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Investigation of factors associated with the level of temporomandibular dysfunction in university students

Üniversite öğrencilerinde temporomandibular disfonksiyon düzeyi ile ilişkili faktörlerin incelenmesi

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ABSTRACT

Aim: Temporomandibular disorders (TMD) and factors associated with them are frequently observed in university students. The aim of this study was to investigate the relationship between different severities of TMD and deep neck flexor muscle endurance, craniovertebral angle, upper neck mobility, and stress levels in university students.

Material and Methods: Our cross-sectional study included 228 students from the Department of Physiotherapy and Rehabilitation at Ankara Medipol University. TMD severity was assessed using the Fonseca Anamnestic Index (FAI), deep neck flexor muscle endurance using the Craniocervical flexion test (CCFT), head-forward posture using the craniovertebral angle (CVA), upper neck mobility using the cervical flexion-rotation test (CFRT), and stress levels using the Perceived Stress Scale (PSS).

Results: Moderate negative correlations were found between FAI and CVA (r=-0.495, p<0.001), CFRT-right (r=-0.486, p<0.001), and CFRT-left (r=-0.443, p<0.001). Weak negative correlations were observed between FAI and both the deep neck flexor activation score (r=-0.352, p<0.001) and performance index score (r=-0.323, p<0.001). In addition, a weak positive correlation was found between FAI and PSS (r=0.327, p<0.001). Significant differences were observed in all measurements across the four TMD severity groups (p<0.05).

Conclusion: TMD in university students is associated with craniovertebral angle, deep neck flexor muscle endurance, upper neck mobility, and stress levels. As TMD severity increases, all these parameters are negatively affected. This study highlights the importance of evaluating TMD and related symptoms in university students.

Keywords: Posture, stress, students, temporomandibular joint disorders

ÖZ

Amaç: Üniversite öğrencilerinde temporomandibular bozukluklar (TMB) ve bu bozukluklarla ilişkili faktörler sıklıkla gözlemlenmektedir. Bu çalışmanın amacı, üniversite öğrencilerinde farklı temporomandibular bozukluk şiddetleri ile derin boyun fleksör kas dayanıklılığı, kraniovertebral açı, üst boyun mobilitesi ve stres düzeyleri arasındaki ilişkiyi incelemektir.

Gereç ve Yöntemler: Kesitsel bir çalışma olarak planlanan araştırmamıza, Ankara Medipol Üniversitesi Fizyoterapi ve Rehabilitasyon bölümünden çalışmaya 228 öğrenci dahil edildi. Bireylerin TMB şiddeti Fonseca Anamnestik İndeksi (FAİ) ile, derin boyun fleksör kas enduransı Kranioservikal fleksiyon testi (KSFT) ile, baş önde postür kraniovertebral açı (KVA) ile, üst boyun mobilitesi servikal fleksiyon-rotasyon testi (SFRT) ile, stres düzeyleri ise Algılanan Stres Ölçeği (ASÖ) kullanılarak değerlendirildi.

Bulgular: FAİ ile KVA (r=-0.495, p<0.001), SFRT-sağ (r=-0.486, p<0.001) ve SFRT-sol (r=-0.443, p<0.001) arasında orta düzeyde negatif anlamlı bir korelasyon bulundu. Derin boyun fleksörleri-aktivasyon skoru (r=-0.352, p<0.001) ve derin boyun fleksörleri-performans indeks skoru (r=-0.323, p<0.001) ile FAİ arasında zayıf düzeyde negatif anlamlı bir korelasyon belirlendi. Ayrıca, FAİ ile ASÖ arasında zayıf düzeyde pozitif anlamlı bir korelasyon saptandı (r=0.327, p<0.001). TMB şiddeti farklı olan dört grup arasında tüm ölçüm sonuçlarında anlamlı fark bulundu (p<0.05).

Sonuç: Üniversite öğrencilerinde temporomandibular bozukluklar, kraniovertebral açı, derin boyun fleksör kas dayanıklılığı, üst servikal mobilite ve stres düzeyleri ile ilişkilidir. Bozukluk şiddeti arttıkça tüm bu parametreler olumsuz yönde etkilenmektedir. Bu çalışma, üniversite öğrencilerinde TMB ve ilişkili semptomların değerlendirilmesinin önemini vurgulamaktadır.

