

(FP) represents samples that were incorrectly predicted as positive and false negative (FN) represents samples that were incorrectly predicted as negative. However, accuracy can be misleading in unbalanced datasets. Therefore, this metric is usually evaluated together with other metrics, such as precision, recall, and F1 score. In this study, the performance of the model was analyzed with four different metrics.

Precision (PRE) measures how accurate the model's positive class predictions are and is especially crucial in areas where false positives are costly, such as clinical diagnosis or risk assessment (equation 2):

$$PRE = \frac{TP}{TP + FP} \quad (2)$$

Recall indicates the model's ability to detect true positive examples. This metric is particularly important in scenarios, such as cancer diagnosis, where false negatives can have consequences (equation 3):

$$Recall = \frac{TP}{TP + FN} \quad (3)$$

The F1-score (F1-SCR) represents the harmonic mean of the precision and recall metrics and provides a balance between these two metrics. The F1-score is considered an effective metric for evaluating the overall performance of the model, especially in imbalanced datasets (equation 4):

$$F1 - SCR = \frac{2 * PRE * Recall}{PRE + Recall} \quad (4)$$

The support metric shows the number of instances of each class in the test set. This information provides a contextual framework for interpreting the other metrics and provides important information about the class distribution of the dataset.

Combining these metrics allows for a more comprehensive and versatile evaluation of the classification model's performance. Each metric indicates a different performance dimension of the model. In this way, researchers and practitioners can analyze the strengths and weaknesses of the model in more depth (Chicco & Jurman, 2020; Erenel & Altınçay, 2012; Henderi, Wahyuningsih & Rahwanto, 2021; Powers, 2020).

Data normalization

Data normalization is the process of rescaling values in a dataset within a given scale or range. This process is especially important in ML and DL applications because it helps algorithms perform better and learn faster. Min-max normalization adjusts data to a defined interval (typically ranging from 0 to 1; equation 5):

$$X' = \frac{X - \min(X)}{\max(X) - \min(X)} \quad (5)$$

In equation 5, X' is the normalized value, X is the input variable, and $\min(X)$ and $\max(X)$ refers to the minimum and maximum values in the series (Chicco & Jurman, 2020; Erenel & Altınçay, 2012; Henderi vd., 2021; Powers, 2020).

Receiver operating characteristic curve

A receiver operating characteristic (ROC) curve shows the relationship between the model's true positive rate (TPR) and false positive rate (FPR) in binary classification problems, and were calculated using equations 6 and 7, respectively:

$$TPR = \frac{TP}{TP + FN} \quad (6)$$

$$FPR = \frac{FP}{FP + TN} \quad (7)$$

The ROC curve helps to evaluate the classification performance of the model. A larger area under the curve (AUC) indicates better performance of the model (Nahm, 2022).

RESULTS AND DISCUSSION

The developed DL model showed considerable performance during the training process. Although the accuracy rate was 30% at the beginning, it reached 99% in the last phase of training. The performance on the validation dataset stabilized around 92%. These results show that the model has a high learning capacity on the training data while maintaining its generalization capability. The accuracy output of the model is shown in Figure 3.

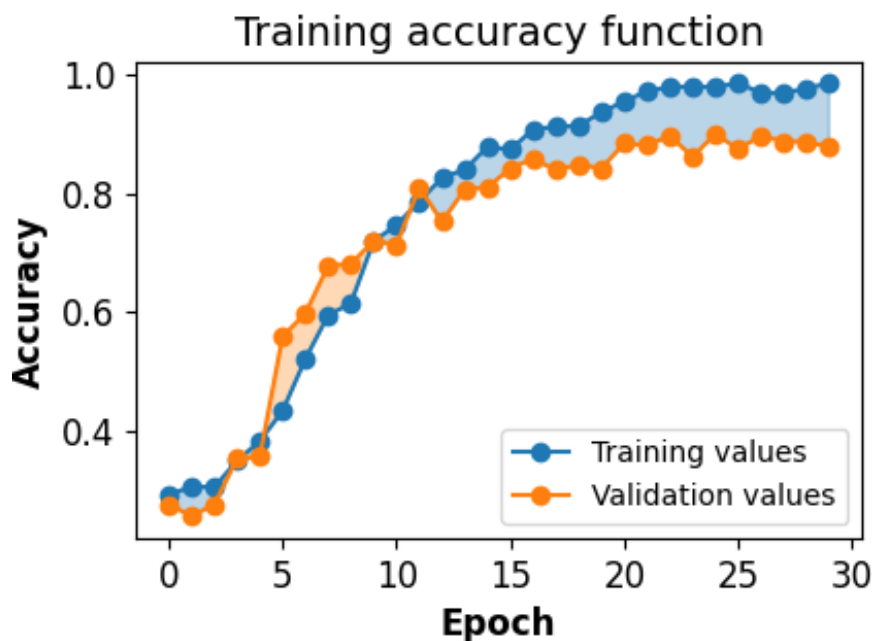


Figure 3: Training and validation accuracy of the model

The dataset was unbalanced; therefore, other performance metrics are presented in Table 4. The performance of the model in four different classes is described along with precision, recall, F1-score, and support values. The model classified brain tumors with high accuracy in the four different classes.

Table 4: Model performance results

Class	Precision	Recall	F1-Score	Support
Glioma	0.87	0.92	0.89	177
Meningioma	0.89	0.87	0.88	182
Normal	0.93	0.93	0.93	89
Pituitary	0.96	0.94	0.95	171
Accuracy	–	–	0.95	619
Macro average	0.93	0.93	0.93	619
Weighted average	0.93	0.93	0.93	619

Analyzing Table 4, the architectural pituitary tumor class had the highest F1-Score (0.95) and precision (0.96), meaning that the model can predict this tumor accurately. The normal class model performed well with an F1-Score of 0.93 and precision of 0.93. The overall accuracy was 93%, which shows that the model performed strongly overall. However, the model's prediction results in the glioma and meningioma classes showed slightly lower performance than the other classes. Especially in the glioma class, precision was lower than the other classes with a score of 0.87.

The confusion matrix shows the relationship between a model's predictions and the actual labels (figure 4).

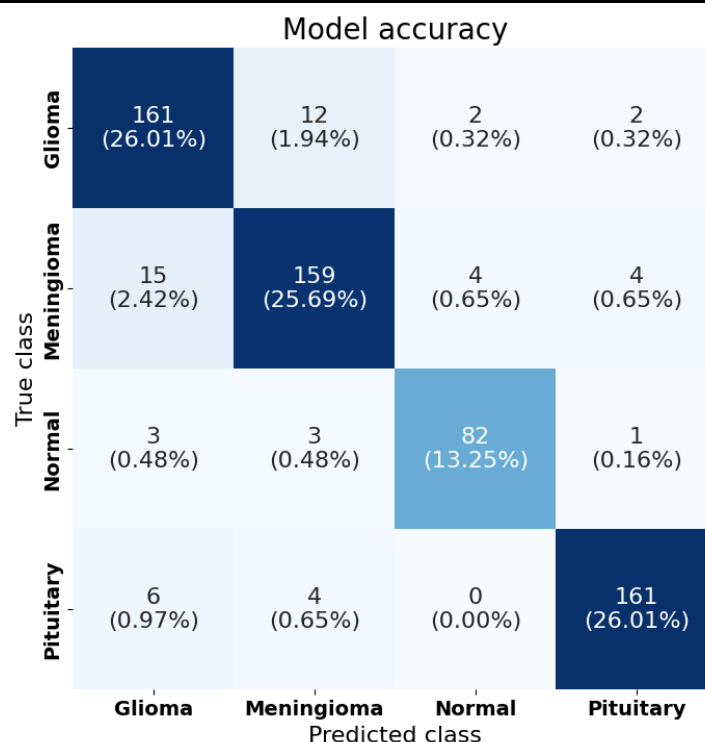


Figure 4: Confusion matrix

While 161 correct predictions were made for glioma tumors, 12 meningiomas, two normal, and two pituitary tumors were misclassified. In the meningioma tumor class, 159 correct predictions were made; 15 gliomas, four normal, and four pituitary tumors were misclassified. In the normal class, 82 correct predictions were made, while three were misclassified as glioma, three as meningioma, and one as a pituitary tumor. Lastly, in the pituitary tumor class, 161 correct predictions were made, while six gliomas and four meningiomas were misclassified. The proposed model showed success in classifying tumor classes; however, there was more confusion between the glioma and meningioma classes. The true classification rate was high in normal and pituitary tumor classes. In particular, in the pituitary and glioma tumor classes, the performance of the model was very strong.

The ROC curve presented in Figure 5 shows the performance of the classification of our proposed model for the four different classes. The ROC curve had an AUC of 0.97 for the glioma class. The model was successful at discriminating between the glioma class. The curve is almost close to the upper left corner, which implies both high accuracy of positive classification and a low false positive rate. For the meningioma class, the AUC was 0.96. Similarly, the model performed very well for meningioma. Given the AUC value of 0.96, the model was also very successful at recognizing the meningioma class. For the normal class, the model achieved an AUC score of 1.00, perfectly classifying the MRI images of normal

individuals. The curve completely converges to the upper left corner, and the model worked without errors. The model achieved an AUC score of 0.99 for the pituitary class. Thus, the model performed almost perfectly and was successfully classified with high accuracy.

In general, the ROC curves for all classes are close to the upper left corner, and the AUC ranges between 0.96 and 1.00. Accordingly, our proposed model performed well in all classes. The high AUC values, especially in class imbalances or in distinguishing different classes, indicate that the model is reliable.

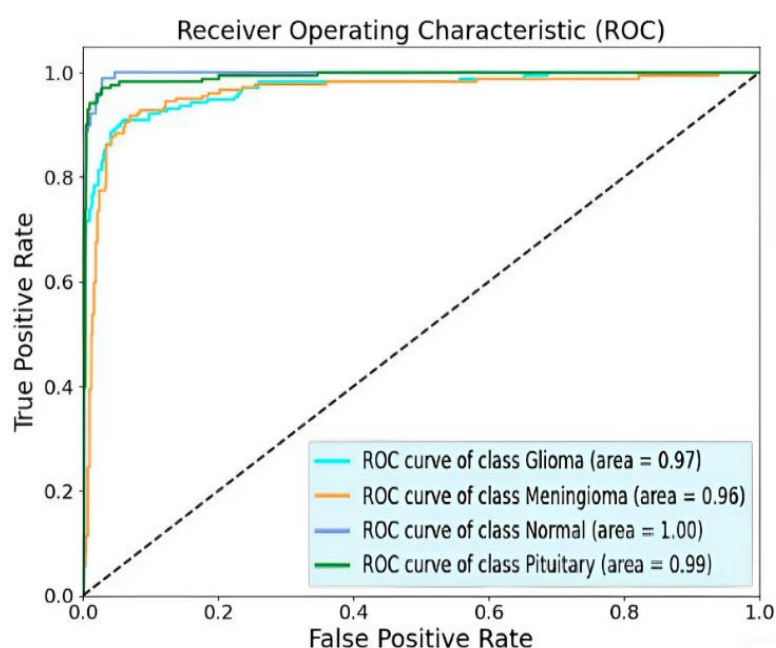
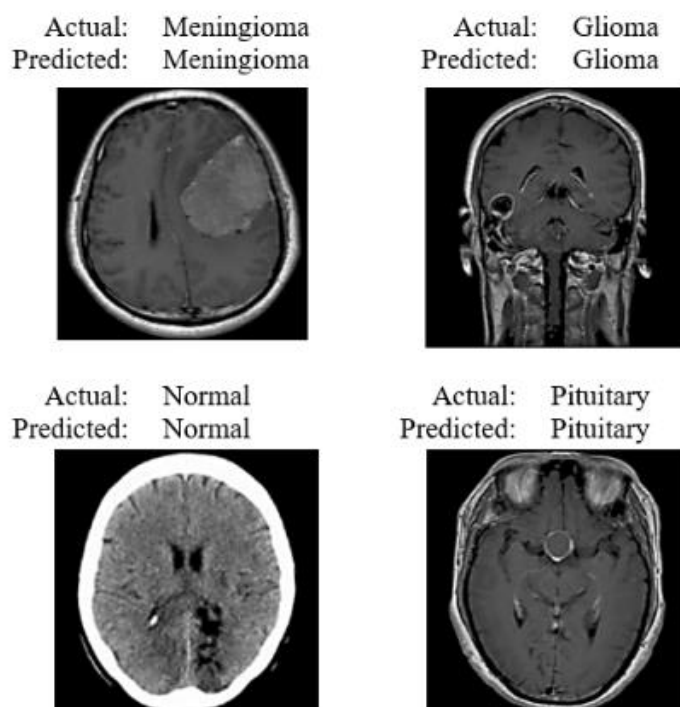


Figure 5: ROC curves and the AUC

Our high-performing model was evaluated with test images. Accordingly, the model's predictions and actual visual output are shown in Figure 6, which shows that the model is able to accurately distinguish tumor types.

**Figure 6:** Actual and predicted output

These results show that the model performed very well at brain tumor classification in general. In particular, pituitary tumor detection was outstanding. However, there is potential room for improvement in meningioma tumor classification.

To determine the performance of our proposed CNN architecture, we compared it with established deep learning models that are widely used in medical image analysis. Table 5 presents the comparison of our model with popular architectures such as VGG16, ResNet50 and EfficientNetB0 on the same dataset.

Table 5: Performance comparison with standard deep learning models

Model	Accuracy	F1-Score	AUC	Parameters(millions)
Proposed CNN	93%	0.95	0.96-1.00	1.85
VGG16	90%	0.89	0.95	138
ResNet50	92%	0.92	0.94	25.6
EfficientNetB0	89%	0.88	0.93	5.3

As shown in Table 5, our proposed CNN model exhibits similar or superior performance despite requiring significantly fewer parameters compared to commonly used architectures. This computational efficiency is critical, especially in clinical settings with limited computing resources. However, while transfer learning approaches require extensive pre-training on large datasets such as ImageNet, our model is trained directly on the MRI dataset. This results in a more specialized performance on the brain tumor classification task.

This study successfully demonstrated the effectiveness of CNN in brain tumor classification. The ability of the developed model to discriminate between four different intracranial conditions with 90% accuracy emphasizes the effectiveness of this model and system for neuroradiological diagnosis. The findings of this study align with previous research, highlighting the considerable potential of using DL for medical diagnostics. Our model's high precision in detecting pituitary tumors (96%) suggests that these tumors have distinct and easily identifiable features on MRI scans. However, the comparatively lower performance in classifying gliomas (87%) might reflect the inherent heterogeneity of these tumors, which presents a greater challenge for accurate classification. These results underscore the varying complexity of different tumor types and suggest that further model refinement is necessary for better handling of more heterogeneous conditions such as glioma. The strength of our study was the use of a large and diverse dataset, which suggests that working with data can increase the overall validity of the model. However, important limitations include the fact that the model was trained with only four categories and that the data was obtained from a single center. The performance of the model can be further improved with larger datasets obtained from different health centers.

CONCLUSION

In this study, a classification system was developed to categorize brain tumors into four different classes (ie, glioma tumor, meningioma tumor, normal brain state, and pituitary tumor) using a DL-based model. The proposed model showed high performance in brain tumor classification. When the class-wise performance metrics were analyzed, the model was particularly successful in pituitary tumor and normal brain tissue classifications. Although lower performance was observed in meningioma tumor classification compared with the other categories, While the model demonstrates high diagnostic accuracy, real-world clinical validation across multiple centers remains a necessary step before deployment in clinical settings. However, the performance of the model can be improved with additional optimization approaches, such as data augmentation techniques, the use of larger datasets, and methods to address class imbalance.

The results of this study indicate that DL methods can be used as a reliable and effective tool for brain tumor classification. The widespread use of the developed model in the healthcare sector can make major contributions to accelerate diagnostic processes and increase its accuracy. In future studies, it is recommended to test the model in real clinical settings and validate it on different patient populations.

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INVESTIGATION OF THE PREVALENCE OF HYPODONTIA IN THE PERMANENT DENTITION OF CHILDREN

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ABSTRACT

The aim of this study was to investigate the prevalence and distribution of congenital tooth deficiency in the pediatric patient population in Erzincan region. In this study, digital panoramic radiographs of 1421 children (714 girls, 707 boys) aged 6-12 years who applied to the Oral and Maxillofacial Radiology Clinic of Erzincan Oral and Dental Health Education and Research Hospital were examined. Descriptive statistics were used to calculate the number and rates of missing teeth, and the chi-square test ($p < 0.05$) was used to evaluate whether there was a significant difference between the groups. The prevalence of congenital tooth deficiency was found to be 6.22% in males, 5.18% in females and 5.70% in total. No statistically significant difference was found between gender and tooth deficiency ($p > 0.05$). It was determined that mandibular second premolars were the most frequently missing teeth, followed by maxillary lateral teeth and maxillary second premolars. Hypodontia frequency was observed as 5.70% in patients living in Erzincan region. Accordingly, digital panoramic radiographs taken in children over 6 years of age who apply for dental examination are of great importance for the diagnosis and detection of possible hypodontia. Early diagnosis of congenitally missing teeth plays a crucial role in treatment planning that provides patients with lower costs and more accurate occlusion in the future.

INTRODUCTION

Hypodontia, or congenital tooth agenesis, is one of the most common dentofacial malformations that affects individuals both aesthetically and functionally. Although the etiology of hypodontia remains unclear, it is thought to be associated with heredity (such as Down syndrome, ectodermal dysplasia, etc.), local inflammation, trauma, radiation, and diseases such as rickets and syphilis (Aras & Dogan, 2020). In the literature, different terms are used depending on the number of congenitally missing teeth: the absence of 1 to 6 teeth is referred to as “hypodontia,” more than 6 missing teeth is termed “oligodontia,” and the complete absence of all teeth, a rare condition, is called “anodontia” (Dzemidzic, Nakas, Gagula, Kozadra & Tiro, 2020; Gracco et al., 2017; Meistere, Kronina, Karkle & Neimane, 2024). Studies have shown that the prevalence and location of hypodontia vary among different ethnic groups, ranging from 0.3% to 34.3% (Aras & Dogan, 2020; Mahjoub et al., 2024).

Depending on the number and region of the affected teeth, this anomaly may lead to varying degrees of dental malposition, reduced alveolar bone height, and consequently to functional impairments such as difficulties in chewing and speaking, as well as aesthetic problems and associated self-confidence issues (Rakhshan, 2015). Early diagnosis of hypodontia is important for preventing potential future complications and for developing more effective treatment options (Ayrancı, 2019).

The aim of this study is to examine the prevalence and distribution of hypodontia in the permanent dentition of children in the Erzincan region.

MATERIAL AND METHOD

Study Type

This is a retrospective study conducted to examine the prevalence and distribution of hypodontia in the permanent dentition of children in the Erzincan region.

Study Population and Sample

In this study, digital panoramic radiographs of a total of 1,421 patients, 707 boys and 714 girls, were evaluated. These patients had presented to Erzincan Oral and Dental Health Training and Research Hospital between May 2022 and October 2022 and were between the ages of 6 and 12 at the time the radiographs were taken. Only high-quality, artifact-free digital panoramic radiographs were included in the study, while those with insufficient clarity or image quality were excluded. Based on a previous similar study (Aras & Dogan, 2020), the prevalence of hypodontia in the Erzincan region was assumed to be 6.6% for the purpose of estimating the sample size. With a 5% margin of error and 90% statistical power, the 1,421 panoramic radiographs collected from randomly selected patients over a six-month period were determined to meet the required minimum sample size.

Data Collection and Analysis

Digital panoramic radiographs (Planmeca ProOne® orthopantomographic imaging unit) obtained from patients who presented to Erzincan Oral and Dental Health Training and Research Hospital were used as the data collection tool in this study. Panoramic images with low resolution, artifacts, or unclear visualization of erupted teeth and tooth germs, as well as those belonging to patients with extracted teeth, cleft palate, or craniofacial syndromes, were excluded. All panoramic radiographs were examined using a digital viewer by an Oral and maxillofacial radiologist with 10 years of experience. Teeth, excluding third molars, were diagnosed as congenitally missing if crown mineralization could not be detected.

IBM SPSS Statistics 27 (SPSS Inc., Armonk, NY, USA) was used for statistical analysis. The data were analyzed using frequency, descriptive statistics, and the Chi-square test. The level of statistical significance was set at $p < 0.05$.

