



## Comparison of Balance, Kinesiophobia and Spinal Status Between Individuals with Temporomandibular Joint Disorder and Healthy Controls

Mehmet Canli <sup>ID</sup>1, Hikmet Kocaman <sup>ID</sup>2, İrem Canli <sup>ID</sup>1, Şafak Kuzu <sup>ID</sup>1, Anıl Özüdoğru <sup>ID</sup>1, Nazım Tolgahan Yıldız <sup>ID</sup>2, Nursinem Yıldız <sup>ID</sup>1, Büşra Çöl <sup>ID</sup>1, Fatmanur Aslan <sup>ID</sup>1, Kader Azizoğlu <sup>ID</sup>1, Mert Tosun <sup>ID</sup>1

1 School of Physical Therapy and Rehabilitation, Kırşehir Ahi Evran University, Kırşehir, Türkiye

2 Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Karamanoglu Mehmetbey University, Karaman, Türkiye

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### Abstract

**Objective:** Temporomandibular joint disorder (TMD) can affect jaw joint function as well as impair neuromuscular control and postural stability. This study aims to compare balance, kinesiophobia, and spinal function parameters in individuals with TMD with healthy controls.

**Methods:** A total of 71 participants were included in the study, comprising 35 individuals with TMD and 36 healthy controls. Participants' static and dynamic balance was assessed using the Biodex Balance System, kinesiophobia was evaluated using the Tampa Kinesiophobia Scale, and spinal function was measured with the Spinal Mouse device.

**Results:** When individuals with TMD were compared to the healthy control group, significant differences were found between the groups in favour of the healthy control group in static and dynamic balance (anterior-posterior, medial-lateral, and overall) and spinal assessment parameters (spine check score, posture and mobility) ( $p<0.05$ ). Furthermore, it was found that individuals with TMD had significantly higher levels of kinesiophobia ( $p<0.05$ ).

**Conclusion:** This study demonstrates that parameters relating to static and dynamic balance, kinesiophobia, spinal condition, mobility and posture are adversely affected in individuals with TMD compared to healthy individuals. The findings highlight the importance of interventions targeting these parameters in TMD management and suggest that they may contribute to the personalisation of treatment strategies.

**Keywords:** Temporomandibular joint disorder, balance, kinesiophobia, spine

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Correspondence / Yazışma Adresi: Mehmet Canli, School of Physical Therapy and Rehabilitation, e\_mail: canlimehmet600@gmail.com Kırşehir, Türkiye

## Temporomandibular Eklem Bozukluğu olan Bireyler ve Sağlıklı Kontroller Arasında Denge, Kinezyofobi ve Spinal Durumun Karşılaştırılması

### Öz

**Amaç:** Temporomandibular eklem bozukluğu (TMB), çene eklemi fonksiyonunu etkileyebileceği gibi nöromusküler kontrolü ve postüral stabiliteyi de bozabilir. Bu çalışma, TMB'li bireylerde denge, kinezyofobi ve spinal fonksiyon parametrelerini sağlıklı bireylerle karşılaştırmayı amaçlamaktadır.

**Yöntemler:** Çalışmaya 35 TMB'li birey ve 36 sağlıklı kontrol olmak üzere toplam 71 katılımcı dahil edildi. Katılımcıların statik ve dinamik dengeleri Biodex Denge Sistemi ile, kinezyofobi düzeyleri Tampa Kinezyofobi Ölçeği ile ve spinal fonksiyonları Spinal Mouse cihazı ile değerlendirildi.

**Bulgular:** TMB'li bireyler sağlıklı kontrol grubu ile karşılaştırıldığında, statik ve dinamik denge parametrelerinde (antero-posterior, medio-lateral ve genel skorlar) ve spinal değerlendirme parametrelerinde (spinal kontrol skoru, postür ve mobilite) sağlıklı grup lehine anlamlı fark bulundu ( $p<0.05$ ). Ayrıca TMB'li bireylerin kinezyofobi düzeylerinin anlamlı derecede yüksek olduğu saptandı ( $p<0.05$ ).

**Sonuç:** Bu çalışma, statik ve dinamik denge, kinezyofobi, omurga durumu, mobilite ve postürle ilgili parametrelerin, TMB'li bireylerde sağlıklı bireylere kıyasla olumsuz etkilendiğini göstermektedir. Bulgular, TMB yönetiminde bu parametreleri hedefleyen müdahalelerin önemini vurgulamakta ve tedavi stratejilerinin kişiselleştirilmesine katkı sağlayabileceğini düşündürmektedir.