Anahtar Kelimeler: Öğrenciler, postür, stres, temporomandibular eklem bozuklukları

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Highlights

- Temporomandibular disorder (TMD) was prevalent among university students, with more than half demonstrating mild to severe symptoms.
- TMD severity showed moderate negative correlations with craniovertebral angle and upper cervical mobility.
- Deep neck flexor muscle endurance decreased as TMD severity increased.
- Perceived stress levels were positively associated with TMD severity.
- Cervical posture and mobility exhibited large effect sizes across TMD severity groups, indicating clinical relevance.

INTRODUCTION

The term "temporomandibular disorders" (TMD) refers to conditions affecting the muscles and joints responsible for the movement of the temporomandibular joint and its structures. The etiology of TMD is multifactorial. Individuals with TMD may be asymptomatic or may present with symptoms such as pain, limited movement, and joint sounds (1). Previous studies have revealed that 85% to 95% of individuals experience at least one TMD symptom during their lifetime, with peak incidence occurring between 20 and 40 years of age (2). Furthermore, epidemiological studies have shown that TMD prevalence among students ranges from 50% to 77%, while in Turkish student populations this rate varies between 47% and 81% (3). These findings underscore the importance of investigating TMD-related factors in young adult populations, particularly in academic settings.

Cervical spine problems and postural disorders may also be associated with TMD symptoms due to altered head posture influencing mandibular position and masticatory muscle activity. The craniocervical and craniomandibular systems interact anatomically, as the mandibular muscles connect the hyoid, cranial, and cervical vertebrae, suggesting a direct relationship between the temporomandibular joint (TMJ) and the cervical spine (4).

Considering the biomechanical link, extension movement is seen in the craniocervical junction during standard mouth opening, and limitations in the upper cervical spine may reduce mouth opening capacity. Reduced mouth opening capacity or pain at maximum mouth opening may cause different craniocervical postures (5). Studies have shown that individuals with TMD have lower upper cervical mobility values than those without TMD (6,7). Cranio-cervical flexion (CCF) is provided by the deep cervical flexor (DCF) muscles at the atlanto-occipital joint and upper cervical segments C1-2. These are the main postural muscles in the anterior neck that support cervical lordosis. Studies have shown that deep cervical flexor strength and endurance are reduced, superficial muscle activity is increased, and mandibular functions are negatively affected in individuals with TMD (8).

There has been much research on the link between forward head posture (FHP) and TMD, including a case–control study of individuals with myogenic TMD (2), a study investigating cranio-cervico-mandibular function and postural stability in patients with TMD (8), and a cross-sectional study assessing masticatory muscle pressure pain thresholds in patients with TMD (9). FHP is characterized by a head deviating forward in the sagittal plane due to increased extension in the upper cervical spine and increased flexion in the lower cervical spine. When assessed by craniovertebral angle (CVA), individuals with TMD have significantly higher FHP than those without TMD (8).

In most individuals with TMD, psychological factors are highly influential in the onset and progression of the dysfunction (10). Individuals with TMD report exposure to stressful life situations before developing their symptoms. Evidence suggests that stress leads to increased muscle activity, which causes pain in areas close to the TMJ. Such pain and dysfunction may negatively affect mastication, speech, and cervical function, and can also impair academic and professional performance, ultimately reducing social participation and quality of life (10,11).

University students, due to long-term poor posture related to excessive computer and smartphone use, are considered a significant risk group (12). The progression of TMD symptoms in this population can negatively affect both academic performance and quality of life. Therefore, early identification of individuals with TMD and determination of risk factors are important for preventing progression and protecting public health.

The aim of this study was to investigate the relationship between different severities of temporomandibular disorders (TMD) and deep neck flexor muscle endurance, craniovertebral angle, upper neck mobility, and stress levels in university students.