Limitations of the Study

This study is limited by the sample size obtained. The panoramic radiographs included in the study were collected from children who presented with dental problems during the specified period. A more homogeneous and larger sample is required to improve the generalizability of the results.

Ethical Considerations

This study was approved by the Non-Interventional Clinical Research Ethics Committee of Erzincan Binali Yıldırım University Faculty of Medicine (approval number: 2024-13/03) and was conducted in accordance with the Declaration of Helsinki.

RESULTS

A total of 137 congenitally missing permanent teeth were identified in 81 of the 1,421 patients included in the study (Figure 1). The prevalence of permanent tooth agenesis was found to be 6.22% in males, 5.18% in females, and 5.70% overall. No statistically significant difference was observed between gender and tooth agenesis ($p > 0.05$). The mean age was 8.65 ± 1.82 years for boys, 8.67 ± 1.79 years for girls, and 8.66 ± 1.81 years overall.

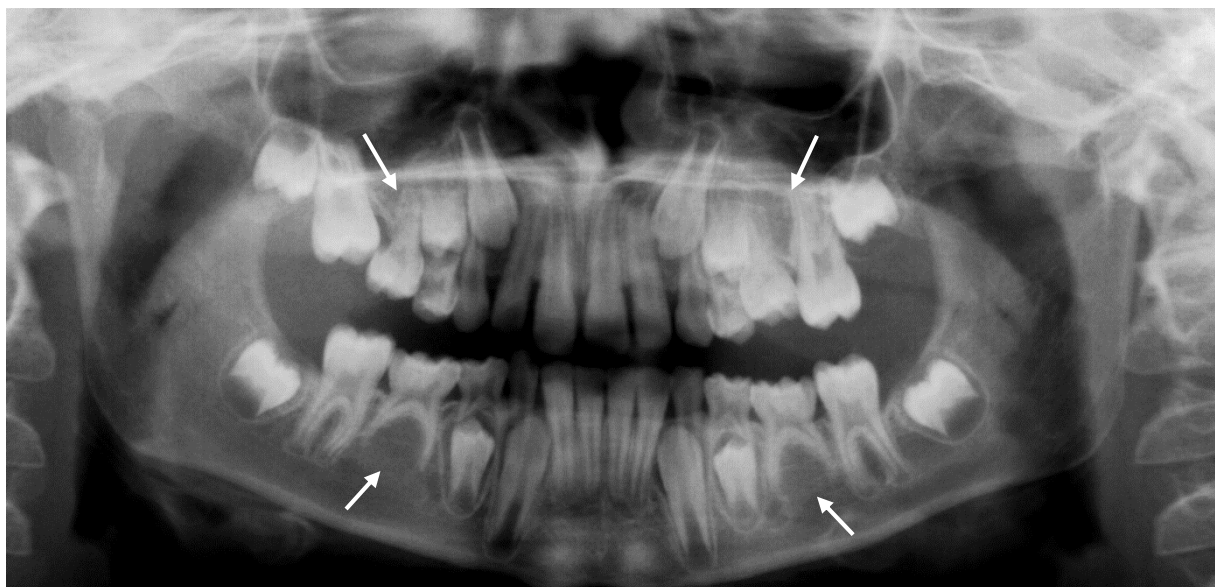


Figure 1. A case of hypodontia showing the absence of all second premolar tooth germs in both the maxilla and mandible (indicated by arrows).

In this study, the most common finding was the absence of a single tooth, observed in 49.4% of cases, followed by the absence of two teeth (39.5%), three teeth (6.2%), and four teeth (3.7%). The distribution of tooth agenesis by number and gender is presented in Table 1. The most frequently missing teeth were the mandibular second premolars (42.3%), followed by the maxillary lateral incisors (29.2%), maxillary second premolars (19%), mandibular lateral incisors (3.7%), and mandibular central incisors (5.8%) (Figure 2).

Table 1. Distribution of the Number of Missing Teeth by Gender

Number of Missing Teeth	Males with Tooth Agenesis (n)	Females with Tooth Agenesis (n)	Distribution (%)
1	22	18	49.4
2	16	16	39.5
3	4	1	6.2
4	1	2	3.7
5	0	0	0
6	1	0	1.2
Total	44	37	100

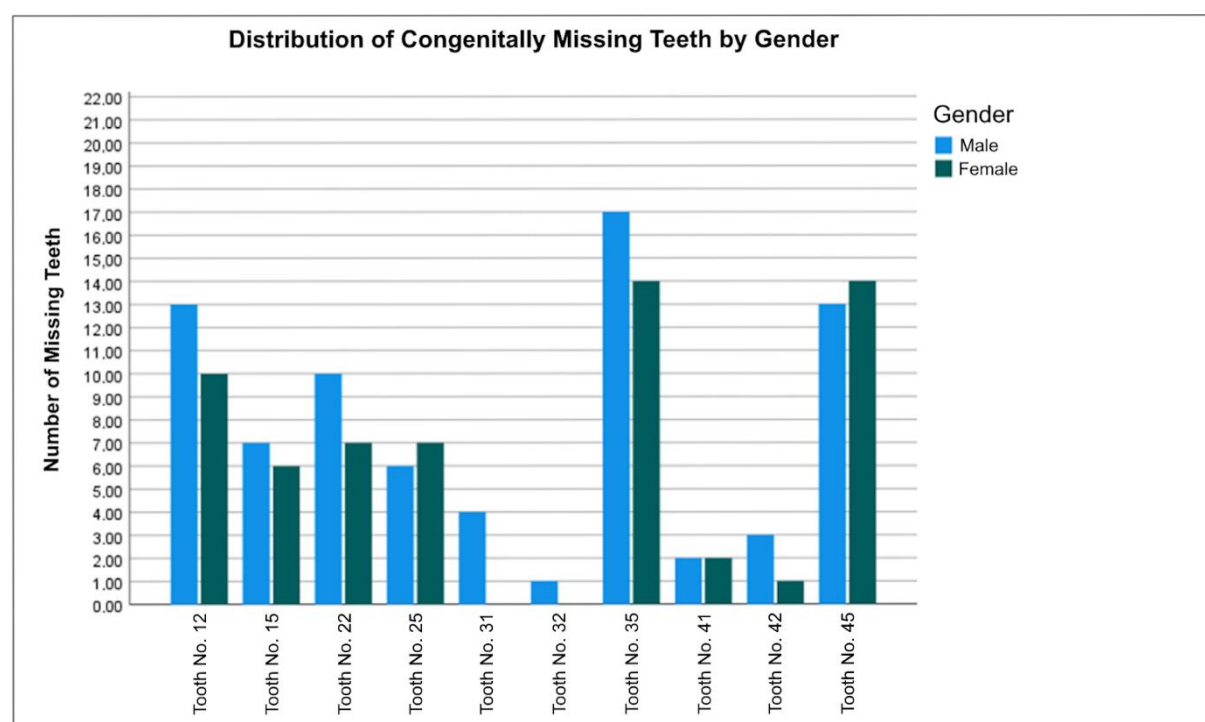


Figure 2. Distribution of Congenitally Missing Teeth by Gender

Of the 137 congenitally missing teeth, 76 were found in males and 61 in females. The distribution by quadrant showed 36 missing teeth in the first quadrant, 30 in the second quadrant, 36 in the third quadrant, and 35 in the fourth quadrant.

DISCUSSION

A review of the literature reveals numerous studies on the prevalence of congenitally missing permanent teeth, apart from third molars, conducted in various populations (Aras & Dogan, 2020; Ayrancı, 2019; Sökücü, Ünal, Topcuoğlu & Öztaş, 2009). These studies indicate that the prevalence of hypodontia varies greatly among different ethnic groups, ranging from 0.3% to 34.3% (Aras & Dogan, 2020; Mahjoub et al., 2024; Meistere et al., 2024). Gelgör et al., reported the prevalence of tooth agenesis as 2% in females and 1.6% in males in a study covering the regions of Kırıkkale and Konya (Gelgör, Şişman & Malkoç, 2005). Altug-Atac et al. reported a prevalence of 2.76% for congenitally missing teeth in a study involving 3,043 individuals (Altug-Atac & Erdem, 2007). In their study conducted in the Central Black Sea region, Ayrancı observed a prevalence of 6.5% in females, 8% in males, and approximately 7.3% overall for permanent tooth agenesis (Ayrancı, 2019). Yıldız et al. found the prevalence of hypodontia to be 4% in males, 5.9% in females, and 5% overall in their study of 969 individuals (Yıldız, Ataş, Tekin & Ataş, 2022). Bağ reported a prevalence of 8.26% for congenitally missing teeth in a study conducted in the Kütahya region with 1,441 participants. (Bağ, 2022). In the present study, the overall prevalence of permanent tooth agenesis was found to be relatively lower. The differences between the reported rates may be attributed to variations in sample size and ethnic background. Although there is no clear consensus in the literature, most studies have reported that mandibular second premolars are the most commonly missing teeth, followed by maxillary lateral incisors (Aras & Dogan, 2020; Ayala Sola, Ayala Sola, De La Cruz Pérez, Nieto Sánchez & Díaz Renovales, 2018; Gracco et al., 2017; Sökücü et al., 2009; Yıldız et al., 2022). In addition, the literature suggests that in order to avoid potential false-positive diagnoses of tooth agenesis, the radiological evaluation of mandibular second premolar calcification should be performed at age nine or older (Arandi & Rabi, 2024). The inclusion of panoramic radiographs from children aged 6 to 12 in this study may be considered a limitation; however, the most commonly missing teeth were the mandibular second premolars, followed by the maxillary lateral incisors, maxillary second premolars, mandibular lateral incisors, and mandibular central incisors, respectively. Meistere et al. reported that 41% of the missing teeth were located in the maxilla and 59% in the mandible (Meistere et al., 2024). Similarly, Kirzioglu et al. found that in the Isparta region, the prevalence of missing teeth was 50.3% in the mandible and 49.7% in the maxilla (Kirzioglu, Koseler Sentut, Ozay Erturk & Karayilmaz, 2005). In the present study, the distribution of congenitally missing teeth by jaw was found to be similar to previous findings, with 48.18% in the maxilla and 51.82% in the

mandible. No statistically significant difference was observed between the upper and lower jaws. Sökücü et al. reported that maxillary central incisor agenesis was observed in only one patient, whereas the prevalence of missing mandibular central and lateral incisors was 12.95% (Sökücü et al., 2009). Similarly, in the present study, no cases of maxillary central incisor agenesis were observed, while the prevalence of missing mandibular central and lateral incisors was found to be lower. When hypodontia was classified according to the number of missing teeth, Ayrancı (2019) reported that the most common was the absence of a single tooth (56.2%), followed by the absence of two teeth (31.5%) (Ayrancı, 2019). Cavare et al. reported that the most common finding in their study was the absence of a single tooth (50.8%), followed by the absence of two teeth (35.7%) (Cavare, Decaup, Boileau & Garot, 2024). Similarly, in the present study, single-tooth agenesis was the most frequently observed condition, while six missing teeth were identified in only one patient.

CONCLUSION



The prevalence of hypodontia among patients living in the Erzincan region was found to be 5.70%. Accordingly, digital panoramic radiographs obtained from children aged six and above who present for dental examination are of great importance for the diagnosis and detection of possible hypodontia. Early diagnosis of hypodontia and a multidisciplinary treatment approach are highly important for achieving better functional and aesthetic outcomes in the future.

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THE EFFECT OF HEALTH LITERACY ON ADAPTATION AND SELF-EFFICACY IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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ABSTRACT

The aim of this study is to determine the effect of health literacy on disease adaptation and self-efficacy in patients with Type 2 diabetes mellitus. This cross-sectional study was conducted with 106 volunteer patients with Type 2 diabetes mellitus who were treated in the internal medicine, cardiology, endocrinology, physical medicine and rehabilitation clinics of a state hospital between January and May 2024. Data were evaluated by independent t-test, Pearson correlation, linear regression analysis using SPSS 22.0 software. Statistical significance level was taken as $p<0.05$. The mean age of patients with type 2 diabetes mellitus was 59.41 ± 13.22 years. The participants' total scores were 80.50 ± 22.54 in the Health Literacy Index, 83.84 ± 8.63 in the Adaptation to Chronic Illness Scale and was 64.01 ± 17.19 in the Diabetes Management Self-Efficacy Scale for Patients with Type 2 Diabetes Mellitus. According to regression analysis, health literacy had a significant effect on both adaptation to chronic illness ($B=0.277$, $p<0.001$) and self-efficacy ($B=0.601$, $p<0.001$). In this study, patients with Type 2 diabetes mellitus had moderate health literacy, high level of adherence to chronic illness and moderate level of self-efficacy. Health literacy had a strong effect on adaptation to chronic illness and self-efficacy.

INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by elevated blood glucose levels, which can cause serious damage to the heart, kidneys, blood vessels, and nerves over time. More than 90–95% of patients with diabetes mellitus suffer from Type 2 diabetes mellitus (Babazadeh, Lotfi & Ranjbaran, 2023). Type 2 diabetes mellitus (T2DM) results from links between genetic, behavioral, and environmental risk factors (Göksu & Ünal, 2017). Being one of the major public health problems in the world and in Türkiye, T2DM is a significant cause of rising mortality and morbidity (Özpak & Pazarbaşı, 2021) and poses a global burden due to its costs on human health and the healthcare system (Butayeva, Ratan, Downie & Hosseinzadeh, 2023). According to data from the International Diabetes Federation (IDF), 537 million people worldwide had diabetes in 2021, and this figure is estimated to reach 783 million by 2045 (Sun

et al., 2022). According to 2019 UDF data, the prevalence of T2DM in Türkiye was reported as 14.5% (Saeedi et al., 2019).

Diabetes mellitus requires patients to actively self-manage the disease in their daily lives (Marciano, Camerini & Schulz, 2019). Therefore, patients should be equipped with adequate self-care skills to control their blood glucose levels, regulate their diet, exercise regularly, and take their medications correctly following medical recommendations (Wu et al., 2023). Non-modifiable risk factors for T2DM include age, genetics, and race, while modifiable risk factors include obesity, poor diet, chronic illnesses, and physical inactivity. A potentially modifiable risk factor for T2DM is also the level of health literacy (Tajdar et al., 2021). In general, health literacy refers to the individual skills that enable a person to access, understand, comprehend, and use health knowledge in their daily living behaviors to maintain good health (Ishikawa & Kiuchi, 2019). Low health literacy in individuals has been associated with negative health outcomes such as deterioration in overall health conditions, prolonged hospital stays, raised morbidity and mortality, poor ability to manage chronic illnesses, impaired quality of life, and elevated medical expenditures (Butayeva et al., 2023). Findings of the studies have indicated that individuals with diabetes mellitus have low levels of health literacy (Hussein, Almajran & Albatineh, 2018), and individuals with low levels of health literacy have HbA1c values above normal and less glycemic control (Alvarez et al., 2024).

For effective chronic disease management, it is crucial that individuals understand and accept all changes that they may go through due to the disease and adapt to them (Aslan, Çetkin & Demir, 2021). In order for individuals to be able to adapt to the disease, they must act in cooperation with healthcare professionals, comply with the recommendations made about the disease, care, and treatment, and assume an active role in the processes related to the illness (Lubi, 2019). Adaptation to the illness includes adhering to the treatment and care plan, taking medications regularly and correctly, avoiding self-checks, and adopting behaviors appropriate for life changes (Acaroğlu Değirmenci, 2019). Adaptation to the illness is a key factor in achieving optimal diabetes outcomes. Adaptation behavior has a strong positive correlation with disease outcomes, and there are many factors that have been suggested to affect adaptation (Yeh et al., 2018). Besides patient characteristics such as diagnosis duration, age, profession, gender, and educational level, a proper understanding of health knowledge by patients is one of the main factors that affect disease adaptation (Akpınar, Mandıracıoğlu, Ozvurmaz, Kurt & Koç, 2023). Poor health literacy is indisputably one of the major risk factors for non-adherence to medications and health behaviors (Yeh et al., 2018). Patients with poor health literacy have difficulty in adhering to treatment, accessing preventive health services, understanding their

conditions, understanding health knowledge, and taking care of themselves (Ekenler & Altinel, 2024). Moreover, health literacy serves as an important component in improving self-efficacy in individuals with diabetes mellitus (Öğüt Düzen & Sezer Balcı, 2023). Self-efficacy refers to an individual's confidence and belief in their personal abilities to engage in a particular behavior (Liang et al., 2021). Furthermore, self-efficacy is a mediator between knowledge and practice. Therefore, people's ability to acquire and apply health-related knowledge may have a significant effect on their well-being (Masoompour, Tirgari & Ghazanfari, 2017). The level of self-efficacy has a positive effect on an individual's self-care and management (Amer, Mohamed, Elbur, Abdelaziz & Elrayah, 2018). Therefore, patients' perception of self-efficacy is important during the process of illness adaptation (Kim, Sereika, Lingler, Albert & Bender, 2021). In Iran, self-efficacy has been associated with treatment adherence and physical activity in elderly patients with diabetes, and health literacy has been reported as a predictive factor of self-efficacy (Roshan, Hosseinkhani & Norouzadeh, 2023). Moreover, patients with greater health literacy may exhibit better self-efficacy behaviors, which may result in more adherence to diabetes medications and a lower level of HbA1c (Huang, Shiyanbola & Chan, 2018).

Numerous studies have examined health literacy, self-efficacy and adherence separately or together in patients with diabetes mellitus (Akpınar et al., 2023; Ekenler & Altinel, 2024; Butayeva et al., 2023; Tajdar et al., 2021). To the best of our knowledge, no study has yet investigated the correlation of health literacy with illness adaptation and self-efficacy levels in patients with T2DM. Therefore, this study aimed to investigate the effect of health literacy on illness adaptation and self-efficacy levels in patients with T2DM. The study sought answers to the following questions:

- What are the health literacy, illness adaptation, and diabetes self-efficacy levels in patients with T2DM?
- Does health literacy have an effect on the illness adaptation levels in patients with T2DM?
- Does health literacy have an effect on self-efficacy levels in patients with T2DM?
- Is there any correlation between health literacy, illness adaptation and the self-efficacy levels of patients with T2DM?

MATERIAL AND METHOD

Design of the Study

This cross-sectional study was conducted between January and May 2024 to examine the effect of health literacy on illness adaptation and self-efficacy level in patients with T2DM treated in a state hospital in the South-eastern Anatolia Region.

Population and Sample

All patients with T2DM who were treated in the internal medicine, cardiology, endocrinology, physical medicine and rehabilitation clinics of a state hospital in the South-eastern Anatolia Region between January and May 2024 were included in the study. Since the present study was designed as a cross-sectional study, sample selection was not used. The patients who had been diagnosed with T2DM for at least 6 months, were over 18 years of age, had no mental, hearing or visual impairments, were voluntary to participate in the study, and were able to communicate in Turkish were included in the study. The patients (26 patients) who had cognitive, mental or physical impairments that might prevent them from completing the questionnaire, had visual and hearing impairments, withdrew from the study during the data collection phase, and did not volunteer to participate in the study were excluded from the study. The study was conducted with 106 patients with T2DM who met the inclusion criteria in order to clarify the correlation between the variables. The questionnaires were completed by holding face-to-face interviews with the participants. It took approximately 25-30 minutes to complete the forms.

Data Collection Tools

In the present study, a Patient Information Form, the Health Literacy Index, the Adaptation to Chronic Illness Scale, and the Diabetes Management Self-Efficacy Scale for Patients with Type 2 Diabetes Mellitus were used as data collection tools.

Personal Information Form

The researchers collected socio-demographic characteristics and disease data of individuals with T2DM based on the literature using a patient information form (Özonuk & Yılmaz, 2019; Bilgiç & Pehlivan, 2023). This form consisted of 17 questions about gender, age, marital status, educational level, profession, duration of the disease, family history of diabetes, history of other chronic diseases, type of treatment, duration of insulin injection, frequency of visits to health institutions, perceived overall health condition, diabetes training, status of

knowing how to measure blood glucose, status of considering treatment knowledge adequate, status of knowing the names of laboratory tests, and body mass index (BMI).