**Anahtar kelimeler:** Temporomandibular eklem bozukluğu, denge, kinezyofobi, omurga.

### INTRODUCTION

Temporomandibular joint disorder (TMD) is defined as a neuromuscular and musculoskeletal disorder involving dysfunction of the temporomandibular joint (TMJ), masticatory muscles, and surrounding tissues<sup>1</sup>. Affecting approximately 5 to 12 per cent of the general population, TMD is more common in the 20–40 age group and has a higher prevalence in women than in men<sup>2,3</sup>. Pain, difficulty chewing, and joint noises (crepitus, clicking) are among the most common symptoms of TMD. The aetiology of TMD is multifactorial and nonspecific<sup>4</sup>. However, structural factors such as musculoskeletal disorders, functional factors such as postural abnormalities, and psychological factors such as stress are among the important risk factors for TMD<sup>5</sup>.

The TMJ is directly connected to the cervical and scapular regions via a shared neuromuscular system<sup>4</sup>. Considering this connection, it is thought that TMD may adversely affect not only the craniomandibular system but also posture, postural control, and coordination<sup>6</sup>.

Furthermore, TMD may cause pain and functional limitations by restricting cervical spine mobility<sup>7</sup>. Studies in the literature highlight the relationship between TMD and cervical pain, postural abnormalities, and functional limitations<sup>8</sup>. These findings demonstrate the clinical importance of the biomechanical and neuromuscular relationship between the TMJ and the spine<sup>9</sup>.

The stomatognathic system comprises the TMJ, masticatory muscles, teeth, and associated structures that function together in activities such as chewing, speaking, and postural control<sup>10</sup>. It has been reported that changes occurring in the TMJ region have significant effects on postural balance and the proprioceptive system<sup>11</sup>. Stomatognathic system disorders developing due to structural and functional changes in the periodontal ligament or TMJ may lead to impairments in posture control due to neurological connections between different nerve nuclei in the brainstem<sup>12</sup>. In addition, psychosocial factors

have been reported to increase the clinical course and severity of TMD<sup>13</sup>. Kinesiophobia is defined as an excessive and irrational fear of movement due to the expectation of pain or re-injury. Kinesiophobia, in particular, stands out as an important psychosocial parameter<sup>14</sup>. These variables play a critical role in understanding the functional capacity and quality of life of individuals with TMD.

There are a limited number of studies in the current literature that examine the effects of TMD on balance, kinesiophobia and spinal status together. Therefore, the assessment of these parameters in individuals with TMD is important for understanding the multidimensional consequences of the disorder. This study aims to compare balance level, kinesiophobia level, and spinal condition in individuals with TMD and healthy individuals.

## METHODS

### Design and setting

This study is a cross-sectional study conducted between July and November 2025 at the Physical Therapy and Rehabilitation School of Kırşehir Ahi Evran University. The study was conducted in accordance with the Helsinki Declaration. The study received ethical approval from the Scientific Research and Publication Ethics Committee of the Faculty of Health Sciences at Karamanoğlu Mehmetbey University (Date: 17 June 2025, No: 07-2025/107). Study participants were divided into two groups: the TMD group and the healthy control group.

### Sample size calculation

The sample size of the study was calculated using data obtained from a pilot study conducted prior to the commencement of the research. In the pilot study, the dynamic mediolateral (M-L) balance parameter was evaluated in 10 individuals with TMD and 10 healthy controls. The dynamic M-L value was found to be  $0.92 \pm 0.18$  in the TMD group and

$0.79 \pm 0.15$  in the control group. Based on these values, the effect size was found to be approximately 0.78. Using this effect size, a power analysis performed with the G\*Power 3.1 programme at  $\alpha=0.05$  and  $1-\beta=0.90$  (power=90%) levels calculated that at least 34 participants were needed for each group. To minimise the risk of potential loss/missing data, it was planned to include at least 35 participants in each group, and ultimately 35 participants in the TMD group and 36 participants in the control group were included in the study.