MATERIAL and METHODS

Study Design and Participants

Using the Pearson correlation coefficient r=0.30 with 80% power (alpha=0.05, two-way) in the G*power program, the power analysis for the study's sample size showed that 200 participants were needed to perform the correlation analysis. Our study, which was designed to be cross-sectional, involved 234 students aged 18 to 22 who were enrolled in Ankara Medipol University's Department of Physiotherapy and Rehabilitation from 2024–2025. Six students who did not want to make the evaluations left the study, and the study was completed with 228 participants. Individuals with neurological or chronic systemic diseases, individuals with psychiatric disorders, individuals with a history of trauma in the last six months, individuals with chronic pain syndromes such as trigeminal neuralgia, individuals with rheumatic or orthopedic problems that may affect TMJ, individuals who have undergone musculoskeletal surgery, individuals with diagnosed TMD, and individuals who have received any dental treatment in the last six months were not included in the study. Before starting the study, Ankara Medipol University Non-Interventional Clinical Research Ethics Committee approval was obtained (Date: 25/12/2024 Decision No: 170). Before the study, each participant received information about it and signed the "Informed Consent Form." Our study followed the principles of the Helsinki Declaration.

Measuring Methods

The individuals' demographic information was obtained. The questionnaires assessed TMD and stress levels, while the upper neck mobility, craniovertebral angle, and deep neck flexor muscle endurance were assessed using objective measurement methods. All measurements were made outside the exam period.

Ten questions from the Fonseca Anamnestic Index (FAI) were utilized in this investigation to categorize the presence and severity of TMD (13). Joints, head and neck pain, pain when chewing, parafunctional behaviors, reduced joint mobility, occlusal disorders, and mental stress are all covered in the questionnaire. Each question has three possible answers: "Yes: 10 points", "no: 0 points", and "Sometimes: 5 points". The questionnaire's results are classified into four categories based on the participants' answers: mild TMD (20–40), moderate TMD (45–65), severe TMD (70–100), and no TMD (0–15). According to Kaynak et al. (14), whose Turkish validity and reliability assessment was carried out, the questionnaire's Cronbach's alpha value was 0.80. Our study had a Cronbach's alpha of 0.79.

The endurance of the DNF muscles was assessed using the Cranio Cervical Flexion Test (CCFT) (15). An uninflated Pressure Biofeedback Unit (Chattanooga Stabilizer, USA) was positioned between the earlobe and the chin prominence, with the subject in the chin position and the neck in a neutral posture. It was then inflated to an initial pressure of 20 mmHg. Individuals were first instructed to place their tongues on the roof of their mouths, with their lips close together and their teeth touching, thus minimizing muscle activity in the jaw area. A practice session was then conducted to reduce the possibility of not understanding and performing the test as recommended (16). While the examiner gave visual feedback, the subject was asked to perform a slow and smooth craniocervical flexion without lifting the head and to nod as if to indicate "yes." In incremental increments of 2 mmHg, the DNFs' activation and performance index scores were measured between 20 and 30 mmHg. The pressure level that could be maintained for ten repeats of ten seconds each was used to calculate the activation score. The performance index score was computed based on how many repetitions the person could keep the position for 10 seconds at the pressure level. For example, if the individual could reach the second pressure level (24 mmHg) and correctly hold the craniocervical flexion for 10 seconds five times, the performance index is $4 \times 5 = 20$. The highest activation score is 10 mmHg, and the highest performance index score is 100.

FHP was evaluated using the CVA measurement (17). Markers were placed on the ear tragus, and the spinous process of the seventh cervical vertebra (C7) was used to employ lateral photography for measuring. The participant was 200 cm away from the digital camera positioned at acromion level to record CVA. The tripod held the camera in place. This technique shows high reliability (ICC = 0.94). Participants were asked to maintain a comfortable posture by sharing their weight symmetrically on both lower extremities with their feet shoulder-width apart. Before taking the photograph, each participant was asked to flex and extend their neck three times. Participants were then instructed to look straight ahead in their natural posture. An angle was measured between a line that extended from the ear tragus to the C7 vertebra and a horizontal line that went through the C7 spinous process. As a result of the measurement, the photographs were analyzed with the Image-J program (18). The smaller the CVA, the more forward the head posture. The average value of the three measurements was recorded as CVA.

Upper neck mobility was assessed with the Cervical flexion-rotation test (CFRT) (19). The participant's comfort was a priority throughout the assessment. The cervical range of motion device was securely attached to the head of the participant while lying on his back, and the examiner brought him to the limit of cervical flexion. In this flexion position, the head and neck were passively rotated within pain and physiological limits. Measurements were made without encountering resistance or pain. The interval was recorded. The average of three range of motion measurements on both sides was calculated, with a 30-second rest between each repetition, and this represented the final values for the left and right ranges of motion.