Health Literacy Index

This is a 47-item scale developed by Sorensen et al., in the European Health Literacy Project (The European Health Literacy Survey, HLS-EU) (2009-2012). Once again, Sorensen et al. (2013) tested the validity and reliability of the Health Literacy Index and simplified it to 25 items (Toçi et al., 2013). The Turkish validity and reliability study of the health literacy index was conducted by Bayık Temel and Aras (2017). The Health Literacy Index consists of 25 items and four subscales. “*Accessing to Information*” subscale consists of five items (items 1-5), “*Understanding Information*” subscale consists of seven items (items 6-12), “*Appraising/Evaluating Information*” subscale consists of eight items (items 13-20), and “*Applying/Using Information*” subscale consists of five items (items 21-25). The items of this five-point Likert scale are rated as “5: I have no difficulties at all; 4: I have little difficulty; 3: I have some difficulty; 2: I have great difficulty; 1: I am unable to do it/I have no ability to do it/it is impossible for me to do it.” The index has no reverse items. The minimum and maximum scores for the index are 25 and 125 points, respectively. As the scores on the scale fall, the health literacy is poor, inadequate, and problematic; as the scores rise, the health literacy is excellent and adequate. The standard deviation of the scale is 0.95 and the internal consistency coefficients (Cronbach’s alpha) determined for the subscales of the scale range between 0.90 and 0.94 (Bayık Temel & Aras, 2017). In the present study, its Cronbach’s alpha value was found to be 0.96.

Adaptation to Chronic Illness Scale

Atik and Karatepe developed this scale in 2016. The scale is used to assess the illness adaptation level of patients with chronic illnesses. The scale has three subscales and 25 items: the items 1, 9, 10, 13, 14, 15, 16, 18, 22, 23, and 24 (maximum 55, minimum 11 points) assess physical adaptation; the items 2, 3, 5, 7, 17, 19, and 25 (maximum 35, minimum 7 points) assess social adaptation; and the items 4, 6, 8, 11, 12, 20, and 21 (maximum 35, minimum 7 points) assess psychological adaptation. The total score of the scale is 125. The higher the scores from the subscales and/or the overall scale, the higher the patients’ level of adaptation to the illness. In their study, Atik and Karatepe reported that Cronbach’s alpha value of the overall scale is 0.88 (Atik & Karatepe, 2016). In the present study, its Cronbach’s alpha value was found to be 0.71.

Diabetes Management Self-Efficacy Scale for Patients with Type 2 Diabetes Mellitus

The scale was developed by Bijl et al., (1999) to determine the self-efficacy levels of individuals diagnosed with T2DM (Van Der Bijl, Van Poelgeest-Eeltink & Shortridge-Baggett, 1999) and adapted into Turkish by Kara et al., (2006) (Kara, Van Der Bijl, Shortridge-Baggett, Astı & Ergüney, 2006). This 5-point Likert-type scale consists of 3 subscales and 20 items. The responses to this scale are as follows: “yes, I am sure: 5 points, “yes”: 4 points, “neither yes nor no”: 3 points, “no”: 2 points, “no, I am not sure”: 1 point. The total score of the scale ranges between 20 and 100. The higher the score obtained from the scale, the higher the self-efficacy level of individuals. Cronbach’s alpha value of the scale is 0.89. In this study, Cronbach’s alpha value was found to be 0.95.

Ethical Considerations

In order to conduct the study, Ethics Committee Approval (2023/E-29977877-605.01-82885) was obtained from a state university and institutional permission (2023/E-35694300-044-232008291) was obtained from the Provincial Directorate of Health. The study adhered to principles of the Declaration of Helsinki. Written and verbal informed consent was obtained from the individuals who agreed to participate in the study.

Data Analysis

The data of the study were calculated using frequency, percentage, mean, standard deviation, kurtosis, skewness, Pearson correlation, linear regression and independent t-test analysis using SPSS 22.0 software. It was determined that the variables were normally distributed. Parametric methods were used to analyze the data and results were considered as statistically significant for $p < 0.05$.

RESULTS

Findings on Socio-demographic and Health Conditions

The mean age of patients with T2DM was found to be 59.41 ± 13.22 years. 70.8% of the patients were female, 34.0% were aged 51-60 years, 88.7% were married, 52.8% were illiterate, and 74.5% were categorized as “other”. 34.9% of the patients were diagnosed with T2DM for 9 years or more, 54.7% had no family history of diabetes, 85.8% had any other chronic disease, 50.9% were treated with insulin, 40.6% injected insulin for 6 months to 2 years, and 32.1% visited the healthcare institution once a month for its follow-up. 55.7% of the patients considered their health as “poor.” 52.8% of them did not receive training on diabetes, 70.8%

knew how to measure blood glucose, 52.8% found treatment knowledge partially sufficient; and 81.1% did not know the names of laboratory tests (Table 1).

Table 1. Socio-Demographic Characteristics and Health Conditions of the Patients

Characteristics	Frequency (n)	Percentage (%)
Gender		
Female	75	70.8
Male	31	29.2
Marital Status		
Single	12	11.3
Married	94	88.7
Educational Level		
Illiterate	56	52.8
Primary School	35	33.0
High School and above	15	14.2
Profession		
Civil servant	5	4.7
Worker	4	3.8
Retired	8	7.5
Self-employed	10	9.4
Other (Housewife, farmer, etc.)	79	74.5
Duration of Illness		
6 months - 2 years	28	26.4
3-5 years	16	15.1
6-8 years	25	23.6
9 years and above	37	34.9
Family History of Diabetes		
Yes	48	45.3
No	58	54.7
History of Other Chronic Diseases		
Yes	91	85.8
No	15	14.2
Type of Treatment		
Oral antidiabetic drug	7	6.6
Insulin	54	50.9
Oral antidiabetic drugs and insulin	45	42.5
Duration of Insulin Treatment		
6 Months-2 Years	43	40.6
3-5 years	25	23.6
6-8 years	17	16.0
9 years and above	21	19.8
Frequency of Visits to Health Institutions		
Once a month	34	32.1
Once every 2 months	21	19.8
Once every 3 months	16	15.1
Once every 6 months	24	22.6
Once a year	11	10.4
Perception of Health		
Good	24	22.6
Moderate	23	21.7

Poor	59	55.7
Status of receiving treatment on Diabetes		
Yes	50	47.2
No	56	52.8
Status of knowing How to Measure Blood Glucose		
Yes	75	70.8
No	31	29.2
Status of considering Treatment Knowledge sufficient		
Sufficient	35	33.0
Partially Sufficient	56	52.8
Poor	15	14.2
Status of knowing the Names of Laboratory Tests		
Yes	20	18.9
No	86	81.1
Body Mass Index (BMI) (kg/m²)		
Normal Weight	19	17.9
Overweight	33	31.1
Obese	54	50.9
	Mean	SD
BMI	30.46	5.42
Age (year)	59.41	13.22

Mean Scores of Health Literacy, Adaptation to Illness and Self-Efficacy

The mean score of the patients on the Health Literacy Index was 80.50 ± 22.54 (Min=25; Max=125), indicating that their health literacy level was moderate. When the subscale scores of patients with T2DM on the health literacy index were analyzed, it was found that their scores were 16.69 ± 5.31 (Min=5; Max=25) for “accessing to information” subscale, 20.03 ± 7.12 (Min=7; Max=35) for “understanding information” subscale, 25.61 ± 8.22 (Min=8; Max=40) for “appraising/evaluating information” subscale, and 18.15 ± 4.38 (Min=5; Max=25) for “applying/using information” subscale (Table 2).

The total mean score of the patients on the Adaptation to Chronic Illness Scale was 83.84 ± 8.63 (Min=55; Max=104), indicating that the illness adaptation level of the patients was above average. The subscale scores on the scale were 38.50 ± 5.68 (Min=20; Max=52) for the physical adaptation subscale, 20.30 ± 3.03 (Min=14; Max=30) for the social adaptation subscale, and 25.03 ± 2.98 (Min=16; Max=32) for the psychological adaptation subscale (Table 2).

On the other hand, the total mean score of the participants on the Diabetes Management Self-Efficacy Scale for Patients with Type 2 Diabetes Mellitus was 64.01 ± 17.19 (Min=20; Max=99). The self-efficacy levels of the patients were moderate. The mean scores for the subscales of the self-efficacy scale were 35.15 ± 9.55 (Min=11; Max=55) for “diet and foot care control”, 12.10 ± 4.55 (Min=4; Max=20) for “medical treatment control” and 9.52 ± 2.73 (Min=3; Max=15) for “physical exercise” (Table 2).

Table 2. Mean Scores of Health Literacy, Adaptation to Illness, and Self-Efficacy

Scales	Mean± SD.	Min-Max score	Alpha
Health Literacy Index			
Total	80.50±22.54	25.00-125.00	0.969
Accessing to information	16.69±5.31	5.00-25.00	0.945
Understanding information	20.03±7.129	7.00-35.00	0.956
Appraising/Evaluating Information	25.61±8.223	8.00-40.00	0.952
Applying/Using Information	18.15±4.386	5.00-25.00	0.922
Adaptation to Chronic Illness Scale			
Total	83.84±8.637	55.00-104.00	0.856
Physical Adaptation	38.50±5.68	20.00-52.00	0.824
Social Adaptation	20.30±3.03	14.00-30.00	0.810
Psychological Adaptation	25.03±2.98	16.00-32.00	0.836
Diabetes Management Self-Efficacy Scale for Patients with Type 2 Diabetes Mellitus			
Total	64.01±17.19	20.00-99.00	0.954
Diet and Foot Care Control	35.15±9.552	11.00-55.000	0.906
Medical Treatment Control	12.10±4.55	4.00-20.00	0.928
Physical Exercise	9.52±2.73	3.00-15.00	0.929

The Correlation Between Health Literacy and Adaptation to Illness and Self-Efficacy

According to the correlation analysis results, a positive correlation was found between the total score for adaptation to chronic illness and health literacy ($r=0.724$, $p<0.01$). Especially, a strong correlation was observed between health literacy and physical adaptation subscale ($r=0.726$, $p<0.01$), and a weaker but still significant correlation was observed between health literacy and social adaptation subscale ($r=0.222$, $p<0.05$). A moderate positive correlation was also found between the psychological adaptation subscale and health literacy ($r=0.486$, $p<0.01$).

A high positive correlation was found between the participants' total scores on the health literacy index and Diabetes Management Self-Efficacy Scale for Patients with Type 2 Diabetes Mellitus ($r=0.788$, $p<0.01$). A similarly strong positive correlation was found between patients' health literacy and the "diet and foot care control" subscale ($r=0.793$, $p<0.01$), a moderate positive correlation between their health literacy and the "medical treatment control" subscale ($r=0.703$, $p<0.01$), and a lower, but still significant positive correlation between their health literacy and "physical exercise" ($r = 0.654$, $p < 0.01$).

Table 3. Correlation Analysis Between the Scores on Health Literacy Index and Adaptation to Chronic Illness Scale and Diabetes Management Self-Efficacy Scale for Patients with Type 2 Diabetes Mellitus

		Health Literacy Index				
		Total	Accessing to information	Understanding information	Appraising/Evaluating Information	Applying/Using Information
Adaptation to Chronic Illness Scale	Total	r	0.724**	0.631**	0.643**	0.670**
		p	<0.001	<0.001	<0.001	<0.001
	Physical Adaptation	r	0.726**	0.609**	0.617**	0.700**
		p	<0.001	<0.001	<0.001	<0.001
		r	0.222*	0.175	0.277**	0.168

Diabetes Management Self-Efficacy Scale for Patients with Type 2 Diabetes Mellitus	Social Adaptation	p	0.022	0.073	0.004	0.085	0.096
	Psychological Adaptation	r	0.486**	0.486**	0.404**	0.433**	0.442**
		p	<0.001	<0.001	<0.001	<0.001	<0.001
	Total	r	0.788**	0.719**	0.636**	0.748**	0.744**
		p	<0.001	<0.001	<0.001	<0.001	<0.001
	Diet and Foot Care Control	r	0.793**	0.725**	0.646**	0.752**	0.741**
		p	<0.001	<0.001	<0.001	<0.001	<0.001
	Medical Treatment Control	r	0.703**	0.628**	0.571**	0.685**	0.640**
		p	<0.001	<0.001	<0.001	<0.001	<0.001
	Physical Exercise	r	0.654**	0.624**	0.509**	0.593**	0.667**
		p	<0.001	<0.001	<0.001	<0.001	<0.001

*<0.05; **<0.01; Pearson Correlation Analysis

The Effect of Health Literacy on Adaptation to Chronic Illness and Self-Efficacy

Table 4 analyses the effect of health literacy on the score on adaptation to chronic illness. According to the regression analysis, health literacy had a significant positive effect on adaptation to chronic illness ($B = 0.277$, $p < 0.001$). This result indicated that a one-unit increase in health literacy led to a 0.277-unit increase in the score on adaptation to chronic illness. According to the standardized coefficient ($\beta = 0.724$), health literacy had a very strong effect on adaptation to chronic illness. The explanatory level of the model was high, and the R^2 value was calculated as 0.520. This suggested that health literacy accounted for 52% of the variance in the score on adaptation to chronic illness. On the other hand, the overall significance of the model was confirmed by the F value (114.735) and p value ($p < 0.001$). On the other hand, the Durbin-Watson value (1.966) indicated that there was no autocorrelation in the model.

Table 4. The Effect of Health Literacy on Adaptation to Chronic Illness

Independent Variable	Unstandardized Coefficients		Standardized Coefficients	t	p	95% Confidence Interval	
	B	SE	β			Lower	Upper
Fixed	61.516	2.164		28.421	0.000	57.224	65.808
Total Health Literacy	0.277	0.026	0.724	10.711	0.000	0.226	0.329

*Dependent Variable = Total Adaptation to Chronic Illness, $R=0.724$; $R^2=0.520$; $F=114.735$; $p=0.000$; Durbin Watson Value=1.966

On the other hand, Table 5 shows the effect of health literacy on the scores of Type 2 diabetes self-efficacy. According to the regression analysis, health literacy significantly affected the scores of Type 2 diabetes self-efficacy ($B = 0.601$, $p < 0.001$). This result indicated that a one-unit increase in the health literacy score led to a 0.601-unit increase in the score on the type 2 diabetes self-efficacy. Furthermore, according to the standardized coefficient ($\beta = 0.788$), health literacy had a strong effect on Type 2 diabetes self-efficacy. The explanatory

power of the model was high, and the R^2 value was calculated as 0.617. This indicated that health literacy accounted for 61.7% of the variance in the score of Type 2 diabetes self-efficacy. The F value (170.437) and the p value of the model ($p < 0.001$) showed that the model was generally significant. The Durbin-Watson value (1.903) indicated that there was no autocorrelation in the model.

Table 5. The Effect of Health Literacy on Type 2 Diabetes Self-Efficacy

Independent Variable	Unstandardized Coefficients		Standardized Coefficients β	t	p	95% Confidence Interval	
	B	SE				Lower	Upper
Fixed	15.655	3.846		4.071	0.000	8.029	23.282
Health Literacy	0.601	0.046	0.788	13.055	0.000	0.510	0.692

*Dependent Variable = Type 2 Diabetes Self-Efficacy Total, $R=0.788$; $R^2=0.617$; $F=170.437$; $p=0.000$; Durbin Watson =1.903

DISCUSSION

Low level of health literacy has been known to negatively affect the patient's adaptation to illness and self-efficacy behaviors. Therefore, this study mainly aims to determine the effect of health literacy on adaptation to illness and self-efficacy levels in patients with T2DM. The literature review suggests that this study will contribute to the related field due to its originality, as it is the first study in Türkiye to examine these three different issues in individuals with T2DM. The findings of this study indicated that patients with T2DM having a higher level of health literacy had better adaptation to illness and self-efficacy levels. In short, it highlights the important effect of health literacy on adaptation to illness and self-efficacy in patients with T2DM.

Low level of health literacy in patients with chronic diseases, especially diabetes, is associated with higher health care costs, inadequate disease management, and adverse health outcomes(Yeh et al., 2018). This study indicated that the health literacy level of individuals with T2DM was moderate (80.50 ± 22.54). Different studies have also reported that patients with T2DM have a moderate level of health literacy (Özonuk & Yılmaz, 2019; Parlak & Şahin, 2021). The literature findings are compatible with the results of the present study. According to this data, health literacy takes an important place in Türkiye and in the world; however, health literacy levels of patients should be considered in health care services and education programs to be provided by healthcare professionals to individuals with chronic illness, and importance should be attached to taking necessary initiatives to improve the education and health literacy levels of the society.

Diabetes is a chronic disease that takes a long time to cope with psychological and cognitive problems, as well as physiological complications that may arise (Kaymaz & Akdemir, 2016). The extent to which individuals with chronic illness are affected by the illness varies according to factors such as the duration, severity, and structure of illness, and biological functions, coping capacity and problem-solving ability of the individual (Duran & Keser, 2021). Therefore, it is of great importance for the course of the disease that patients understand, accept and adapt to all changes that may arise due to the disease in order to be effective against them (Aslan et al., 2021). In order to adapt to the illness, the patient should accept the recommendations of healthcare professionals, comply with the medical treatment plan, regularly attend health checks and implement the recommended life changes (Acaroğlu Değirmenci, 2019). The present study showed that the total mean score of the patients on the adaptation to chronic illness scale was 83.84 ± 8.63 , and this mean score indicated that the patients' level of adaptation to the illness was above the mean value. Another study conducted with individuals with diabetes reported that the level of adaptation to illness was at a moderate level (Kaymaz & Akdemir, 2016), which is compatible with the present study. Another study indicated that patients' adaptation to illness had a negative correlation with duration of the illness and age and a positive correlation with quality of life (Bilgiç & Pehlivan, 2023).

Self-efficacy represents the patient's overall self-confidence, behavior, ideation and emotional reactions when faced with different environmental challenges or new circumstances. It is known that the effect of self-efficacy on health behavior and health outcomes is significant. The high self-efficacy level of patients with T2DM is one of the main factors that facilitate the management of the disease (Canbolat, Ekenler & Polat, 2022). In addition, individuals with diabetes who have a high self-efficacy level are easier to adapt to illness and can manage complications that may develop in the future more easily (Yıldız, 2021). The present study revealed that the total mean score of the Diabetes Management Self-Efficacy Scale for Patients with Type 2 Diabetes Mellitus was moderate (64.01 ± 17.19). The related studies indicated that high self-efficacy and adaptation levels of patients with diabetes mellitus had a positive effect on the prevention of complications (Amer et al., 2018; Roshan et al., 2023). A study examining the correlation between fear of hypoglycemia and self-efficacy levels of patients with diabetes mellitus using insulin reported that the self-efficacy levels of the patients were moderate (Bal Özkaptan & Demirci, 2023). The findings of the present study are compatible with the literature. The moderate level of diabetes self-efficacy may be associated with the fact that more than half of the participants were literate, and healthcare professionals did not receive training on T2DM (Table 2).

According to the correlation analysis results of the present study, another important finding was that there was a positive correlation between health literacy and the total score of adaptation to chronic illness. Moreover, the present study revealed stronger correlations with health literacy, especially in physical and psychological adaptation, while a weaker but significant correlation was found in social adaptation. According to the regression analysis of the present study, the level of health literacy among patients with T2DM had a strong effect on adaptation to chronic illness. No studies were found in the literature that investigated the correlation between health literacy, illness adaptation, and self-efficacy level in patients with T2DM. However, there are studies in which any two of these variables were studied together. Health literacy holds an important place in the use and implementation of acquired knowledge and disease management. The related studies have indicated that the health literacy levels of individuals with chronic diseases have a great effect on their adherence to treatment (Akpınar et al., 2023; Erdoğan Yüce & Muz, 2023). Different studies have also found that those with high health literacy have high levels of adaptation to illness and adherence to treatment (Akpınar et al., 2023; Liu, Qian, Chen & He, 2020). The findings of the present study are compatible with the literature, and other studies have also shown that health literacy level plays an important role in adaptation to illness (Erdoğan Yüce & Muz, 2023; Candemir, Yıldırım, Yaşar, Erten & Göker, 2023). These results are important in terms of showing that as the health literacy levels of patients with T2DM elevate, their level of adaptation to illness may elevate.