### Participants

The Fonseca Anamnestic Index (FAI) was used to determine the presence and severity of TMD. The FAI is a self-administered questionnaire consisting of 10 items used to assess the presence and severity of TMD. Each item is scored as “yes” (10 points), “sometimes” (5 points), or “no” (0 points), resulting in a total score ranging from 0 to 100. Higher scores indicate greater severity of TMD. Based on the total score, TMD severity is classified as follows: 0–15 (no TMD), 20–40 (mild TMD), 45–65 (moderate TMD), and 70–100 (severe TMD)<sup>15</sup>. Although the FAI is not considered a gold-standard diagnostic tool, it was preferred in this study due to its practicality, ease of administration, and validated use in epidemiological and clinical research settings. A standardized clinical diagnostic protocol (e.g., DC/TMD) was not applied due to time and resource constraints. Participants who had experienced pain, functional limitation, or joint noise in the TMJ for at least three months were considered to have chronic symptoms.

The inclusion criteria for the TMD group were as follows: 1) having TMD according to the FAI, 2) having a history of temporomandibular pain or dysfunction lasting at least three months, and 3) being aged between 18 and 65. Individuals with the following characteristics were excluded from the study: history of trauma, fracture, or surgical intervention involving the

temporomandibular region within the last six months; presence of acute inflammatory, neurological, or rheumatological disease; systemic rheumatological diseases such as rheumatoid arthritis or ankylosing spondylitis; fibromyalgia; infection, malignancy or congenital anomalies affecting the jaw; treatment for TMD within the last three months, such as physiotherapy, splint therapy or botulinum toxin; pregnancy or breastfeeding; serious psychiatric disorder or significant cognitive impairment that could interfere with compliance with the assessment.

The inclusion criteria for the healthy control group were as follows: 1) no TMD symptoms according to the FAI, 2) no pain, joint noise or chewing difficulty in the temporomandibular region in the last six months, and 3) no musculoskeletal problems. Participants in the control group were matched with the TMD group in terms of age and gender.

A total of 40 individuals were screened in the TMD group; 5 participants did not meet the inclusion criteria and were therefore excluded from the study. In the control group, 38 healthy individuals were evaluated; 2 of these did not meet the matching or inclusion criteria. A total of 35 individuals with TMD and 36 healthy individuals were included in the study.

### **Data collection tools**

#### **Balance**

The balance levels of individuals with TMD were assessed using the Biodex Balance System. The device measures balance levels in the mediolateral (M-L), anteroposterior (A-P) and overall directions through static and dynamic modules. In this study, floor stability was set at level 6, with high scores indicating poor balance and postural control<sup>16</sup>.

#### **Kinesiophobia**

The Tampa Kinesiophobia Scale (TKS), which has proven validity and reliability in Turkish,

was used to assess the level of kinesiophobia among participants. The scale assesses fear of movement due to pain, fear of injury, and avoidance behaviours, with higher scores indicating a higher level of kinesiophobia<sup>17</sup>.

#### **Spinal assessment**

Spinal assessments were performed using the Spinal Mouse device by an experienced physiotherapist following a standardized protocol. For static postural assessment, participants stood in a relaxed neutral position while measurements were taken from C7 to S3. For dynamic mobility assessment, participants performed maximal trunk flexion and extension, and measurements were repeated along the same spinal landmarks during these movements. Each measurement was performed twice, and the average value was used for analysis<sup>18</sup>.

#### **Statistical Analysis**

The data obtained from the study were evaluated using the IBM SPSS 22.0 statistical analysis programme. The normality of the data distribution was determined using the Kolmogorov-Smirnov and Kurtosis-Skewness tests. The mean and standard deviation values of the demographic information, balance, kinesiophobia, and spinal condition data of the individuals were provided. Group differences were examined using the Chi-square ( $\chi^2$ ) test for categorical variables and the independent samples t-test for quantitative variables. The level of statistical significance was set at  $p < 0.05$ .

### **RESULTS**

The comparison of demographic characteristics between individuals with TMD and healthy individuals included in the study is presented in Table 1. When the demographic characteristics of the TMD group were compared with the control group in terms of age, gender, height, weight, and BMI, no statistically significant difference was found between the groups

( $p>0.05$ ). This result indicates that the groups are similar in terms of the distribution of demographic characteristics.