The students' stress levels were assessed using the 14-item Perceived Stress Scale (PSS) designed by Cohen et al. (20). The scale includes positive and negative questions about stress. It is a self-report scale designed to assess the perception of the degree to which a given situation is considered stressful. Each item is scored between 0 and 4; a total PSS score of 0 to 56 is obtained by summing all items. The higher the score, the greater the perceived stress. According to validity and reliability research by Eskin et al. (21), the Turkish version had a Cronbach's alpha value with subscales ranging from 0.66 to 0.88. The Cronbach's alpha value in this investigation was 0.75.

Statistical Analysis

The statistical analyses of the study were performed using the 'Statistical Package for Social Sciences ' (SPSS) version 21.0 (SPSS Inc. Chicago, IL, USA). To assess the normal distribution of variables, visual methods (histograms, probability plots), skewness and kurtosis values, and analytical tests were considered. Given the sample size, the Kolmogorov–Smirnov test was primarily used, while the Shapiro–Wilk test was reported only for comparative purposes. The results were consistent across all approaches. Categorical variables were expressed as percentage (%) and number of people (n), while mean and standard deviation (SD) values for continuous variables were also defined. A one-way ANOVA test was used to compare the evaluation parameters between groups. Effect sizes for the one-way ANOVA were calculated using partial eta squared (ηp^2) and interpreted as small (0.01), medium (0.06), and large (0.14), according to conventional thresholds. Pearson correlation analysis was used to determine the relationship between evaluation parameters. The statistical significance level was consistently set at $p < 0.05$ in all tests.

RESULTS

The demographic characteristics of the 228 university students who participated in the study are shown in Table 1. The university students' mean CVA was 44.93±6.60. In CCFT, mean DNF- activation scores were 5.82±2.03, while mean DNF- performance index scores were 64.54±26.94. The mean angles of the CFRT measurements were 41.83±11.97 on the right side and 40.07±10.85 on the left side. The mean scores of PSS were 29.38±8.71 (Table 2).

Table 3 shows the severity levels of Temporomandibular disorders in the participants. In our study, moderate negative correlations were observed between FAI and CVA (r=-0.495) (p<0.05), CFRT-R (r=-0.486) (p<0.05), and CFRT-L (r=-0.443) (p<0.05). Weak negative correlations were found between FAI and DNF-Activation score (r=-0.352) (p<0.05) and DNF-performance index score (r=-0.323) (p<0.05). A weak correlation was observed between FAI and PSS (r=0.327) (p<0.05, Table 4).

Table 1: Demographic characteristics of participants

		Participants (n=228)	
		$\bar{X}$±s	
Age (years)		19.32±2.41	
BMI (kg/m^2)		22.21±3.42	
		n	%
Gender	Female	149	65.35
	Male	79	34.65

x̄±s: mean±SD, **m:** meter, **kg:** kilogram, **BMI:** body mass index, **n:** sample size.

Table 2: Participants' Fonseca anamnestic index, Craniovertebral angle, Cranio-cervical flexion test, Cervical flexion-rotation test and stress measurement results

	Participants (n=228)
	$\bar{X}$±s
FAI score (0-100)	25.74±22.04
CVA (°)	44.93±6.60
CCFT	
DNF- Activation score	5.82±2.03
DNF- Performance index score	64.54±26.94
CFRT	
Right (°)	41.83±11.97
Left (°)	40.07±10.85
PSS score	29.38±8.71

x̄±s: mean±SD, **FAI:** fonseca anamnestic index, **CVA:** craniovertebral angle, **CCFT:** cranio-cervical flexion test, **DNF:** deep neck flexor, **CFRT:** cervical flexion-rotation test, **(o):** angle, **PSS:** perceived stress scale, **n:** sample size.

Table 3: Temporamandibular disorders severity levels of participants

	Participants (n=228)	
	n	%
FAI Score (0-100)		
No TMD (0–15)	108	47.37
Mild TMD (20–40)	76	33.33
Moderate TMD (45–65)	32	14.03
Severe TMD (70–100)	12	5.27

FAI: fonseca anamnestic index, **TMD:** temporamandibular disorders, **n:** sample size.