Another important finding of this study was a high positive correlation between the total score of health literacy and the total score of Type 2 diabetes self-efficacy (Table 3). A strong correlation was observed with the health literacy of the patients, especially in the diet and foot care control subscale, a moderate correlation in the medical treatment control subscale, and a low but significant correlation in the physical exercise subscale. According to the regression analysis of this study, health literacy had a strong effect on the self-efficacy of individuals with T2DM. Health literacy plays a fundamental role in self-management, as it includes the skills necessary to improve one's health, such as the ability to be proficient in taking medications correctly, consulting doctors about exercise methods that improve symptoms, and analyzing the accuracy of health information obtained (Zou et al., 2024). The study by Öğüt Düzen and Sezer Balcı (2023) reported that the health literacy of individuals with T2DM was significantly correlated with diabetes self-efficacy (Öğüt Düzen & Sezer Balcı, 2023). There are also different studies that found a significant positive correlation between health literacy and Type 2 diabetes self-efficacy (Masoompour et al., 2017; Liu et al., 2020). The findings of the present study are compatible with the literature. These results suggest that health literacy level is a

major determinant of both adaptation to chronic illness and Type 2 diabetes self-efficacy. Therefore, it is crucial to consider an individual's health literacy levels when working to improve their adaptation to illness and raise their level of self-efficacy.

Limitations

The study was conducted with patients with T2DM treated in a state hospital in the south-eastern Türkiye. It was conducted in a single centre and not compared with other hospitals. Therefore, the results of this study may be limited to the centre of the study and should not be generalized.

CONCLUSION

The adaptation of patients with T2DM to chronic illnesses was found to be high, and their health literacy and type 2 diabetes self-efficacy were found to be moderate. Moreover, the health literacy levels of the patients had a strong effect on their adaptation to illness and self-efficacy. When the results of the present study and the findings in the relevant literature were analyzed, it was concluded that high health literacy levels in patients had a positive effect on their adaptation to their illness and their self-efficacy skills. In order to elevate the health literacy level of patients, it is important to employ diabetes nurses and establish diabetes schools in hospitals, to prepare appropriate educational materials for patients, to provide appropriate education according to the level of understanding of individuals, and to try to find answers to patients' questions in a question-and-answer format. As a result of growing technological advances, web applications should be designed to continuously improve the knowledge and skills of patients, and patients' knowledge should be constantly updated through group- or individual-based interviews. In order to raise health literacy levels, more comprehensive research should be conducted on patients. Accordingly, necessary policies and strategies should be developed by relevant institutions or organizations.

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AN EXAMINATION OF UNIVERSITY STUDENTS' FEAR OF MISSING OUT (FOMO) ON SOCIAL MEDIA: AN ANALYSIS OF DIFFERENT VARIABLES

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ABSTRACT

The purpose of this study is to examine the fear of missing out (FoMO) among university students according to various variables. This descriptive study was conducted with 379 students enrolled at a state university. The sample size was determined by power analysis, and data were collected using a Personal Information Form and the FoMO Scale. The study was initiated after obtaining approval from the ethics committee. The data were analyzed using descriptive statistics, t-tests, and analysis of variance. Fifty-one point seven percent of the participants were female, and 42.5% were first-year students. FoMo levels showed significant differences according to variables such as social media usage, academic year, department type, and social media and smartphone usage duration ($p < 0.05$). FoMO levels were higher among second-year students enrolled in vocational schools who used Facebook, Instagram, YouTube, and TikTok, and among those who actively shared content on social media. In conclusion, students who spend a significant amount of time interacting in digital environments tend to exhibit higher levels of FoMO. Therefore, awareness campaigns are recommended to encourage students to use digital tools consciously and in a controlled manner.

INTRODUCTION

The increasing prevalence of social media platform use in the digital age has heightened concerns regarding its effects on individuals (Han et al., 2023). With technological advancements, new devices have become integrated into nearly every aspect of daily life, and as a result, communication needs are increasingly being met through social media. Through these platforms, individuals engage in various online activities such as forming and maintaining friendships, as well as sharing information, images, and videos. Although social media offers numerous opportunities for personal development, such as gender and identity exploration, self-expression, and socialization, it is increasingly evidenced that individuals at risk may develop addictive behaviors (Eker et al., 2023; Topino et al., 2023).

The diminishing distinction between the virtual and physical worlds has led to a growing inclination among individuals to spend more time in digital environments rather than in real-life activities (Üzgü et al., 2023). In contemporary society, particularly among young people,

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the excessive and unregulated use of digital devices has emerged as a significant social issue. The literature identifies several associated problems, including reduced engagement in real-world experiences, declines in academic performance, familial and relational conflicts, sleep disturbances, diminished attention and learning capacity, increased risks of obesity and depression, a decline in social skills, and deterioration in both psychological and physical health (Han et al., 2023; Hawi et al., 2019; Kuss & Griffiths, 2017). As of January 2024, there are 5.35 billion internet users globally, accounting for 66.2% of the world's population. Of this total, 5.04 billion individuals – 62.3% of the global population – actively use social media. In terms of platform-specific statistics, 3.049 billion people use Facebook, 2.491 billion use YouTube, 2 billion use WhatsApp, and 1.562 billion use TikTok (Statista, 2024). According to the data from the Turkish Statistical Institute (TÜİK, 2023), the internet usage rate among young people aged 16–24 increased from 96.9% in 2022 to 97.5% in 2023. The same report noted that the most commonly used social media applications among individuals aged 16–74 were WhatsApp (84.9%), YouTube (69.0%), and Instagram (61.4%) (TÜİK, 2023).

The rapidly increasing rates of social media usage both globally and within Turkey have led individuals to spend extended periods on these platforms. This trend has fostered a growing concern among individuals that others may be experiencing rewarding moments from which they themselves are excluded, creating a constant urge to stay informed about others' activities. Consequently, the fear of missing out (FoMO) has emerged as a prevalent phenomenon on social media (Belgin et al., 2021).

The literature presents various theoretical perspectives on the foundations of FoMO. One explanation links FoMO to the psycho-social framework of Maslow's (1943) hierarchy of needs. According to this model, once individuals satisfy their basic physiological and safety needs, they progress to a stage characterized by the need for social connection. The influence of social media may intensify this need, potentially contributing to the development of FoMO (Çelik & Özkara, 2022). Another conceptual framework associated with FoMO is the theory of social exclusion, which emphasizes the fear of being marginalized from one's social environment (Baumeister & Tice, 1990). Zhang et al., (2020), who further developed the FoMO concept, proposed that its theoretical basis lies in the self-perception theory introduced by Rosenberg (1979). According to this theory, individuals possess both personal and social aspects of self: the personal self refers to one's self-evaluation, while the social self pertains to perceptions of how others view the individual (Zhang et al., 2020).

FoMO can also be interpreted within the framework of Self-Determination Theory (SDT). SDT posits that human motivation is grounded in the fulfillment of three basic psychological

needs: competence, autonomy, and relatedness. A failure to satisfy these needs may lead to psychological distress and diminished self-regulation. FoMO may arise from such deficiencies, intensifying individuals' efforts to establish social connections and enhance their sense of social competence by monitoring others' lives through social media. In this context, FoMO is viewed as a consequence of unmet psychological needs and helps to explain the relationship between these deficiencies and patterns of social media use. This theoretical framework offers a valuable foundation for understanding how FoMO influences social media engagement (Przybylski et al., 2013). For individuals experiencing fear of missing out, participation in social media becomes particularly appealing. A persistent desire to stay informed about others' lives and to track their online activity can result in negative emotional states. These individuals struggle to regulate their engagement, spending excessive time on social networks driven by a mix of desire and perceived obligation (Zıvdr & Karakul, 2023). As FoMO typically begins with a desire to remain informed about one's surroundings, it can lead, especially among young individuals with a strong desire for possession and experience, to a loss of control over their lives (Aydın, 2018). With the growing prevalence of social media use, FoMO has become increasingly recognized as a significant psychological concern. A study conducted with nursing students found a positive but weak correlation between social media addiction and FoMO (Eşer & Alkaya, 2019). Another study involving university students identified a moderate and positive relationship between these variables, noting that students who spent more than three hours daily on social media had significantly higher FoMO scores, which in turn amplified their levels of social media addiction (Çağlayan & Arslantaş, 2023). Research with postgraduate students reported moderate levels of both social media use and FoMO (Dündar & Biçer, 2024). In a separate study, male students were found to exhibit higher FoMO levels than their female peers, and students who remained online throughout the day reported higher FoMO levels than those who did not. Moreover, students using platforms such as Twitter, Snapchat, Instagram, and TikTok showed significantly higher FoMO levels compared to non-users (Atabay et al., 2022). Similarly, a study with medical students found that those who frequently used various social media platforms and constantly checked notifications reported higher FoMO levels (Belgin et al., 2021). Regarding its impact on youth, excessive use of social media platforms associated with FoMO has been shown to disrupt sleep patterns, leading to later bedtimes (Güven, 2021). Other studies have reported that individuals with high levels of FoMO are more likely to engage in problematic alcohol use (Riordan et al., 2015), develop social media addiction (Blackwell et al., 2017), and experience internet dependency (Chotpitayasunondh & Douglas, 2016). Additionally, the increased use of smartphones has been associated with a decline in students'

ability to focus during class and a subsequent drop in academic performance (Balcı & Bal, 2022).

In the digital age, shifts in communication culture, which are fueled by heightened curiosity, a desire for self-presentation, and competition, have intensified individuals' pursuit of experiences they perceive as lacking in their lives through social platforms. The advancement of technology and the widespread use of smartphones have led to a marked increase in dependency, contributing significantly to the spread of FoMO (Uyar & Özen, 2023). This study aims to provide valuable insights into the social and behavioral implications of social media addiction and FoMO. Moreover, as FoMO becomes more prevalent alongside the rising use of social media among university students, understanding its impact on their educational trajectories and personal development is crucial for designing effective intervention strategies. While the existing literature often addresses social media addiction and FoMO within a general framework, this study focuses specifically on university students, which offers a more nuanced understanding of how young individuals engage with the digital environment and develop social media habits. Within this context, the present research investigates university students' fear of missing out (FoMO) on social media with respect to various variables.

Research Questions:

1. What is the level of fear of missing out (FoMO) on social media among university students?
2. Is there a significant relationship between the social media platforms used by university students and their levels of FoMO?
3. Is there a significant relationship between university students' demographic characteristics, social media usage habits, and their FoMO levels?

MATERIAL AND METHOD

Aim and Study Design

This study was conducted using a descriptive cross-sectional design to determine the level of fear of missing out (FoMO) on social media among university students and to examine FoMO in relation to various variables.

Population and Sample

The study population consisted of students enrolled at a university ($n = 6,520$). The required sample size was calculated using power analysis via the G*Power 3.1 software. At a 95% confidence level ($1-\alpha$) and a significance threshold of 0.05 (α), the minimum sample size

was determined to be 363. A stratified sampling method was employed. In this method, subgroups (strata) are formed based on specific characteristics (e.g., faculty or school affiliation), and random sampling is performed within each stratum (Büyüköztürk et al., 2024; Yağar & Dökme, 2018). Accordingly, the participating students were divided into five strata based on their academic departments. After proportional allocation based on the number of students in each stratum, simple random sampling was used to select participants. Considering possible data loss, the final sample included 379 students who voluntarily agreed to participate in the study.

Inclusion Criteria

- Being a registered student at the university
- Voluntary participation in the study
- Completing all survey items

Exclusion Criteria

- Having a psychiatric condition that would prevent participation
- Providing incomplete responses to the survey or scales

Table 1: Demographic Characteristics of Participants (N=379)

	Number	Percentage
Gender		
Female	196	51.7
Male	183	48.3
Year of Study		
First year	161	42.5
Second year	100	26.4
Third year	48	12.7
Fourth year	70	18.5
Faculty/College		
Vocational School of Health Services	63	16.6
Faculty of Health Sciences	40	10.6
Faculty of Engineering / Faculty of Agriculture / Faculty of Theology	118	31.1
Faculty of Economics and Administrative Sciences / Faculty of Tourism / School of Physical Education and Sports	48	12.7
Faculty of Fine Arts	57	15.0
Vocational School	53	14.0
Mother's Educational Level		
Illiterate	179	47.2
Primary School / Middle School	151	39.8
High School	30	7.9
University and above	19	5.0
Father's Educational Level		
Illiterate	46	12.1
Primary School / Middle School	219	57.8
High School	65	17.2
University and above	49	12.9

According to Table 1, 51.7% of the participants were female, 42.5% were first-year students, and 31.1% were enrolled in faculties such as Engineering, Agriculture, or Theology. In terms of parental education, 47.2% of the participants reported that their mothers were illiterate, while 57.8% stated that their fathers completed primary or middle school.

Data Collection

Personal Information Form: This form included questions related to the students' sociodemographic characteristics, such as gender, year of study, faculty or vocational school, parents' educational background, use of Facebook, Instagram, YouTube, and TikTok, purposes for using social media, frequency of sharing content on social media, daily smartphone use, and daily time spent on social media.

Scale: The data were collected through face-to-face interviews with university students using the Fear of Missing Out on Social Media Scale.

Fear of Missing Out on Social Media (FoMO) Scale

The scale was originally developed by Zhang et al., (2020). Its Turkish validity and reliability study was conducted by Çelik et al., (2022). The scale consists of two subdimensions: Personal FoMO (5 items) and Social FoMO (4 items). It is a 7-point Likert-type scale ranging from "1 = strongly disagree" to "7 = strongly agree". The total score ranges from 9 to 63, with higher scores indicating greater levels of FoMO. In the original study, the Cronbach's alpha was reported as 0.86 for Personal FoMO and 0.92 for Social FoMO, with excellent model fit indices for the two-factor structure. In the Turkish validation study by Çelik and Özkara (2022), Cronbach's alpha coefficients were 0.90 for Personal FoMO and 0.89 for Social FoMO. In the present study, the overall Cronbach's alpha was calculated as 0.92.

Data Collection Tools

The data were collected between September and November 2024 through face-to-face interviews with the participating university students. The data collection process was carried out during students' non-class hours using two instruments: the Personal Information Form and the FoMO Scale. Prior to participation, the students were informed about the purpose of the study, and verbal consent was obtained. Data collection was conducted under the supervision of the researcher in classroom settings, through individual interviews lasting approximately 10–15 minutes per participant. A random sampling method was employed in selecting participants, and participation was entirely voluntary. The forms were administered during students' available time slots, such as breaks between classes or during free periods.

Data Analysis: The data were analyzed using SPSS version 22.0. Descriptive statistics including frequency, percentage, mean, and standard deviation were used to summarize the participants' characteristics. The Kolmogorov-Smirnov test was used to assess the normality of data distribution. For normally distributed variables, Student's t-test and one-way analysis of variance (ANOVA) were applied. Since homogeneity of variance was confirmed, post hoc analyses were performed using the Tukey test. A p-value of less than 0.05 was considered statistically significant.

Limitations of the Study

The findings of this study are generalizable only to those students enrolled at the university where the research was conducted. Additionally, the study is limited to the students who were present and voluntarily participated during the data collection period.

Ethical Considerations

Ethical approval was obtained from the Ethics Committee of a University (Decision No: 01.08.2024-E-97974870-050.99-106972). Verbal consent was obtained from all participants, confirming their willingness to take part in the study.

RESULTS

This section presents the mean scores of the participants on the FoMO Scale and its subdimensions.

Table 2. Mean Scores of Participants on the FoMO Scale and Its Subdimensions

	Min.	Max.	X±SD
Personal FoMO	5	35	11.77±6.11
Social FoMO	4	28	9.21±5.68
Total FoMO	9	63	20.98±11.05

As shown in Table 2, the participants' average total FoMO score was 20.98 ± 11.05 . The mean scores for the FoMO subdimensions were 11.77 ± 6.11 for Personal FoMO and 9.21 ± 5.68 for Social FoMO. These results indicate that the students exhibited a moderate level of FoMO, with personal FoMO levels being higher than social FoMO levels. In Table 3, the FoMO scale and its subdimensions are compared according to the participants' use of social media platforms to assess whether there were significant differences based on platform usage.

Table 3. Comparison of Mean Scores on the FoMO Scale and Its Subdimensions by Social Media Platform Usage

Variables	n/%	Personal FoMO	Social FoMO	Total FoMO
Facebook Usage				
Yes	105/27.7	13.24±7.10	10.51±5.95	23.76±12.23
No	274/72.3	11.20±5.60	8.71±5.50	19.91±10.39
		t=-2.648	t=-2.688	t=-2.847
		P=0.00	P=0.00	P=0.00
Instagram Usage				
Yes	293/77.3	13.94±8.24	11.31±6.95	25.25±14.48
No	86/22.7	11.13±5.18	8.59±5.10	19.73±9.49
		t=2.992	t=3.368	t=3.333
		P=0.00	P=0.00	P=0.00
YouTube Usage				
Yes	221/58.3	12.65±6.88	10.12±6.73	22.78±12.88
No	158/41.7	11.13±5.43	8.56±4.70	19.69±9.34
		t=2.313	t=2.517	t=2.567
		P=0.02	P=0.01	P=0.01
TikTok Usage				
Yes	187/49.3	12.43±7.06	9.73±6.49	22.17±12.88
No	192/50.7	11.08±4.87	8.67±4.65	19.76±8.65
		t=2.172	t=1.821	t=2.130
		P=0.03	P=0.06	P=0.03

t: independent sample test; p<0.05

As presented in Table 3, statistically significant differences were found in personal FoMO, social FoMO, and total FoMO scores according to the participants' use of Facebook, Instagram, YouTube, and TikTok ($p < 0.05$). The participants who reported using these platforms had significantly higher scores on all dimensions of FoMO compared to those who did not. These findings suggest that social media usage habits play a meaningful role in shaping individuals' FoMO levels. To explore this relationship further, Table 4 presents a comparison of FoMO scores based on participants' demographic characteristics and patterns of social media use.

Table 4. Comparison of Mean Scores on the FoMO Scale and Its Subdimensions According to Participants' Demographic Characteristics and Social Media Use Habits

Variables	n/%	Personal FoMO	Social FoMO	Total FoMO
Year of Study				
First Year	161/42.5	10.93±5.37	8.58±5.10	19.51±9.78
Second Year	100/26.4	14.44±7.72	11.53±6.86	25.97±13.89
Third Year	48/12.7	10.62±4.18	7.85±3.98	18.47±7.32
Fourth Year	70/18.5	10.67±5.13	8.28±5.20	18.95±9.18
		F=9.240	F=8.181	F=10.003
		P=0.00	P=0.00	P=0.00
Post Hoc		2>1, 2>3, 1>3,	2>1, 2>3	2>1, 2>3, 1>3
Faculty/College				
Vocational School of Health Services (1)	63/16.6	11.71±5.10	8.85±4.98	20.57±9.46
Faculty of Health Sciences (2)	40/10.6	10.92±3.96	9.12±5.43	20.05±8.84
Engineering/Agriculture/Theology (3)	118/31.1	10.74±5.13	8.51±5.32	19.26±9.40

Faculty of Economics and Administrative Sciences/Faculty of Tourism (4)	48/12.7	8.89±4.31	6.62±3.09	15.52±6.76
Fine Arts (5)	57/15.0	11.26±5.00	8.15±4.61	19.42±9.28
Vocational School (6)	53/14.0	17.90±8.76	14.73±6.90	32.64±14.59
		F= 16.479	F= 15.218	F= 18.481
		P= 0.00	P= 0.00	P= 0.00
Post Hoc		6>1,2,3,4,5	6>1,2,3,4,5	6>1,2,3,4,5
Purpose of Social Media Use				
Communicating with friends (1)	121/31.9	12.16±6.00	9.08±5.47	21.24±10.53
Making new friends (2)	30/7.9	12.80±7.80	10.00±6.96	22.80±13.93
Information seeking (3)	77/20.3	10.25±4.72	8.20±4.78	18.46±8.93
Sharing videos/photos (4)	32/8.4	16.43±8.10	13.46±6.69	29.90±13.64
Passing time (5)	119/31.4	10.83±5.27	8.65±5.33	19.48±10.07
		F=7.331	F=5.821	F=7.451
		P=0.00	P=0.00	P=0.00
Post Hoc		4>1,2,3,5	4>1,2,3,5	4>1,2,3,5
Frequency of Social Media Sharing				
Never (1)	46/12.1	12.13±7.18	8.39±5.52	20.52±12.15
Every day (2)	78/20.6	14.57±8.12	11.46±6.80	26.03±14.10
Once a week (3)	102/26.9	11.63±4.86	9.25±5.63	20.89±9.67
Once a month (4)	106/28.0	10.56±4.88	8.33±4.74	18.89±8.99
Once or twice a year (5)	47/12.4	9.76±4.36	8.19±4.96	17.95±8.54
		F=6.845	F=4.475	F=6.255
		P=0.00	P=0.00	P=0.00
Post Hoc		2>1, 2>5, 3>5	2>1, 2>5,	2>1, 2>5, 3>5
Daily Smartphone Use				
Less than 1 hour (1)	31/8.2	9.70±4.54	7.87±4.84	17.58±8.37
1-2 hours (2)	41/10.8	11.78±6.07	9.95±6.72	21.73±12.13
3-4 hours (3)	98/25.9	13.50±7.91	10.73±6.60	24.23±13.85
5 hours or more (4)	209/55.1	11.26±5.14	8.55±4.93	19.81±9.26
		F=4.378	F=4.189	F=4.782
		P=0.00	P=0.00	P=0.00
Post Hoc		3>1, 3>2, 5>1, 5>1	3>1, 3>2, 5>1, 5>1	3>1, 3>2, 5>1, 5>1
Daily Social Media Use				
Less than 1 hour	90/23.7	10.22±5.21	8.37±5.02	18.60±9.42
1-2 hours	76/20.1	11.02±5.75	8.53±5.12	19.56±10.04
3-4 hours	97/25.6	12.80±7.02	10.07±6.51	22.87±12.76
5 hours or more	116/30.6	12.59±5.94	9.58±5.68	22.18±10.99
		F=4.016	F=1.925	F=3.272
		P=0.00	P=0.12	P=0.02
Post Hoc		3>1, 3>2, 5>1,		3>1, 3>2, 5>1

F: One-way ANOVA (Post Hoc Tukey); p<0.05

Table 4 presents the comparison of the participants' scores on the FoMO Scale and its subdimensions based on their demographic characteristics and social media usage habits. Statistically significant differences were found in Personal FoMO, Social FoMO, and Total FoMO scores according to year of study ($p < 0.05$). Post hoc analyses revealed that the second-year students reported significantly higher levels of Personal FoMO, Social FoMO, and Total FoMO compared to the first- and third-year students. Furthermore, the first-year students also showed higher Personal and Total FoMO scores than the third-year students.