**Table I:** Comparison of the demographic characteristics of individuals with TMD with those of healthy individuals.

Variables	TMD group (n=35)	Control group (n=36)	p
	Mean±SD	Mean±SD	
Age (years)	25.68±6.60	24.75±4.26	0.479
Height (m)	166.60±8.69	165.91±8.54	0.739
Weight (kg)	66.48±14.02	65.47±16.93	0.785
BMI (kg/m <sup>2</sup> )	23.73±3.77	23.59±4.62	0.890
FAI	42.38±4.81	8.72±2.15	0.001
	n (%)	n (%)	
Sex	Female	27 (77)	0.719
	Male	8 (23)	
FAI classification	Absence of TMD	-	36 (100)
	Mild TMD	23 (65.7)	-
	Moderate TMD	9 (25.7)	-
	Severe TMD	3 (8.6)	-

TMD: Temporomandibular disorders, BMI: Body mass index, SD: Standard deviation, FAI: Fonseca Anamnestic Index

The comparison of static and dynamic equilibrium oscillation amounts (A-P, M-L, and overall), kinesiophobia, and spinal assessments (spine check score, posture, mobility) between individuals with TMD and the healthy control group is presented in Table 2. Statistically significant differences were found between the

two groups for all variables assessed ( $p<0.05$ ). Compared to healthy individuals, individuals with TMD had higher static and dynamic balance amounts and kinesiophobia levels, while their spinal assessment scores were lower.

**Table II:** Comparison of balance, kinesiophobia and spinal assessment parameters in individuals with TMD versus healthy individuals.

Variables	TMD group (n=35)	Control group (n=36)	Mean difference (95% CI)	p
	Mean±SD	Mean±SD		
Static A-P	0.71±0.17	0.50±0.14	0.21 (0.13, 0.29)	<0.001
Static M-L	0.71±0.15	0.49±0.13	0.21 (0.15, 0.28)	<0.001
Static Overall	1.04±0.25	0.72±0.18	0.31 (0.20, 0.42)	<0.05
Dynamic A-P	1.00±0.17	0.78±0.15	0.21 (0.13, 0.29)	<0.001
Dynamic M-L	0.98±0.17	0.78±0.15	0.19 (0.11, 0.27)	<0.001
Dynamic Overall	1.56±0.27	1.19±0.22	0.37 (0.25, 0.49)	<0.05
TKS	26.68±5.48	17.15±3.45	9.68 (7.86, 11.50)	<0.001
SCS	25.17±5.99	35.47±7.01	-10.30 (-13.39, -7.20)	<0.05
Posture	30.31±7.29	47.41±7.12	-17.10 (-20.51, -13.68)	<0.001
Mobility	23.71±6.05	44.75±6.44	-21.03 (-23.99, -18.07)	<0.001

SD: Standard deviation, CI: Confidence interval, A-P: Anterior-posterior, M-L: Medial-lateral, TKS: Tampa Kinesiophobia Scale, SCS: Spine Check Score

## DISCUSSION

According to the results of this study, when healthy individuals were compared with those with TMD, it was observed that individuals with TMD had lower spinal assessment results, higher static and dynamic balance amounts (A-P, M-L and overall) and higher levels of kinesiophobia.

A review of the literature suggests that TMD causes changes in cervical posture due to pain and changes in posture. For this reason, it is stated that changes in body and spinal posture have a negative effect on the body's static and dynamic balance function<sup>19</sup>. Furthermore, the relevant literature points to numerous connections between the structures of the stomatognathic system and the structures responsible for maintaining body balance. Nota et al.<sup>20</sup> compared individuals with myogenic TMD with a healthy control group and reported increased postural sway in individuals with TMD. Similarly, Kim et al.<sup>9</sup> demonstrated that balance-related parameters, including hip and centre of mass control, were adversely affected in individuals with painful TMD compared to healthy controls. Ries et al.<sup>21</sup> noted that more postural asymmetry was observed in individuals with TMD compared to healthy individuals and stated that TMD causes cervical region pain, which negatively affects postural stability. Oltramari-Navarro et al.<sup>22</sup> reported that the presence and severity of TMD in elderly adults did not cause significant changes in postural balance and that more studies are needed to clarify this issue. In our study, the impairment of all static and dynamic balance parameters in individuals with TMD compared to healthy controls can be explained by the trigeminocervical connections between the TMJ and the cervical region, a decrease in pain-related proprioceptive feedback, and changes in postural alignment. Muscle tension and neuromuscular control disorders accompanying TMD may have negatively

affected the sensory integration necessary for balance, leading to a decrease in postural stability.