In Table 5, significant differences were observed among the four groups according to TMD severity levels. Effect size analysis (ηp²) indicated large effects for craniovertebral angle and cervical flexion–rotation test measurements, and moderate effects for deep neck flexor endurance and perceived stress.

DISCUSSION

This study showed that TMD is prevalent among university students. Its severity correlates with craniovertebral angle, DNF endurance, upper neck mobility, and stress levels.

Our study determined that the average FAI score of university students was 25.74±22.04, and only 47.37% did not have TMD. Studies in the literature show that the frequency of TMD is high in university students (11,22,23). Studies like ours have indicated that students' TMD severity levels are mostly mild. In addition, our study's 5.27% severe TMD level shows the importance of differential diagnosis in this population. University years are when various health problems occur, and unfortunately, people usually do not care too much. Since TMD etiology is very complex, it is confused with many health problems and, unfortunately, is mainly ignored by students' self-medication (24). Therefore, differential diagnoses, especially in this population, can reduce the progression of TMD and prevent different problems.

We found the mean CVA to be 44.93±6.60. In addition, a moderate negative correlation was found between FAI and CVA (r=-0.495, p<0.05), indicating that CVA decreased as TMD severity increased. Studies similar to ours in the literature show that CVA, used in evaluating head forward posture, is associated with TMD (9,25). One study stated that forward head posture is typical in individuals with TMD, but this forward head posture is not associated with TMD symptoms in the absence of pain (9). In another study, it was stated that the position of the head posture affects TMD (25). Our study observed a relationship between CVA, which determines the forward head posture, and TMD. The muscles in the craniomandibular and craniocervical regions should work in harmony, but there may be imbalances of strength and tension between these muscles in forward head postures. This situation may even affect the position of the mandible (26). Considering the ergonomic problems and hormonal irregularities that are particularly common among university students (27), the likelihood of developing forward head posture may increase. The moderate strength of the correlation, together with the observed group differences, suggests that cervical posture may be clinically relevant in individuals with higher TMD severity.

The correlation between the increase in TMD severity level and CVA supports our results. Although studies indicate that DNF and upper cervical mobility are affected in individuals

Table 4: Relationship between participants' Fonseca anamnestic index scores and Craniovertebral angle, Cranio-cervical flexion test, Cervical flexion-rotation test and stress level measurement scores

	Participants (n=228)
	Fonseca Anamnestic Index Score (0-100)
CVA	r= -0.495 p< 0.001*
DNF-Activation score	r= -0.352 p< 0.001*
DNF-Performance index score	r= -0.323 p< 0.001*
CFRT-R	r= -0.486 p< 0.001*
CFRT-L	r= -0.443 p< 0.001*
PSS score	r= 0.327 p< 0.001*

Pearson correlation analysis, **r:** correlation coefficient, **CVA:** craniovertebral angle, **DNF:** deep neck flexors, **CFRT:** cervical flexion-rotation test, **R:** right, **L:** left, **PSS:** perceived stress scale, **n:** sample size.

Table 5: Comparison of participants' Craniovertebral angle, Cranio-cervical flexion test, Cervical flexion-rotation test and stress level measurements according to temporomandibular severity levels

	TMD Severity Levels					
	No TMD	Mild TMD	Moderate TMD	Severe TMD	p	ηp²
CVA	49.29±4.65	43.39±4.44	39.28±5.79	30.95±2.28	0.001*	0.347
DNF-activation score	6.33±1.92	5.61±1.03	5.12±1.82	4.53±1.18	0.039*	0.102
DNF-performance score	74.64±21.26	57.94±28.64	53.40±29.36	46.00±35.55	0.003*	0.130
CFRT-R	45.99±7.99	41.98±13.74	33.25±10.16	26.10±3.49	0.001*	0.228
CFRT-L	45.18±7.52	37.42±11.75	33.42±9.31	26.99±4.82	0.001*	0.260
PSS	27.40±7.87	28.85±8.30	34.64±6.67	37.15±8.06	0.014*	0.129