Significant differences were also identified based on the participants' faculty or vocational school ($p < 0.05$). According to further analyses, the students from Vocational Schools (Group 6) had significantly higher scores across all FoMO dimensions compared to the students from other faculties. Regarding the purpose of social media use, significant differences were observed in all FoMO dimensions ($p < 0.05$). The participants who used social media primarily for sharing videos and photos exhibited significantly higher levels of Personal FoMO, Social FoMO, and Total FoMO than those who used it for communication, making new friends, information seeking, or passing time.

The frequency of social media content sharing was also significantly associated with FoMO scores ($p < 0.05$). The students who shared content daily scored higher in all FoMO dimensions than those who never shared or who shared only once or twice per year. Additionally, the participants who shared weekly had higher Personal and Total FoMO scores than those who shared once or twice per year.

Significant differences were found in FoMO scores according to daily smartphone usage ($p < 0.05$). The participants who used their smartphones for 3–4 hours or more than 5 hours daily had significantly higher levels of Personal, Social, and Total FoMO compared to those who used them for less than 1 hour or for 1–2 hours.

Lastly, daily social media usage was significantly associated with Personal and Total FoMO scores ($p < 0.05$). The students who spent 3–4 hours or more than 5 hours per day on social media had significantly higher scores compared to those who used it for less than 1 hour or for 1–2 hours. Notably, those who used social media for 5 or more hours also had significantly higher scores than those who used it for less than 1 hour.

DISCUSSION

The rapid advancement of technology has undoubtedly facilitated everyday life; however, its excessive and inappropriate use has also contributed to various psychological, physical, and behavioral issues. Among young individuals in particular, the persistent desire to stay up to date through social media has been identified as a contributing factor to digital dependency (Korkmaz, 2023). Considering the transitional phase of university students preparing for adulthood, early identification of such issues is thought to be crucial for implementing preventive strategies and raising awareness.

Significant differences were observed in the total scores and subdimension scores (Personal FoMO and Social FoMO) of the FoMO Scale based on the participants' year of study. Notably, the second-year students exhibited higher levels of FoMO across all dimensions

compared to their peers in other academic years. However, these findings should be interpreted with caution, taking into account the potential influence of sample characteristics. For instance, the relatively larger representation of the first-year students may have influenced the observed differences in FoMO scores among the second-year students. Consistent with these findings, a study by Çınar and Mutlu reported that first-year students had higher FoMO levels compared to fourth-year students (Çınar & Mutlu, 2018). Similarly, Kaçık & Acar (2020) found statistically significant differences in FoMO levels by academic year, with third-year students scoring higher than both first- and fourth-year students (Kaçık & Acar, 2020). In contrast, a study by Yaman and Kavuncu (2019) reported no significant differences in FoMO based on year of study (Yaman & Kavuncu, 2019). These discrepancies in literature may be attributed to variations in institutional curricula and exposure to media literacy education. As students progress in their academic careers, increased exposure to critical thinking, access to accurate information, and greater awareness of digital well-being may contribute to more mindful and regulated use of social media platforms. Thus, higher academic standing may be associated with more deliberate decision-making regarding media consumption.

It was found that the students enrolled in vocational schools exhibited higher levels of FoMO compared to those studying in other faculties or schools. This finding aligns with the study by Hoşgör (2019) which reported that students outside of health-related departments had higher average FoMO scores (Hoşgör et al., 2019). Similarly, research conducted with students in faculties of health sciences found that reduced time spent on social media was associated with a lower risk of developing FoMO and social media addiction (Tekin et al., 2024). These findings suggest that students from non-health disciplines may possess lower levels of awareness regarding the implications of social media and the digital environment. Their more frequent and intense engagement with these platforms appears to expose them to heightened levels of stress and anxiety induced by digital interactions. This underscores the need for integrating discussions of social media use into educational curricula and highlights the importance of raising awareness to prevent digital dependency.

Among the participating university students, those who reported using Facebook, Instagram, YouTube, and TikTok had significantly higher FoMO levels than non-Susers. In a similar study, found a positive relationship between the number of social media platforms used and levels of fear of missing out (Çınar & Mutlu, 2018). Research conducted among medical students at the University of Khartoum in Sudan also identified a moderate positive correlation between social media usage intensity and FoMO (Mohammed et al., 2023). Likewise, a study involving Latinx students reported a positive association between social media use and fear of

missing out (Vernon et al., 2024). Collectively, these findings indicate that increased engagement with social media is closely linked to elevated levels of FoMO among students. Observed significantly lower levels of FoMO among individuals who abstained from social media, suggesting that excessive use of such platforms may contribute to the development of high FoMO tendencies (Montag & Markett, 2023). In another study, individuals who interacted with Facebook during peak hours of the day were found to have higher levels of FoMO (Przybylski et al., 2013). Individuals experiencing FoMO often feel compelled to check social media immediately upon waking, driven by a fear that others may discover or share updates before they do. This constant desire to monitor social media activity reflects a deeper anxiety about being left behind in the digital social landscape (Aliçavuşoğlu & Boyraz, 2019).

In this study, it was found that the students who actively used social media exhibited higher levels of FoMO compared to those who did not. This finding suggests that social media usage is a contributing factor to increased levels of fear of missing out. Similar to prior research, the increase in FoMO appears to be associated with increased engagement in social media platforms.

The participants who reported using social media primarily for sharing videos and photos demonstrated significantly higher levels of Personal FoMO, Social FoMO, and Total FoMO compared to those who used it for other purposes such as communicating with friends, making new acquaintances, acquiring information, or passing time. This result aligns with the findings of Çağlayan and Arslantaş (2023), who observed that individuals who used social media for sharing content exhibited higher levels of social media addiction (Çağlayan & Arslantaş, 2023). The ease of posting and monitoring others' profiles in virtual environments has enabled individuals to remain connected independent of time and space. Social media has thus become an indispensable part of daily life, especially for users who continuously track others' posts (Tanhan et al., 2022). These findings indicate that FoMO is strongly linked to the constant need for updates and information through social media. The elevated FoMO levels among students who share visual content may be driven by a desire for self-expression and visibility on these platforms. Key drivers of FoMO include constant exposure to others' shared experiences, the pressure to participate in visible activities, continuous online presence, and the number of social media accounts used (Shi et al., 2023; Zhu & Xiong, 2022). In this regard, using social media for content sharing may lead individuals to engage in more frequent interactions and become increasingly sensitive to feedback received from these engagements.

In the study, those individuals who posted daily had significantly higher Personal, Social, and Total FoMO scores compared to those who never posted or posted only once or twice per

year. Furthermore, the participants who shared content weekly had higher Personal and Total FoMO scores than those who shared less frequently. This is consistent with findings from Uygun and Kalender (2023), who reported that individuals posting daily had significantly higher FoMO scores than less frequent users (Uygun & Kalender, 2023). A study conducted among nursing students revealed a positive relationship between daily smartphone usage, time spent online via smartphones, and the frequency of checking smartphones (e.g., once per hour) with FoMO levels (Tuna et al., 2023). These results support the notion that greater social media interaction and constant online activity may heighten fear of missing out, and that frequent checking behaviors may further exacerbate this psychological tendency. In parallel with other studies, the current findings confirm that the frequency of social media posting is a significant factor contributing to the development of FoMO. Prolonged engagement with social media platforms and frequent sharing behaviors appear to contribute to the intensification of FoMO. Increased social interaction on these platforms may lead individuals to monitor their own content more frequently and spend additional time online out of fear of missing others' updates.

In this study, the participants who reported using their smartphones for 3–4 hours or more than 5 hours per day had significantly higher levels of Personal FoMO, Social FoMO, and Total FoMO compared to those who used them for less than 1 hour or between 1–2 hours. This finding is supported reported that increased frequency of smartphone checking was associated with elevated levels of FoMO (Hoşgör et al., 2019). Similarly, in a study conducted among medical students, those who checked their smartphones more than 50 times per day had significantly higher FoMO scores than those with fewer interactions, and social media users exhibited higher FoMO levels than non-users (Akbay et al., 2020). Given that smartphones provide constant and immediate access to social media, students aiming to avoid missing out can remain connected at all times and in any location. The widespread adoption of smartphones appears to contribute to increased FoMO through the greater ease and frequency of social media access.

Additionally, the participants who spent 3–4 hours or more than 5 hours per day on social media reported significantly higher Personal and Total FoMO scores than those who used social media for less than 1 hour or 1–2 hours daily. Notably, the students who spent over 5 hours per day on social media had significantly higher FoMO scores than those using it for less than an hour. These findings are consistent with the results of who found that health sciences students spending 6 or more hours per day on social media had significantly higher scores in Total FoMO, social tolerance, and virtual communication subdimensions than those who used it for 2 hours or less (Tekin et al., 2024). Akbay et al., (2020) also observed that medical students with higher daily social media use reported greater fear of missing out (Akbay et al., 2020).

Likewise, Eker et al., (2023) reported that students who spent 3–6 hours on social media had significantly higher FoMO levels compared to those who used it for less than an hour (Eker et al., 2023). Prolonged engagement with social media may weaken real-life friendships and increase the severity of dependence (Zıvıdır & Karakul, 2023). In line with previous research, extended time spent on social media contributes to the development of FoMO. Long-term use of these platforms may lead individuals to disengage from real-world social environments, intensifying curiosity and time spent in digital spaces. This, in turn, may heighten FoMO and foster a tendency to constantly monitor others' lives and compare them with one's own experiences.

CONCLUSION AND RECOMMENDATIONS

The findings of this study revealed that Instagram was the most frequently used social media platform among the participants, with 77.3% reporting active use. The results also demonstrated that FoMO levels were significantly higher among those in their second year of study, those enrolled in vocational schools, those who used platforms such as Facebook, Instagram, YouTube, and TikTok, those who primarily used social media for sharing videos and photos, those who posted daily, and those who spent 3–4 hours per day on smartphones and social media.

In light of these findings, it is essential to develop effective counseling programs that promote digital awareness and time management skills to foster more mindful and controlled use of social media among students. To mitigate the negative effects of FoMO, supportive initiatives such as stress management workshops, emotional regulation training, and group therapy sessions aimed at enhancing psychological resilience are recommended. These programs may help students maintain a healthy balance in their digital lives. Integrating courses on media literacy, responsible internet use, and addiction prevention into university curricula would be a crucial step. Additionally, encouraging student participation in cultural and social activities, organizing sports events, and providing opportunities to pursue hobbies should be complemented by accessible psychological counseling services. Such measures may contribute to reducing social media dependence and promoting overall digital well-being. Future research could investigate the impact of FoMO on health behaviors, particularly in relation to dietary habits, sleep patterns, and harmful behaviors such as smoking or alcohol consumption. The results of this study may inform policy development regarding social media use and serve as a foundation for youth-centered awareness programs, offering actionable insights for real-world applications.

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Conflict of Interest

The authors declare no personal or financial conflicts of interest.

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DEVELOPMENTAL COORDINATION DISORDER AND CO-OCCURRING MOTOR DIFFICULTIES IN CHILDREN WITH ATTENTION DEFICIT AND HYPERACTIVITY DISORDER

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ABSTRACT

Children diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) commonly experience challenges in both fine and gross motor skills. Nevertheless, the specific domains of dysfunction in these children have yet to be established through comprehensive neurological assessments. This study aims to determine the prevalence of Developmental Coordination Disorder (DCD) in children with ADHD and identify the specific domains of dysfunction. Participants were 32 children diagnosed with ADHD aged between 5 and 12 years (M = 8.5; 75% male) and 36 typically developing children in the same age range (M = 8.1; 63.9% male). DCD and neurological examination were performed using DCD-Q and Touwen examination, respectively. Children diagnosed with ADHD were more prone to having DCD compared to their peers ($p < 0.05$). According to Touwen's examination, children with ADHD had dysfunction in the domains of involuntary movements, associated movements, coordination-balance, fine manipulation, and sensory function. When a child is diagnosed with both ADHD and DCD, a personalized approach to evaluating and treating both conditions is necessary. A comprehensive assessment that includes neurological components and identifying dysfunctional domains can help determine the most suitable intervention program for children with ADHD.

INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is the most common neuropsychiatric syndrome in childhood (Thomas, Sanders, Doust, Beller & Glasziou, 2015). The reported prevalence among school students ranges from 2% to 17% (Scahill & Schwab-Stone, 2000). The symptoms of this disorder are the inability to sit still, fidgeting, interrupting those who are talking, being unable to continue the task, and being easily distracted (Pediatrics, 2002). ADHD symptoms in children persist into adolescence. From childhood to adolescence, symptoms of hyperactivity decrease, but attention deficits and impulsive symptoms continue to affect their relationships negatively, complicating interpersonal relationships (Zhang & Jin, 2007).

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An essential subset of children with ADHD has impaired motor performance (Czamara et al., 2013). Children with ADHD may have significant rates of fine and gross motor problems (Kleeren et al., 2023). The link between ADHD and Developmental Coordination Disorder (DCD) has been known for decades, and the prevalence of DCD has been reported to be 50% among individuals with ADHD (Watemberg, Waiserberg, Zuk & Lerman-Sagie, 2007). Developmental Coordination Disorder (DCD) is a neurodevelopmental condition characterized by marked impairment in the development of motor coordination, which significantly interferes with daily functioning and academic performance. In accordance with the Diagnostic and Statistical Manual of Mental Disorders (DSM-V-TR), DCD is defined as a significant impairment in the acquisition and execution of coordinated motor skills that is not attributable to intellectual disability or a general medical condition (Segal, 2010). The disorder often manifests as clumsiness, delays in achieving motor milestones, and difficulties in tasks such as dressing, eating, writing, and participating in sports or playground activities, thereby affecting children's independence and participation in age-appropriate activities (Van der Linde et al., 2015). Handwriting difficulties, fine and gross motor delays, abnormal movement programming, and deficits in parameter sets have been reported for children with both diagnoses (Kleeren et al., 2023). While a group of children with ADHD might not satisfy the full diagnostic criteria for DCD, they may still experience noticeable challenges in fine motor tasks. These may include deficiencies in motor parameters such as strength, pressure control, agonist-antagonist timing, and slower execution of skilled movements (Schoemaker, Ketelaars, Van Zonneveld & Minderaa, 2005).

Detailed evaluation of these deficits in children with ADHD is clinically essential. In the literature, it has been reported that the motor skills of these children decrease; however, in which neurodevelopmental areas there is retardation has not been studied much. Various studies have been conducted on the prevalence of motor skill problems in individuals diagnosed with ADHD, and at least half of these individuals have been found to have motor problems associated with DCD (Farran et al., 2020; Lee et al., 2021; Montes-Montes, Delgado-Lobete & Rodríguez-Seoane, 2021). Although the findings reveal that motor difficulties are frequently observed in individuals with ADHD, there is no consensus on the cause of these difficulties. Some studies suggest that these motor difficulties may not be a direct component of ADHD and instead may result from other neurodevelopmental disorders, such as DCD, which often coexist (Meachon, Melching & Alpers, 2024). Therefore, in order to clarify the extent of motor difficulties accompanying ADHD, studies with large participation and cultural diversity that address ADHD and DCD together are needed (Farran et al., 2020; Montes-Montes et al., 2021;

Pillay, Meyer & Mokobane, 2019). However, even when DCD is excluded, individuals with ADHD report more motor problems compared to their typically developing peers (Farran et al., 2020; Kaiser, Schoemaker, Albaret & Geuze, 2015; Klupp, Möhring, Lemola & Grob, 2021). This suggests that motor difficulties accompanying ADHD exist, but these difficulties may be milder in severity compared to DCD (Lee et al., 2021). However, the lack of sufficient focus on motor skill problems in ADHD and the significant overlap with DCD that is often overlooked increases uncertainties in this area (Kaiser et al., 2015; Meachon, Zemp & Alpers, 2022). In addition, the fact that ADHD-specific symptoms of inattention and hyperactivity can also be observed in individuals diagnosed with DCD can cause diagnostic confusion (Bon throne et al., 2024). This situation is further complicated by the inadequate recognition of DCD in clinical practice and low awareness (Lee et al., 2021). In this context, we planned to conduct an evaluation using age-specific neurological examination methods in order to define these motor difficulties in detail. Based on the current literature, it was hypothesized that children diagnosed with ADHD would demonstrate a higher incidence of Developmental Coordination Disorder (DCD) and more frequent dysfunctions in age-related neurological domains compared to their typically developing peers. Therefore, this study aims to determine the incidence of DCD and dysfunctional areas in children with ADHD.

MATERIAL AND METHOD

This study was designed as a comparative cross-sectional study aiming to examine neurodevelopmental differences between children diagnosed with attention deficit hyperactivity disorder (ADHD) and their typically developing peers. The research was conducted at the Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Gazi University. ADHD diagnoses were made by a child and adolescent psychiatrist at Gazi University Hospital. The study included children who applied to the relevant clinic between February 2023 and July 2023. Prior to data collection, detailed information about the study's purpose and procedures was provided to both the children and their parents. Written informed consent was obtained from the parents, and verbal assent was also obtained from all participating children. Only children who agreed to participate voluntarily were included in the study, and no child refused participation.

Participants

In the study, outpatients between the ages of 5 and 12 years who met the DSM-IV-TR diagnostic criteria for ADHD were evaluated (American Psychiatric Association &

Association, 2013). In addition, 36 healthy children in the same age range were included in the study. Inclusion criteria were: 1) have an ADHD diagnosis made by a pediatric psychiatrist, 2) no known sensory, motor, neurological, or intellectual impairment, and 3) no emotional or social problems that could affect development. Children with documented substantial learning disabilities, autism, neuromotor issues, or significant medical conditions were excluded from the study due to potential challenges that might hinder their ability to follow the instructions for the Touwen examination tests.

Initially, thirty-six children were deemed eligible; however, four of them were later excluded for meeting specific exclusion criteria, with three diagnosed with specific learning disabilities and one with autism spectrum disorder. Thus, the study included 32 children diagnosed with ADHD, referred by the Department of Child and Adolescent Psychiatry, and 36 typically developing children, who were randomly matched with the ADHD group based on age and sex. The average age in the ADHD group was 8.5 ± 1.8 years, whereas the control group had a mean age of 8.1 ± 1.5 years. In the ADHD group, 75 percent of the children were male, while 63.9 percent of the children in the control group were male.

Using the G*Power program (version 3.1.9.2 Universität Düsseldorf, Düsseldorf, Germany), Based on the results obtained from the reference study (Thomas et al., 2015), it was determined that for a study to achieve 85% power with 95% confidence, a minimum of 64 individuals (at least 32 per group) needed to be included. Considering the dropout possibility, 72 children were evaluated (36 children with ADHD and 36 of their typically developing peers). As a result, 32 children with ADHD and 36 children with typical development were included in the study.

Measurements

All children included in the study were evaluated by a pediatric physiotherapist with approximately ten years of clinical experience. The total assessment time lasted about 40 minutes for each child, depending on the children's motivation. The evaluations were finalized during a subsequent session if the children lacked motivation.

Developmental Coordination Disorder Questionnaire (DCDQ)

A parent self-administered questionnaire assists healthcare professionals in identifying developmental coordination disorders (Wilson, Kaplan, Crawford, Campbell & Dewey, 2000). It provides a quick, inexpensive, and reliable assessment of children's motor skills (Martini & Wilson, 2012). Created as DCDQ with 17 items in 2000, the tool underwent revision in 2007. The updated version employed in this study comprises 15 items designed to assess children

aged between 5 and 15 years (Yıldırım, Altunalan, Acar, Elbasan & Gucuyener, 2019). Administering the scale takes approximately 10-15 minutes and enables a comparison of the child's motor coordination and development with a normative group of typically developing children.

The Turkish adaptation of the DCDQ shows strong psychometric properties. The internal consistency of the total scale is high, with a Cronbach's alpha of .890. All item-deleted Cronbach's alpha values remain lower than the total value, indicating that each item contributes positively to the overall reliability. Test-retest reliability values range from .99 to 1.00, demonstrating excellent temporal stability. These findings support the Turkish DCDQ as a valid and reliable screening tool for assessing motor performance in children aged 5 to 15 years (Yıldırım, Altunalan, Acar, Elbasan & Gucuyener, 2019).

The questionnaire includes three subscales: control during movement, fine motor and handwriting, and general coordination. These subdomains provide a comprehensive understanding of different aspects of motor function, facilitating a more targeted assessment of children with suspected DCD (Yıldırım, Altunalan, Acar, Elbasan & Gucuyener, 2019).

Touwen Examination

The assessment of neurological development is conducted through a standardized neurological examination tailored to the age of the child, using the Touwen Neurological Examination. The Touwen examination evaluates whether a child's motor performance aligns with age-related expectations and serves as a valid, reliable, and sensitive tool for assessing the quality of motor behavior (Hadders-Algra, 2010). It examines eight functional domains: posture and muscle tone, reflexes, involuntary movements, coordination, fine motor skills, sensory function, cranial nerve function, and associated movements (Hadders-Algra, 2010).

The Touwen examination is widely used in both clinical and research settings, particularly for detecting minor neurological dysfunctions (MND) in children with neurodevelopmental disorders. Studies report high inter-rater reliability and strong construct validity, especially when used by trained professionals in structured settings (Peters, Maathuis, Kouw, Hamming & Hadders-Algra, 2008). Its sensitivity allows for the detection of subtle motor control issues that may not be evident through gross neurological tests alone. Through this examination, dysfunctions in specific neurological domains can be identified and systematically documented, making them valuable components of comprehensive neurodevelopmental assessments (Kakebeeke, Jongmans, S. Dubowitz, Schoemaker & Henderson, 1993).

Statistical Analysis

Data analyses were performed utilizing IBM SPSS version 25 (SPSS Inc., Chicago, IL, USA). Visual means (histograms and probability plots) and analytical techniques (Kolmogorov-Smirnov/Shapiro-Wilk tests) evaluated the variables' normality. Rates of impairments in the Touwen neurological examination and differences in the prevalence of DCD between ADHD and control groups were analyzed using a Chi-square test or Fisher's exact test. When the assumptions of parametric tests were not satisfied, the Mann-Whitney U Test was utilized to evaluate variations between independent groups. A p-value less than 0.05 was regarded as statistically significant in all analyses.

RESULTS

The rate of p-DCD in the ADHD group was statistically higher than in the control group ($p < 0.05$). While the percentage of p-DCD in the ADHD group was 46.9, it was 8.3 in the control group (Figure 1). In addition, children with ADHD exhibited lower scores in both the DCDQ subscales (control during movement, fine motor/handwriting, and general coordination) and total scores ($p < 0.05$) (as shown in Table 1).

Table 1. Comparison of DCDQ subscales/total scores in ADHD and control groups.

DCDQ subscales	ADHD Group (n=32) Mean (SD)	Control Group (n=36) Mean (SD)	p-value
Control during movement	21.03 (7)	26.33(4.7)	< 0.001 ^a
Fine motor/handwriting	13.50 (4.1)	17.78(2.7)	< 0.001 ^a
General coordination	16.13 (5)	22 (3.5)	< 0.001 ^a
DCDQ total score	50.34 (14.2)	66.3(10.2)	< 0.001 ^a

DCDQ = Developmental Coordination Disorder Questionnaire, p-DCD = probable Developmental Coordination Disorder, ADHD = Attention Deficit Hyperactivity Disorder, a: Man-Whitney U Test.

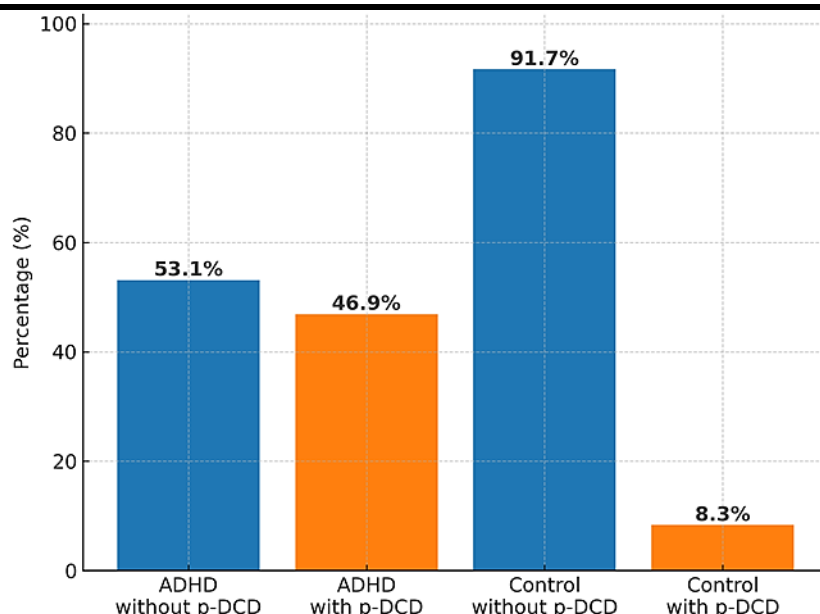


Figure 1. Distribution of p-DCD in the ADHD and control groups

Dysfunction rates were higher in the ADHD group than the control group in the domains of voluntary movements, Coordination and balance, fine manipulation, associated movements, and sensory function, according to the Touwen examination ($p < 0.05$). The groups exhibited no distinctions in terms of posture, muscle tone, reflexes, and cranial nerve function ($p > 0.05$) (Table 2).

Table 2. Rates of impairments in the Touwen neurological examination

	ADHD Group n/N (%)	Control Group n/N (%)	p-value	OR (CI 95%)
Posture and muscle tone	6/32 (18.8%)	2/36 (5.6%)	0.135 ^b	3.92 (0.73-21.05)
Reflexes	3/32 (%)	2/36 (%)	0.66 ^b	1.76 (0.28-11.27)
Involuntary movements	7/32 (21.9%)	1/36 (2.8%)	0.02^b	9.8 (1.13-84.74)
Coordination and balance	14/32 (43.8%)	4/36 (11.1%)	0.002^a	6.22 (1.78-21.77)
Fine manipulation	13/32 (40.6%)	4/36 (11.1%)	0.005^a	5.47 (1.56-19.22)
Associated movements	6/32 (18.8%)	0/36 (0%)	0.008^b	NA
Sensory function	4/32 (12.5%)	0/36 (0%)	0.044^b	NA
Cranial nerve function	2/32 (%)	0/36 (%)	0.218 ^b	NA

^aChi-square Test, ^bFisher's exact, OR: odds ratio, CI: confidence interval

DISCUSSION

ADHD is a prevalent condition in childhood, and considering that there are accompanying motor problems, it is essential to identify them. The present study aimed to evaluate the rate of co-occurring DCD in children with ADHD compared to typically developing peers. In addition, it was aimed to detect dysfunctional domains in these children with a detailed neurological examination.

The rate of co-occurring DCD in children with ADHD

ADHD and DCD are both prevalent developmental disorders that frequently occur during childhood. ADHD and DCD have many similarities, such as high prevalence rates, comorbidities, and poor psychosocial outcomes. Studies have indicated that DCD is the most prevalent co-occurring condition with ADHD. Various studies, mainly conducted on clinical groups, indicate a prevalence rate of 50% or more for this co-occurrence (Green, Baird & Sugden, 2006). In the current study, the occurrence of coexisting DCD in children with ADHD was 46.9%, consistent with existing literature. McLeod and colleagues identified commonalities in dysfunctional brain regions among children with DCD and/or ADHD, encompassing the bilateral inferior frontal gyrus, right supramarginal gyrus, angular gyrus, insular cortices, putamen, pallidum, and amygdala. (McLeod, Langevin, Goodyear & Dewey, 2014). Considering that DCD and ADHD mainly occur together, these two disorders may share a similar etiology. The underlying cause of these deficits remains uncertain, but some theories propose that they may stem from inattention and decreased response inhibition (Kaiser, Schoemaker, Albaret & Geuze, 2015). However, recent studies have indicated that motor symptoms may not be inherent to the ADHD phenotype (Lee et al., 2021). Further comprehensive studies could enhance our understanding of the association between ADHD and DCD. In the current study, the proportion of boys in the ADHD group was notably high (75%). Given that sex differences may influence motor development, this imbalance should be considered when interpreting the motor performance results. Previous research suggests that boys and girls may show differing developmental trajectories in fine and gross motor skills, with boys sometimes exhibiting delays or greater variability in coordination tasks (Saidmamatov, Nascimento, Cerqueira, Rodrigues & Vasconcelos, 2022; Samara, Sidharta, Mediana & Noviyanti, 2012). Therefore, the higher percentage of boys in the ADHD group may have contributed to the overall motor difficulties observed. Future studies are encouraged to control for sex or to examine sex-related effects more specifically to better understand their impact on motor skill profiles in children with ADHD.

Scientific literature extensively documents that a significant portion of children with ADHD display diminished motor skills in comparison to their typically developing counterparts, impacting both fine and gross motor abilities (Fenollar-Cortés, Gallego-Martínez & Fuentes, 2017). Studies on clinical and epidemiological aspects indicate that motor coordination problems are present in 30% to 50% of children diagnosed with ADHD (Wilson, 2005). Challenges in motor coordination, commonly observed in community samples of children, may result in non-motor coordination issues such as subpar academic performance,

reduced self-efficacy, and diminished life satisfaction. Children with ADHD seem to exhibit impaired handwriting performance, as demonstrated by illegible written material and/or inappropriate execution speed when compared to their non-ADHD peers (Racine, Majnemer, Shevell & Snider, 2008). This can harm academic performance and self-esteem, as poor handwriting is a life skill that negatively affects this population (Blank et al., 2019). Furthermore, motor impairments may be associated with emotional and behavioral problems in school-aged children (Mikami et al., 2023). Children with motor coordination difficulties are at increased risk of developing psychological problems in adolescence and adulthood, including symptoms of depression and anxiety, which can negatively impact long-term outcomes. (Zwicker, Harris & Klassen, 2013)

Compared to the control group in this study, children diagnosed with ADHD exhibited lower scores across all facets of motor coordination, including control during movement, fine motor/handwriting, and general coordination. Considering the motor and psychological processes that affect each other, identifying motor problems in children with ADHD may be essential in determining the intervention for these children.

Dysfunctional domains in children with ADHD

Children diagnosed with ADHD frequently do not meet the age-appropriate standards for motor control development, specifically in timed repetitive and sequential movements, balance, and motor overflow (Denckla & Rudel, 1978).

Due to the neurological dimension of ADHD, we deemed it valuable to evaluate these children using the Touwen examination. This assessment employs a sophisticated, sensitive, and age-appropriate methodology specifically designed to account for the developmental aspects of the child's rapidly evolving nervous system (Hadders-Algra, 2010). As far as we know, it was used for the first time in children with ADHD in this study. In their research, Stray et al. administered the Motor Function Neurological Assessment (MFNU), similar in content to the Touwen examination, to define motor dysfunction in boys with ADHD. The results showed significant differences between the ADHD and control groups on all subtests, including the total score, suggesting that the MFNU can distinguish between children with ADHD and standard controls (Stray et al., 2009). Children with ADHD made jerky movements, and it was stated that they needed more time to change the direction of movement than controls (Yan & Thomas, 2002). One study found that children with ADHD had difficulty with fine motor skills and balance disorders. Also, another study found that children with ADHD had difficulty with fine motor skills and balance disorders (Raberger & Wimmer, 2003). The present study noted

higher dysfunction rates in domains related to involuntary movements, coordination and balance, associated movements, fine manipulation, and sensory function. The cause of this problem in motor skills may involve synaptic inhibition mechanisms located in or near the motor cortex. However, dysfunction in involuntary movements, associated movements, and sensory function suggested that neurological components were affected in these children. Therefore, a comprehensive evaluation of children with ADHD and identification of dysfunctional domains may guide the intervention to be applied to these children.

Limitations

In our study, the use of the validated DCD-Q to identify children at risk for DCD instead of a formal diagnosis of DCD according to the DSM-5 diagnostic criteria was a limitation, as this scale can only distinguish the presence of probable DCD (Smits-Engelsman, Schoemaker, Delabastita, Hoskens & Geuze, 2015). Additionally, the sample of this study is small to determine the prevalence and generalize the results. A study with a larger sample is needed to determine the prevalence of DCD in children with ADHD. The lack of classification according to the symptoms of ADHD (inattention, impulsivity, and hyperactivity) is a limitation of the study since an adequate number of children with ADHD were not evaluated. Symptom-based classification can provide deeper insight into the neuropsychological profiles and help tailor intervention strategies more effectively. Furthermore, no information was collected regarding whether participants with ADHD were taking medication. Since pharmacological treatment may influence both attention and motor performance, not accounting for medication use might have affected the results. Future studies should consider medication status as a potential confounding factor when evaluating motor difficulties in this population.

CONCLUSION

This study revealed that DCD disorder essentially accompanies ADHD and that children with ADHD have more neurological dysfunctional domains compared to the control group. Having a child diagnosed with both ADHD and DCD requires an individualized approach to the assessment and treatment of both conditions. To determine the most appropriate intervention program for children with ADHD, a detailed evaluation may be helpful, including neurological components and identifying dysfunctional domains.

A detailed evaluation may help identify specific motor and neurological challenges in children with co-occurring ADHD and DCD. In such cases, a multidisciplinary and individualized intervention plan is crucial. For instance, physiotherapy programs focusing on

balance training, postural control, and coordination exercises (e.g., task-oriented motor training, core stabilization exercises) can effectively address motor impairments. Additionally, occupational therapy interventions such as sensory integration therapy, fine motor skill development activities, and executive function training may help improve daily functional performance and participation. Incorporating playful, structured, and goal-oriented activities tailored to the child's unique needs can enhance engagement and outcomes. Early identification and intervention are essential to support both motor and cognitive-behavioral development in these children. Based on the findings of this study, it is important for both families and professionals to recognize that ADHD and DCD may commonly co-occur, and this should be taken into account during assessment and intervention processes. Families' awareness of their children's motor and attention-related difficulties plays a key role in seeking timely and appropriate support. Furthermore, it may be beneficial for researchers to generate more scientific evidence aimed at identifying effective intervention strategies for children with co-occurring ADHD and DCD.


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TOXIC EFFECTS OF GLYPHOSATE AS A HERBICIDE IN AQUATIC ENVIRONMENT: REPRODUCTIVE HEALTH AND SPERM QUALITY PARAMETERS

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ABSTRACT

Glyphosate is a broad-spectrum herbicide most commonly used to control weeds worldwide. The widespread use of this herbicide has raised concerns about the risk of transfer to aquatic systems and, therefore, to humans. Because terrestrial organisms and humans can be exposed to herbicides in different ways: These can be through herbicide drift into the environment, through inhalation or dermal contact, or through the use of contaminated food or water. Thus, in this study, the *in vitro* effects of different doses of glyphosate in the aquatic environment on the reproductive health of fish were studied. The sperm quality parameters of *Capoeta trutta* in the Upper Euphrates Basin were studied by the computerized sperm analysis system. According to the results, it was decreased statistically significantly ($p<0.05$) in the sperm quality parameters of Straight Linear Velocity (VSL), Curvilinear Velocity (VCL), and Angular Path Velocity (VAP) compared to the control group at all doses of glyphosate. As a result, the presence of glyphosate in the aquatic environment and its transfer from these water sources to food produced through agricultural activities may pose a serious risk to the reproductive health of both humans and other living creatures, and it may be recommended that more extensive scientific research be conducted in the relevant area.

INTRODUCTION

The overall production capacity of glyphosate has been increasing for decades, and it was 1.1 million tons/year in 2012, which far exceeded the real world demand. The Republic of China accounts for a significant portion of the overall production, and it is reported that production amounts increased by 2.6 times from 323 thousand tons/year in 2007 to 826 thousand tons/year in 2010. Statistics show that China alone can meet all the global glyphosate demand to date. While the United States dominated glyphosate production in the seventies, its share in the global annual glyphosate turnover has gradually decreased since then (Székács & Darvas, 2018).

According to 2017 data in Europe, the average active herbicide used per hectare is 0.24 kg glyphosate, while its global use is estimated at 4438.5 million dollars. In the last 20 years, glyphosate as a herbicide has increased in use, especially in North and South America, despite its known water pollutant properties, with the increase in production capacities of genetically

modified grain products (soybeans, corn, etc.). On the other hand, glyphosate, which is used excessively for weed protection in genetically modified grain products, is inevitably carried to surface waters by rain or water currents, and it is estimated that these contamination levels can exceed 5000 µg/L. As a result of glyphosate contamination of surface waters, it will likely have toxic effects on aquatic microorganisms, algae, invertebrates and vertebrates, and it will again reach the terrestrial system and human use from these waters (Coupe, Kalkhoff, Capel & Gregoire, 2012; Ogunbiyi et al., 2023; Székács & Darvas, 2018).

In chronic, developmental and reproductive toxicity studies *in vivo* conducted on mammals, glyphosate has been examined alone to determine toxicity limits. However, since glyphosate is never found alone in formulations, these studies are insufficient. Because it has been reported that glyphosate, which is the active ingredient of more than 750 different herbicides used worldwide, and its commercial formulations may have potential toxic effects even below the specified limit values (Mesnage, Defarge, Spiroux de Vendômois & Séralini, 2015). When glyphosate is absorbed or ingested by the body, it presents critical health concerns, such as glyphosate-based formulations being found in urine and feces and not being converted into other chemicals (Ledoux, Hettiarachchy, Yu, Howard & Lee, 2020).

When looking at the literature, it has been determined that glyphosate poses many risks to human health. For example; there is a correlation between increased exposure to glyphosate-based herbicides and the development of many diseases, including neurodegenerative diseases such as Alzheimer's and Parkinson's, autoimmune diseases, hepatic and nephrotic degenerations, infertility, thyroid, bladder, pancreas, leukemia and breast cancer (Samsel & Seneff, 2013), on the other hand, various health problems such as kidney failure and liver damage in agricultural workers (Wang, Fan, Tan, Cheng & Chen, 2011), adverse effects on the cardiovascular system (Gress, Lemoine, Séralini & Puddu, 2015), the risk of melanoma increasing by 80% (De Roos et al., 2005), children whose mothers and/or fathers are known to have been exposed to glyphosate have been shown to have an increased risk of childhood cancers such as lymphoma (Flower et al., 2004), moreover, it has been multiple myeloma in individuals exposed for long periods (>2 days/year) (Kachuri et al., 2013). While there are few epidemiological studies on the effects of glyphosate exposure on the reproductive system, it was found decreased fertility in women (Sanin, Carrasquilla, Solomon, Cole & Marshall, 2009). Premature birth infections, respiratory distress, feeding difficulties, intraventricular hemorrhage, sepsis and long-term illnesses such as cardiovascular disease, kidney disease, neurodevelopmental delays and lung impairment (Varde et al., 2023).