A one-way ANOVA, **TMD:** temporomandibular disorders, **CVA:** craniovertebral angle, **DNF:** deep neck flexors, **CFRT:** cervical flexion-rotation test, **R:** right, **L:** left, **PSS:** perceived with TMD (9,10), no study has evaluated their relationships with different TMD levels. As a result of our study, the mean DNF-Activation score was 5.82±2.03, while the DNF-Performance index score was 64.54±26.94. In addition, in the CFRT angle evaluating upper cervical mobility, the right side average was 41.83±11.97, and the left side average was 40.07±10.85. Weak negative correlations were found between FAI and DNF-Activation (r=-0.352, $p<0.05$) and DNF-Performance Index (r=-0.323, $p<0.05$), while moderate negative correlations were observed between FAI and CFRT angles (r=-0.486 right; r=-0.443 left; $p<0.05$). In line with our study, it has been shown in the literature that individuals with TMD have lower CCFT scores, which provide DNF measurement, and lower CFRT angles than healthy populations (4-7). Considering the anatomical position and functional duties of the longus capitis and longus colli muscles, which are responsible for DNF, and their proximity to the C1-2 region, where upper cervical region mobility is provided, it is typical for both DNF and upper cervical mobility to be affected by postural changes, especially head posture (28). In particular, due to imbalances caused by postural changes, the superficial muscles are more activated, which can negatively affect the activities of deep muscles (26). Our study found that head-forward posture was more common in university students with TMD. It is usual for the deep muscles to weaken with this posture (26). In addition, the primary function of the DNF muscles is to provide neck stabilization (29). The observed weak correlations with DNF measures and moderate correlations with upper cervical mobility suggest that postural imbalances may progressively affect both stabilization and mobility in this region.

Studies have shown a relationship between TMD and stress levels in university students (30,31). In our study, in line with the literature, a weak positive correlation was observed between FAI and PSS scores (r=0.327, $p<0.05$), indicating that stress levels increased with the progression of TMD severity. The academic stress experienced by university students and the stress levels created in their bodies by their irregular lives may create a vicious cycle for TMD (11). In addition, emotional stress in students may have caused muscle hyperactivity and may have prepared the ground for the formation of TMD. Studies have indicated that psychological factors are effective in the onset and progression of dysfunction in most individuals with TMD (31,32). Recent systematic reviews have further highlighted that stress, anxiety, and depression are closely associated with TMD and headache disorders across different age groups (32) and that depression is significantly linked with TMD in adults (33). Moreover, clinical studies suggest that TMD management approaches such as dry needling and face yoga may also improve psychosocial outcomes, including depression and sleep quality (34). Our findings, consistent with these reports, suggest that psychological stress plays a contributory but relatively weak role in the progression of TMD among university students, potentially influencing their academic performance and psychosocial well-being.

This study has some limitations. First, its cross-sectional design precludes causal inferences, and future longitudinal research is needed to clarify temporal relationships. Second, lifestyle factors such as smoking, bruxism, and sleep quality (34), as well as gender-related differences, were not assessed in detail, which may have influenced the outcomes. Third, the single-center sample consisting only of physiotherapy and rehabilitation students may limit the generalizability of the findings. Despite these limitations, this study provides novel insights by examining TMD severity in relation to cervical posture, muscle endurance, mobility, and stress in a relatively large university population.

Conclusion

Our study emphasizes the importance of identifying TMD and its associated factors in university students. If this disorder is not addressed, it can lead to increased problems later in life. Therefore, when symptoms that may be related are observed, it is crucial to evaluate TMD and take appropriate actions. Future studies could explore the effects of different types of exercise on TMD and associated factors in university students.

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Author Contributions

Study conception and design: **Merve Bulguroğlu, Halil İbrahim Bulguroğlu;** data collection: **Merve Bulguroğlu, Selcan Suiçmez, Serenay Zorlu, Cansu Gevrek Aslan, Gökçe Kılıç;** analysis and interpretation of results: **Cansu Gevrek Aslan, Halil İbrahim Bulguroğlu;** draft manuscript preparation: **Merve Bulguroğlu, Halil İbrahim Bulguroğlu, Gökçe Kılıç.** The authors reviewed the results and approved the final version of the article.

Conflicts of Interest

The authors declare that there is no conflict of interest to disclose.

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Ethical Approval

This study was carried out with the approval of the Ankara Medipol University Non-Interventional Clinical Research Ethics Committee, dated 25/12/2024 and numbered 170.

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