The studies on glyphosate in the reproductive system of terrestrial and aquatic animals as follows: in cattle embryos (Cai et al., 2020), frog (*Xenopus laevis*) oocytes (Slaby et al., 2020), larvae (Fiorino et al., 2018) and sperm (Lopes et al., 2014) of zebra fish (*Danio rerio*), the embryo of common carp (*Cyprinus carpio*) (Socha et al., 2021), sperm of coastline fish (*Jenynsia multidentata*) (Albañil Sánchez, da Costa Klosterhoff, Romano & De Martinez Gaspar Martins, 2019), sperm of grass carp (*Ctenopharyngodon idella*) (Lugowska, 2018), sperm of Nile Tilapia (*Oreochromis niloticus*) (Acar, İnanan, Zemheri Navruz & Yılmaz, 2022), sperm of Argentine silverfish (*Odontesthes bonariensis*) (Menéndez-Helman, Gárriz, del Carmen Ríos de Molina & Miranda, 2025), and sperm of trout (*Onchorhynchus mykiss*) (Akça, Kocabaş & Kutluyer, 2021).

With the increase in pollution in the aquatic environment, it is necessary to monitor the toxicity of pollutants and determine their mechanisms and effect levels in environmental risk assessment. In vitro techniques are important in the assessment of the aquatic environment, which is the main habitat of fish that reproduce with external fertilization, against pollutants (Özgür, Ulu, Sezer, Köytepe & Ateş, 2024). Again, in bony fish that reproduce with external fertilization, the movement times of sperm cells are short and tend to decrease rapidly. For example, sperm cells, whose movement starts when they meet with water, can survive for 20-25 seconds in rainbow trout (*Oncorhynchus mykiss*) and 1-2 minutes in carp (*Cyprinus carpio*) (Alavi & Cosson, 2006). For this reason, Computer-aided sperm analysis (CASA) has become very popular in recent years for fast, practical and effective analysis and has replaced traditional methods and estimation methods based on the personal opinions of sperm analysts (Kime et al., 2001; Özgür, Okumuş, & Kocamaz, 2019). However, the sperm cells of bony fish, which start moving when they come into contact with water but have a very short life span, will of course present a very disadvantageous situation if they encounter pollutants during this short life span. Considering that the main function of sperm cells is to fertilize eggs, the investigation of their survival against pollutants is one of the most important issues. In fish, despite external fertilization and reproductive activities in the aquatic environment, it is difficult to think that sperm cells exposed to toxicity from pollutants will play an active and successful role in the continuation of new generations.

The predicted environmental concentration (PEC) of glyphosate in drinking water is 0.1 µg/L according to the Environmental Quality Standard (EQS) set by the European Union Directive (EU) 2020/218470 for generic pesticides (SCHEER, 2022). Despite the very low levels of glyphosate required in drinking water by these and similar environmental authorities, it is estimated that contamination levels in natural aquatic habitats may exceed 5000 µg/L as a

result of agricultural applications (Coupe et al., 2012; Ogunbiyi et al., 2023; Székács & Darvas, 2018), explaining that the risk of aquatic glyphosate contamination is quite high. On the other hand, unfortunately, in 2022, the European Food Safety Authority (EFSA) decided to renew the approval of glyphosate for the next ten years, considering that the current data does not provide sufficient evidence to prove the mutagenic/carcinogenic effects of glyphosate. The main purpose here is to review the scientific studies that explain the potential risks to human health from glyphosate and to examine its mutagenic and carcinogenic potential and its endocrine disrupting effects on the human reproductive system (Galli et al., 2024).

Despite the existing risk possibilities and due to insufficient scientific data on its effects on the human reproductive system, it has been decided to determine the effects of sperm quality parameters with an animal test alternative as fish. Additionally, in the scientific literature, no studies have been conducted on the toxic effects of glyphosate, especially on fish living in the Upper Euphrates River Basin. So, this study was designed to investigate the effects of the nominal doses of glyphosate (0 (control), 1, 5, 10 and 25 mg/L) on the reproductive health and sperm quality of *Capoeta trutta* fish species. Therefore, the main purpose of the current study is to produce results that can give an idea about the possible consequences for both the reproductive health of fish in aquatic environments and the health of humans and communities that directly interact with water.

MATERIAL AND METHOD

Breeding Fish and Chemicals

Karabalık (*Capoeta trutta*) breeding stocks were caught from Karakaya Dam Lake in the Upper Euphrates River Basin at the beginning of May 2024, and after sperm samples were taken, the fish were released back to their habitats. Sperm samples were collected directly from 10 male fish (325±15 g weight, 27±5 cm total length, Mean±Sd.) without hormonal injection since they were in the reproductive period. Sexual maturity was confirmed by urogenital aperture and reproductive tubercles on the nose. Semen samples were collected in Eppendorf tubes by gently pressing the abdomen, and the sperm pool formed from sperm subgroups was created in a falcon tube with inactivation solution (INAS), which stops the movement of sperm cells. While taking sperm samples, care was taken to avoid contamination with bloody and fecal waste. The sperm samples were then transported with ice support to the laboratory in the Department of Fisheries Engineering of the Faculty of Agriculture at Malatya Turgut Özal University for the experiment. The sperm cell density in the sperm pool was approximately 10.2×10^9 cells/mL. The sperm samples were kept in the refrigerator at +4 °C until analyzed.

The herbicide with the commercial product name Sonround®48 SL, containing glyphosate isopropyl amine salt equivalent to 480 g/L glyphosate, was obtained from a commercial herbicide vendor. It was dissolved in distilled water and added to sperm cells in Eppendorf tubes *in vitro*.

Experimental Application

For the preparation of sperm samples and motility analysis, stock solutions were prepared to obtain inactivation solution (INAS) containing 200 mM KCl and 30 mM Tris-HCl, pH: 8.0 and activation solution (AS) containing 45 mM NaCl, 5 mM KCl and 30 mM Tris-HCl, pH: 8.0 (Özgür et al., 2020; Poupard et al., 1998). Glyphosate nominal doses were determined as 0 (control), 1, 5, 10, and 25 mg/L. 6 sub-sperm samples were taken for each dose from the sperm pool formed by taking 10 brood fish. The sub-sperm samples were diluted with INAS 100 times their amount in Eppendorf tubes, and then glyphosate prepared at different rates was added to the solution, mixed gently, and left for *in vitro* incubation at 4 °C for 4 hours.

Kinematic Parameters of Sperm Cells

All sperm samples were kept on ice throughout the procedure. Samples were taken after 4 hours and examined under a microscope. Sperm samples were activated with AS solution at a ratio of 1:20 and analyzed under a microscope. The final dilution ratio was 2000-fold. The dilution ratios of sperm samples were adjusted according to the 2-set procedure (Billard & Cosson, 1992). Sperm samples were examined with an Olympus BX 53 phase contrast microscope with a Sony CCD VB600B camera, 20x1.25 magnification, and video recordings were taken. The video recordings were evaluated using the BASA-Sperm Aqua module software produced by Merck Biotechnology Ltd., which is also a domestic production model of the Computer-aided Sperm Analysis System (CASA). The following parameters were examined for the kinematics of sperm cells: Sperm cell kinematics such as VSL (linear velocity, $\mu\text{m/s}$), VCL (curvilinear velocity, $\mu\text{m/s}$), VAP (angular path velocity, $\mu\text{m/s}$), LIN (Linearity values, ratio of net distance moved to total path distance, %), ALH (amplitude of lateral displacement of sperm cell head, μm) and MAD (Mean Angular Displacement, °) (Özgür et al., 2019).

Statistical Analysis

Multiple comparisons between groups of glyphosate-exposed sperm samples were performed using one-way ANOVA-Duncan test after a variance homogeneity test in each group. Normality test and descriptive analysis (Means \pm SE, $p < 0.05$) were performed on the data.

Statistics were performed using the SPSS 15 program. Graphs were created using GraphPad Prism 5.

RESULTS AND DISCUSSION

The cytotoxicity of glyphosate at different rates on sperm cells was investigated in this study. The lower and upper limit means of the kinematic parameters of sperm cells exposed to different doses of glyphosate at the $p < 0.05$ level and within the 95% confidence interval are given in Table 1. According to the data obtained at the end of the study, it was observed that the motility parameters of sperm cells, VSL (Straight Linear Velocity), VCL (Curvilinear Velocity) and VAP (Angular Path Velocity), decreased statistically significantly ($p < 0.05$) compared to the control group after glyphosate exposure. This effect began to be evident, especially in the motility speeds of sperm cells, after the 5 mg/L dose. In addition, the lowest values of these speeds were determined at the 25 mg/L glyphosate dose. Although fluctuations were observed in the LIN (Linearity Values) and ALH (amplitude of lateral displacement of the sperm cell head) values, statistically significant ($p < 0.05$) differences were observed when compared to the control group. The MAD value decreased with increasing doses of glyphosate, but statistically insignificant ($p > 0.05$) changes were observed compared to the control group (Table 1, Figure 1).

Table 1. Averages of Sperm Cell Kinematics of *Capoeta trutta* Exposed to Different Doses of Glyphosate, within 95% Confidence Interval and at $p < 0.05$ Level.

Sperm cell kinematics	Glyphosate Doses (mg/L)	Mean±Std. Error*	95% Confidence Interval for the Mean	
			Lower Limit Value	Upper Limit Value
VSL (µm/s)	Control	68.79±5.70 ^a	54.13	83.45
	1	63.28±1.49 ^{ab}	59.45	67.11
	5	57.19±1.52 ^b	53.29	61.09
	10	30.48±2.10 ^c	25.10	35.87
	25	22.88±0.76 ^c	20.92	24.84
VCL (µm/s)	Control	136.82±3.63 ^a	127.49	146.15
	1	130.53±4.87 ^{ab}	118.00	143.06
	5	119.70±3.45 ^b	110.83	128.57
	10	90.69±5.26 ^c	77.17	104.21
	25	79.91±6.71 ^c	62.65	97.16
VAP (µm/s)	Control	71.55±4.19 ^a	60.78	82.33
	1	71.43±4.64 ^a	59.49	83.37
	5	58.31±2.89 ^b	50.87	65.74
	10	26.09±1.64 ^c	21.86	30.32
	25	20.09±2.92 ^c	12.59	27.59

LIN (%)	Control	33.46±1.19 ^a	30.40	36.51
	1	34.92±1.12 ^{ab}	32.04	37.80
	5	39.45±1.93 ^b	34.49	44.40
	10	20.41±3.10 ^c	12.44	28.37
	25	14.42±0.54 ^d	13.02	15.81
ALH (µm)	Control	40.28±0.89 ^a	38.00	42.56
	1	42.91±3.73 ^a	33.32	52.49
	5	33.91±2.06 ^b	28.63	39.20
	10	7.51±1.49 ^c	3.68	11.34
	25	6.31±0.67 ^c	4.58	8.03
MAD (°)	Control	0.04±0.01	0.03	0.06
	1	0.03±0.01	0.02	0.05
	5	0.03±0.00	0.02	.04
	10	0.03±0.00	0.03	0.04
	25	0.03±0.00	0.02	0.04

Means with different letters represent statistically significant differences at the $p < 0.05$ level. VSL (linear velocity, µm/s), VCL (curvilinear velocity, µm/s), VAP (angular path velocity, µm/s), LIN (Linearity values, ratio of net distance moved to total path distance, %), ALH (amplitude of lateral displacement of sperm cell head, µm) and MAD (Mean Angular Displacement, °).

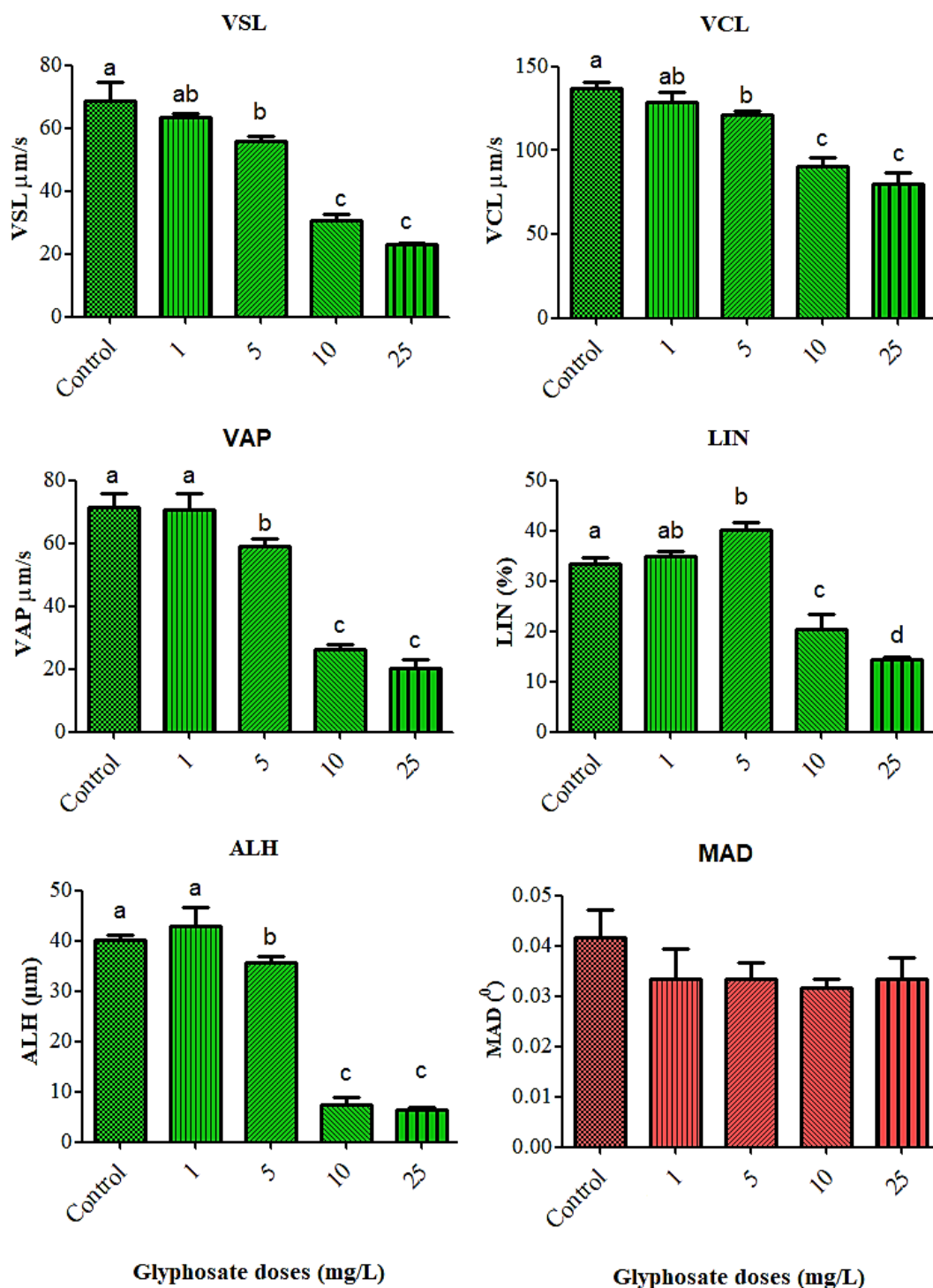


Figure 1. Sperm Cell Kinematics of *Capoeta trutta* Exposed to Different Doses of Glyphosate. Means Shown with Different Letters Represent Statistically Significant Differences at the $p<0.05$ Level. VSL (linear velocity, $\mu\text{m/s}$), VCL (curvilinear velocity, $\mu\text{m/s}$), VAP (angular path velocity, $\mu\text{m/s}$), LIN (Linearity values, ratio of net distance moved to total path distance, %), ALH (amplitude of lateral displacement of sperm cell head, μm) and MAD (Mean Angular Displacement, $^\circ$).

Scientific studies demonstrating potential reproductive health effects caused by glyphosate are very limited, and additional epidemiological studies are needed to better understand these effects. However, there are a few available animal studies demonstrating

harmful reproductive health effects of glyphosate at environmentally relevant doses (Milesi, Lorenz, Durando, Rossetti & Varayoud, 2021), converted into other chemicals (Ledoux et al., 2020). According to the literature presented extensively in the introduction section, it is stated that glyphosate has negative effects on human health, especially on infertility and fertility damage (Samsel & Seneff, 2013; Varde et al., 2023), as well as carcinogenic effects (Flower et al., 2004).

Other hand, the studies in the effects of glyphosate on terrestrial and aquatic animals showed that it caused alarming results in an experiment using cattle embryos and caused embryo death, while it was reported that teratogenic effects (congenital defects in the embryo and fetus) were observed even at very low doses (0.9 mg/L) (Cai et al., 2020). Glyphosate delayed the maturation of frog (*Xenopus laevis*) oocytes (Slaby et al., 2020), and even non-lethal doses of glyphosate caused impairment in the perception of tadpoles (Moore, Chivers & Ferrari, 2015). Glyphosate at doses of 0.005, 0.05, 5, 10 and 50 mg/L impaired locomotor activity in zebrafish (*Danio rerio*) larvae exposed for 96 hours (Fiorino et al., 2018). In an acute toxicity experiment, it was reported that doses of 0.5 mg/L given to the aquatic environment for 24 or 96 hours caused damage to the liver, gills and brain of shoreline fish (*Jenynsia multidentata*) (Albañil Sánchez et al., 2019). It was reported that there was no change in sperm count in male zebrafish exposed to glyphosate at doses of 5 and 10 mg/L, but decreased sperm motility, decreased mitochondrial membrane integrity of sperm cells and DNA damage occurred (Lopes et al., 2014). It was determined that significant adverse effects were observed in carp (*Cyprinus carpio*) during embryonic development and hatching stages (Socha et al., 2021). It was reported that grass carp (*Ctenopharyngodon idella*) eggs (0.1-10 mg/L) and sperm cells (0.1-50 mg/L) were negatively affected (Lugowska, 2018). Akça et al. (2021) studied the toxicity of different glyphosate doses (2.5, 5, 10 mg/L) on trout (*Oncorhynchus mykiss*) sperm. As a result of their studies, they found that glyphosate had a harmful effect on rainbow trout spermatozoa, especially on motility percentage and duration, even at lower doses (Akça et al., 2021). Nile tilapia (*Oreochromis niloticus*) were exposed to 0, 5, 10, 20, 30 and 40 mg/L glyphosate for 14 days, and it was determined that glyphosate at 5 mg/L and above had negative effects on sperm motility parameters of the fish (Acar et al., 2022). Again, it was determined that 1, 5, 10 and 50 mg/L glyphosate in the sperm of the Argentine silverfish (*Odontesthes bonariensis*) species decreased motility at 30 seconds after activation of sperm cells (Menéndez-Helman et al., 2025), while it was reported that glyphosate reduced the motility of human sperm cells, and their quality was negatively affected (Anifandis et al., 2018). The findings of the current study were found to be supported by the results of previous studies

(Acaret et al., 2022; Akça et al. 2021; Albañil Sánchez et al., 2019; Fiorino et al., 2018; Lopes et al., 2014; Menéndez-Helman et al., 2025), and the result that glyphosate had a negative effect on the speed and kinematic characteristics of sperm cells at certain doses was similar. Again, as a result of the study, the data obtained support the suggestion that it will have a negative effect on human reproductive health (Anifandis et al., 2018).

CONCLUSION

Our study, based on the effects of glyphosate on sperm cells of the *Capoeta trutta* from the Karakaya Dam Lake in the Upper Euphrates Basin, creates perspectives on decoration for other fish in the basin. The comparative analysis of glyphosate, a herbicide, on sperm motility is a noteworthy aspect of our study. In general, our results indicate that the presence of glyphosate in water resources in natural habitats negatively affects the reproductive health of fish. However, it is thought that glyphosate exposure and its interaction with the androgen receptor agonist cause estrogenic activity in human cell lines, thus endangering human reproductive health from toxic substances in the environment (Gasnier et al., 2009; Komsky-Elbaz, Saksier & Roth, 2018). Therefore, it is thought that humans may pose a significant risk by using glyphosate-contaminated waters for agricultural purposes and/or for any reason. It was also concluded that the data obtained as a result of the study have the potential to contribute to public health.

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KNOWLEDGE LEVELS AND ATTITUDES OF STUDENTS OF ORDU UNIVERSITY FACULTY OF DENTISTRY TOWARDS THE USE OF SAFE CUTTING AND SHARP INSTRUMENTS

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injuries

ABSTRACT

Sharps injuries are among the leading occupational accidents and risks to which healthcare workers are exposed. Our study aimed to evaluate the level of awareness and approaches of Ordu University Faculty of Dentistry students about the safe use of sharps during their education and throughout their professional lives. The study included 189 students who voluntarily agreed to participate in the study among the 4th and 5th grade students studying at Ordu University Faculty of Dentistry. Demographic information and multiple-choice questionnaire questions were asked to measure the level of knowledge and attitudes of the students toward the safe use of materials. All data of 189 students [147 female (75%) and 42 male (25%)] were included in the study. It was determined that the most common cause of injury was 'glass in the hand as a result of a broken light bulb'. The most common intervention was 'cleaning with antiseptic' with 52%. Dental students are at serious risk of sharps injuries during their clinical practice training. To minimize these risks, faculties should take the necessary precautions by health quality policies.

INTRODUCTION

Sharp objects, defined as any instrument that has the potential to cause penetrating injury in the skin, are the most common cause of infection among healthcare workers (Guilbert, 2002). Healthcare workers are exposed to many different infection factors such as direct contact with blood, bloody bodily fluids, or sharp-penetrating object (SPO) injury. The most common of these factors include the Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Human Immunodeficiency Virus (HIV) (Beltrami, Williams, Shapiro and Chamberland, 2000). It is reported that dentistry infection rates have decreased thanks to vaccinations significantly compared to the past when there were no HBV vaccines and dental applications involved high rates of HBV infections (Ramos-Gomez et. al., 1997).

It is noted that dentists and nurses are more likely to be exposed to sharp-penetrating object injury than other healthcare workers (Bouya et. al., 2020). Dentists, in particular, are one of the occupational groups that are frequently exposed to occupational accidents due to the mobility of patients and working with sharp objects in a setting where the working area is

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confined and visibility is limited (Ramos et al, 1997). Many dentists are exposed to SPO injury at least one time throughout their professional lives (Demirbaş, 2021). Injuries occur mostly while breaking ampoules, handling sharp objects in the team, and closing needle caps (Gerberding et. al., 1990). Also, the students of dentistry are at a high risk of being exposed to SPO injury especially during their clinical practice education mainly due to a lack of medical knowledge, inexperience in practical applications as well as lack of knowledge on personal protective measures (Kumar et. al., 2015).

In our country, SPO injury incidence rates are at high levels, i.e. 50-70%, a significant portion of which have gone unreported (Ayranci & Kosgeroglu, 2004). As such injuries may cause life-threatening conditions as well as pose threats in terms of control of blood-borne diseases such as HIV, HBV, and HCV related to professional exposure undermining both occupational health and safety, it has been made mandatory to report SPO injury incidents (Hanrahan & Hanrahan, 1997).

Dentists and dentistry students are significantly at risk of SPO injury incidents. To minimize these risks, students must receive courses on this subject as part of their curriculum, take personal protective measures, and receive supervision in terms of these measures. These courses should be delivered before clinical education, which must mainly include occupational accident preventive measures, blood-borne infections, correct injury reporting methods, as well as prophylaxis procedures required during post-infection.

The present study aims to reveal the knowledge level and approaches of students at the Faculty of Dentistry, Ordu University, on the safe handling of sharp-penetrating tools they use or will be using during their study and professional life.

MATERIAL AND METHOD

Goal and Type of Research

Our research involves a questionnaire administered to 4th and 5th-year students attending clinical practice at the Faculty of Dentistry of a university.

Universe and Sample of Research

Universe of the Research consists of the students attending clinical practice education in the academic year 2022-2023 in the Faculty of Dentistry of a university (N=189), and no sampling is applied to survey the entire universe.

Data Collection and Analysis

As a data collection tool, a questionnaire created on Google Forms survey tool is used. The first section of the questionnaire asks for demographic data, while the second section contains 18 multiple-choice questions to measure the knowledge level and attitudes of students on the safe handling of SPO. Students are kindly asked to read questions carefully and answer them personally.

Statistical Analysis

We used the IBM SPSS 16.0 (IBM Corp., Armonk, NY, USA) software to conduct statistical analysis of data. While evaluating data, categorical data are presented in numbers and percentages, with numerical data in mean and standard deviation values. Comparisons between groups are made using the Chi-square test. In the analyses, values smaller than $p < 0,05$ are considered statistically significant.

Ethical Considerations in Research

Before starting the research, written permission was obtained from the Clinical Research Ethics Board of Ordu University (Decision No. 125 of 2023). In accordance with the Principles of Helsinki Declaration, each respondent was given an 'Informed voluntary consent form' to prove that they voluntarily participated in the survey. The research was initiated after informing respondents about the study and collecting consent from those who voluntarily wanted to participate in the research.

RESULTS

Entire data collected from a total of 189 respondent students [female 147 (75%) and male 42 (25%)] are included in the study. 142 of the students are in the age range of 18-23 years old [female 106 (81%) and male 73 (19%)]. Of all respondents, 96 students (51.1%) attend their fifth year with 93 students in the fourth year (48.8%).

Of all students, 148 students (77.8%) answered yes when they were asked if they have sustained SPO injury such as needle sticks, or glass shard cuts in the clinical practice settings. Of these students, 73 students accounted for 4th year students while 75 students for 5th year. No statistically significant difference is found between the school years in terms of occurrence of SPO injury ($p < 0.05$). The distribution of the various clinical factors that cause respondents to sustain injury is provided in Figure 1. The most common cause of injury is found to be 'hand cuts by glass shards due to the broken ampoule'.

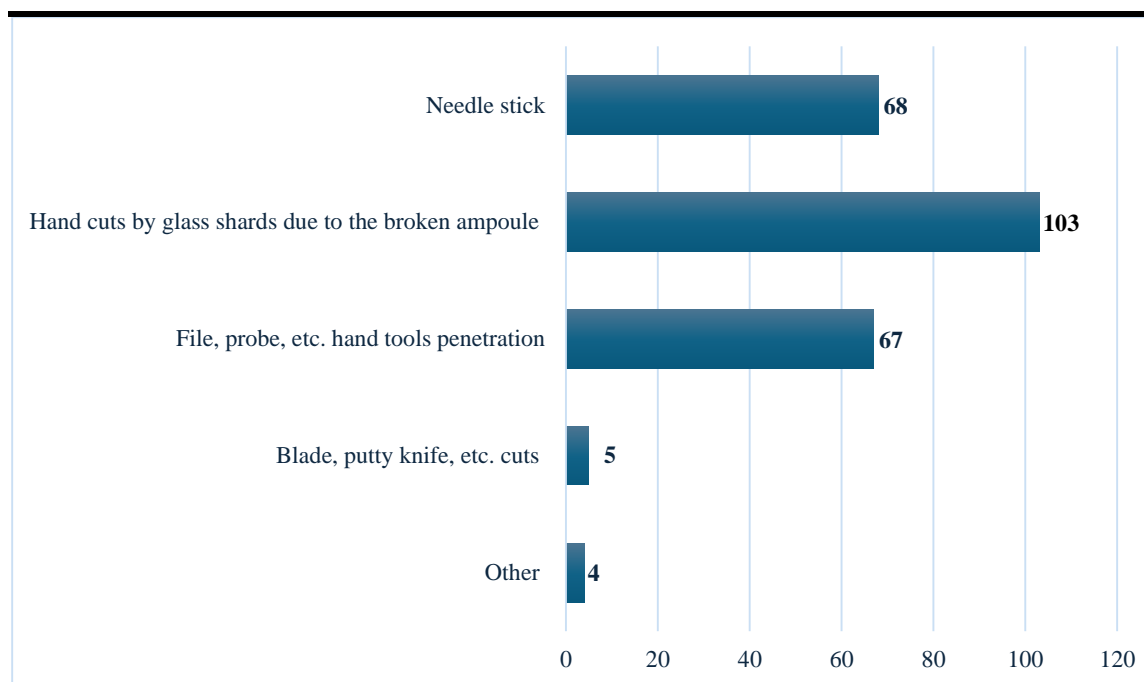


Figure 1. Causes of Injury Sustained by Students Involving Sharp-Penetrating Objects

Figure 2 shows the distribution of answers given by students when asked how you intervened in the injury. With 52%, the most common intervention is observed to be ‘cleansing with antiseptic’.

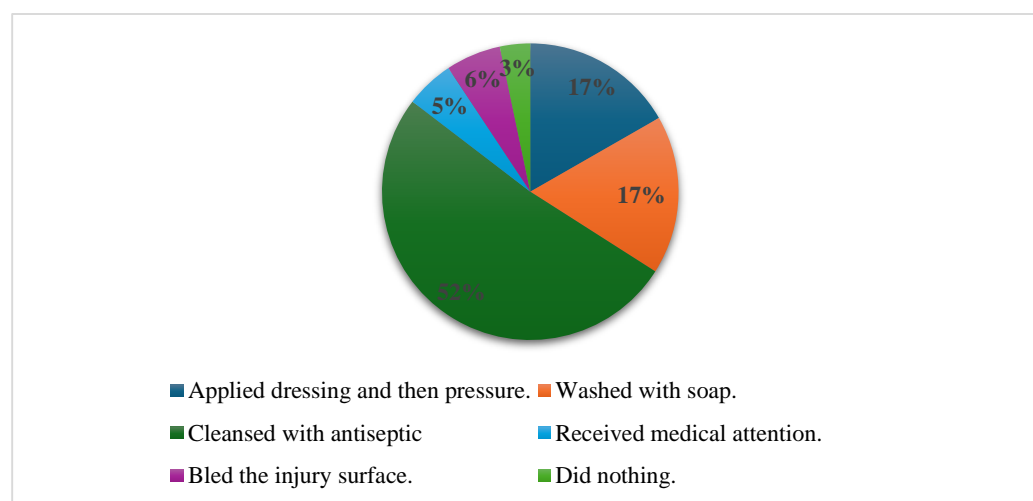


Figure 2. Methods to Intervene in Injury Surface

Respondents are asked if they have reported the injury. Of the respondents, 136 (90.1%) said they did not report injury with 15 (9.9%) said as having reported it. In terms of school year among non-reporting students, fourth-year students account for 92%, with fifth-year students for 88.8%, meaning there is no significant difference between 4th and 5th-year students in terms of non-reporting. ($p < 0.05$) This suggests that there is an important lack of knowledge on reporting injuries in terms of occupational health and safety. Of the reporting students, 13

(86.7%) reported having applied to the quality unit. Figure 3 shows the distribution of causes behind why non-reporting students did so.

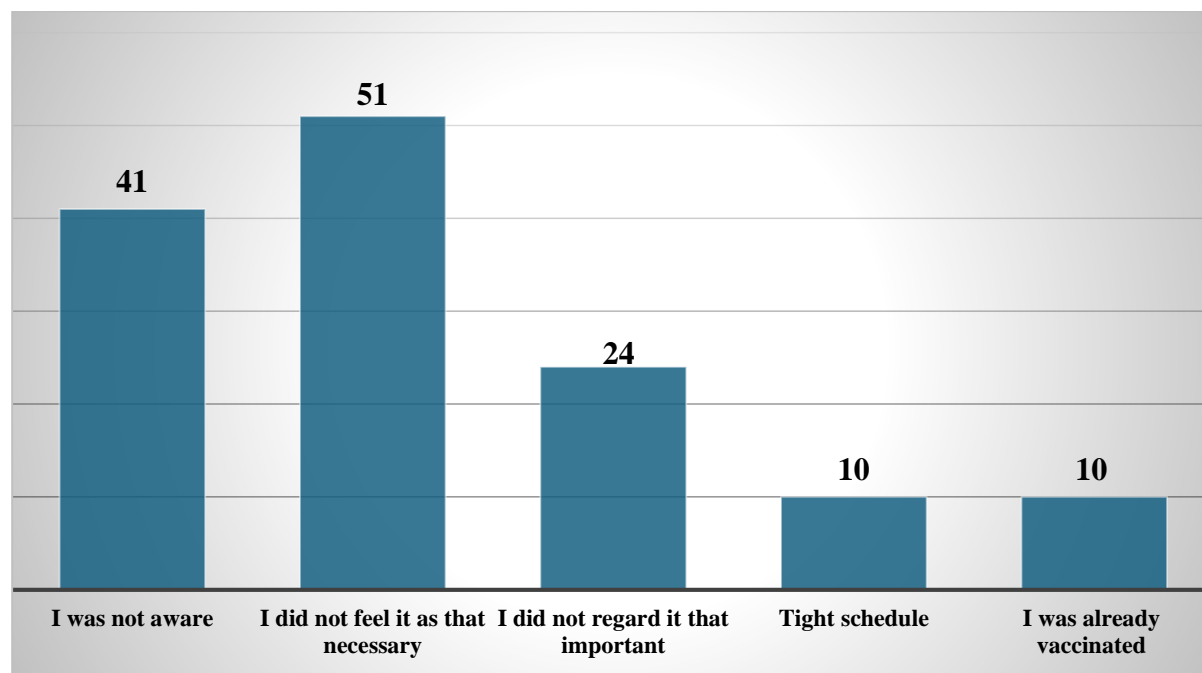


Figure 3. Causes of Non-Reporting

Responding students were asked if they had had any vaccine in the past five years, where 170 of them responded as COVID-19, 170 as Hepatitis B, 113 as tetanus, 63 as Hepatitis A, and 11 as flu vaccine. Students are further asked if they are immune to Hepatitis B, 170 of whom responded yes, 19 as not having had the vaccine, therefore not being immune.

When asked, as per your recall, whether the SPO involved in the most recent incident you have experienced contact with blood and other bodily fluids of patients, 114 students responded No (70.4%), 32 Yes (19.8%), and 16 I do not know (9.9%). The right hand (58.6%) is reported as the most frequently injured body site.

When asked whether they take adequate measures to protect themselves against diseases that are transmissible via SPO injuries, 109 students answered Yes (58.6%) with 77 students as No (41.4%). Finally, 122 students responded No (64.4%), with 67 students Yes (35.6%) to the question as to whether they have ever attended a course on SPO handling and injury.

DISCUSSION

Hospitals are environments where infection agents exist intensively. Healthcare workers, while doing their tasks, are constantly in contact with such agents, which may lead to serious infections. All hospital staff whose duties involve possible contact with blood and bodily fluids are at serious risk of blood-borne diseases. Dentists are a part of the group with a high risk of

exposure to such accidents (Lee et. al., 2014). Students of Dentistry use and handle SPOs frequently during clinical and preclinical studies. Due to the underdeveloped manual dexterity, inadequate practice, lack of knowledge, high anxiety levels, and low-risk perceptions, these students are included in the high-risk group in terms of pathogens that are transmissible via the blood or bodily fluids of patients. As healthcare workers are in direct contact with the blood of patients, they are at constant risk of contracting blood-borne viral infections especially such as HBV, HCV, and HIV (Pavithran, 2015).

A Brazilian study involving dentistry students found 43.1% of respondents were exposed to SPO injuries (Fernandes et. al., 2017). A Taiwanese study reported this rate as 21.28% for dentistry students, 7.50% for assistants, and 6.77% for nursing staff. Studies demonstrated that there is an inverse correlation between the experience-knowledge level and injury incidents (Lee et. al., 2014). The present study planned to measure the knowledge level of dentistry students on SPO handling and found that 77.8% of the respondents were exposed to SPO injury.

As studies on sharp-penetrating object injuries can only reply to the reported incidents, it is estimated that the actual incidence of SPO injuries is much higher than those reported. A study on needle stick injuries at Hamory, a university hospital, notes that 75% of the SPO injuries have gone unreported. It is observed that a questionnaire-based study involving dentistry students revealed that 77% of SPO injuries have gone unreported (Li, Lin and Chang, 2023). Like these studies, our present study also found that 90.1% of the students have not reported SPO injuries.

Studies on SPO injuries among healthcare workers other than dentistry professionals determined that disposable needles account for the common cause of the injuries. Our present study found that two important factors leading to injuries include a sterile glass shard pricking into the hand due to a broken ampoule at 68.7%, followed by an injector needle stick at 45.3%. In dentistry, multiple injections are applied to the patient throughout their treatments. This makes dentists vulnerable to the risk of needle stick injuries. Local anesthesia and re-capping of injectors are two important factors that cause SPO injuries among dentists (Shah, Merchant, and Dosman, 2006). Guidelines of the World Health Organization (WHO) recommend that the injury site should be left bleeding for a short period, and then must carefully be washed under running water and using an antiseptic solution (Toraman et. al. 2011). In our study, when asked how you intervened in the injury, if any, students responded by cleansing it with antiseptic (51.3%), and washing it with soap (17.3%), respectively.

Healthcare workers are working in a setting where they are constantly exposed to pathogens with the potential to cause infections such as HIV, Hepatitis B, and Hepatitis C due

to the need for sticks, SPO injuries, or, saliva and blood spatters. Among these pathogens, Hepatitis B is one of the most contagious ones. However, Hepatitis B vaccination reduces this risk by 90-95%. Therefore, it is vitally important for healthcare workers to receive vaccines regularly and follow the safety measures carefully. Using personal protective equipment and adopting safe applications is also equally important to reduce the risk of other infections. A Brazilian study involving dentistry students indicates that 83.3% of the respondents reported having received Hepatitis B without exception (de Souza et.al., 2006). A Canadian university found a vaccination rate of 95% among dentistry, medicine, and nursing school students. It is observed that there is a direct correlation between the education level and the importance placed on vaccination (McCarty & Britton, 2000). Likewise in our study, 89.9% of the respondents (N=170) reported to have received Hepatitis B vaccination. However, this rate is not sufficiently high for a professional group that inherently bears a high risk of infectious diseases. To increase the vaccination rates, student training, and guidance must be fostered and implemented.

A study involving UK medicine school students reported that only 14% of the respondents were able to define an SPO injury correctly. Said study concluded that students must importantly be fostered in terms of their theoretical knowledge and practical skills on needle sticks and SPO injuries (Elliott, Keeton, and Holt, 2005). A study demonstrated that training effectively reduced SPO injuries among healthcare workers (Wang et. al., 2014). In our study, dentistry students are asked if they have attended a course on SPO handling and injury, and 64.4% of them reported they have never received such training. When asked if they wanted to receive training on the subject, 89% of them responded positively. To protect both doctors and patients against infectious diseases, the curriculum of the dentistry school must be reinforced, starting with first years, with courses on handling and protection of sharp-penetrating objects, as well as post-accident reporting, which must be refreshed regularly.

The present study is subject to certain limitations. First, the present study is single-center. Second, respondents included 4th and 5th year students in the academic year 2022-2023. Results may vary when including students from different faculties or different schools of the same faculty. Third, the study involved students only. Results most likely vary if the target group is extended to include other professional groups (teaching assistants, nurses, technicians, or instructors). Lastly, the effectiveness of the training given in the study is not repeated within a different period. Further studies should be conducted with the same target group or by also including different target groups where pre-training knowledge level and attitudes of respondents on SPO injury are compared and analyzed with that of post-training.

CONCLUSION

It is found out within the limitations of this study that 77.8% of the respondent dentistry students sustained SPO injuries in the past, which were mainly caused by glass shard pricking into hand due to broken sterile ampoule, or injector needle stick, and 90% of injury incidents were not reported.

Dentistry students are at severe risk of SPO injury, especially during their clinical practice education. To minimize these risks, it is imperative for faculties to take necessary measures as required by their health quality policies. To help students protect themselves against SPO injuries, they must be provided with relevant courses regularly, which must mainly include topics such as protective measures against injuries, post-injury interventions, treatment processes, and the importance of reporting. The awareness among students on infectious diseases and the importance of vaccination must be raised, they must also be provided with guidance to encourage them to receive required vaccinations.

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