Kinesiophobia is an excessive and irrational fear of movement or physical activity, typically stemming from a perceived vulnerability to pain or the possibility of re-injury<sup>13</sup>. In individuals with TMD, this fear of jaw movement can reach a level that can negatively affect basic daily activities such as chewing, speaking, facial expressions, and eating<sup>23</sup>. Marciniak et al.<sup>24</sup> concluded that individuals with TMD have higher levels of kinesiophobia than individuals without TMD. Lira et al.<sup>23</sup> observed kinesiophobia in individuals with TMD and concluded that the level of kinesiophobia was associated with anxiety, hyperalgesia, and disability scores. Furthermore, more TMD diagnoses were made in patients with high levels of kinesiophobia. In another study, Häggman-Henrikson et al.<sup>13</sup> reported that individuals with TMD had higher levels of kinesiophobia, pain areas, and somatic symptoms compared to healthy controls. In our study, it was determined that individuals with TMD exhibited significantly higher kinesiophobia scores compared to the healthy control group. This result may be attributed to the expectation of pain, functional limitations, and recurrence of pain during movement associated with TMD, which may increase the tendency to avoid movement in individuals. Although the difference in kinesiophobia levels between groups was statistically significant, its clinical relevance should be considered. The mean TKS score in the TMD group did not exceed the threshold for high kinesiophobia (TKS > 37), indicating that fear levels may not be clinically severe. However, higher scores compared to controls suggest an increased tendency toward movement-related fear, which may still contribute to activity limitation and symptom persistence. Therefore, addressing

kinesiophobia, even at moderate levels, may be beneficial in TMD management.

Posture relies on the holistic biomechanical integration of various segments, and any disruption in a sub-unit leads to compensatory adjustments in other segments. As the muscles of the stomatognathic system are part of the cervical muscle chain, dysfunction in this region can affect postural control<sup>25</sup>. Due to the interconnected structure of the musculoskeletal system, adaptive changes in segments close to or distant from the TMJ cause realignment of posture. In this context, even postural deviations in the lower extremities can affect head and neck posture<sup>26</sup>. Saito et al.<sup>25</sup> reported postural abnormalities in patients with TMD with anterior disc displacement in the pelvis (posterior rotation), lumbar spine (hyperlordosis), thoracic spine (rectification), head (deviation to the right), and mandibles (deviation to the left with open mouth). Mielcarek et al.<sup>27</sup> reported that body posture is affected in individuals with TMD. Ferreira et al.<sup>28</sup> reported a significant decrease in cervical flexion and extension joint range of motion, as well as upper cervical spine (C1-C2) mobility in women with TMD compared to healthy controls. Wolan-Nieroda et al.<sup>29</sup> concluded that both TMJ and cervical region mobility were reduced in young adults with TMD.

In our study, consistent with the literature, it was observed that spine check scores, spinal mobility, and postural parameters were significantly negatively affected in individuals with TMD compared to the healthy control group. This situation may be attributed to muscle imbalance associated with TMD or cervical degenerative changes (e.g., deterioration of spinal joints) negatively affecting spinal function by disrupting postural alignment<sup>30</sup>.

Our study has certain limitations. The sample size is limited, and due to the cross-sectional design, causality could not be established. TMD

diagnosis in this study was based solely on FAI, which, although validated and widely used for screening purposes, is not considered a gold-standard diagnostic tool. The absence of a standardized clinical diagnostic protocol, such as the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), limits the diagnostic accuracy and may affect the generalizability of the findings. Furthermore, no differentiation, classification, or statistical analysis was performed based on TMD severity; this limits the generalisability of the findings to subgroups. The lack of control for factors such as psychological status and pain level accompanying TMD can also be considered another limitation in terms of interpretation.

## CONCLUSION

This study suggests that both static and dynamic balance control are significantly associated with TMD. In addition, individuals with TMD exhibited higher levels of kinesiophobia and lower spinal function and posture scores compared to healthy individuals. These findings indicate that TMD may be related to alterations in neuromuscular control and postural stability. These results emphasise the importance of interventions targeting balance training, postural control, and kinesiophobia in TMD management. Future studies examining the effects of TMD severity and subtypes on balance and spinal parameters may contribute to the personalisation of treatment strategies.

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**Ethics Committee Approval:** The study received ethical approval from the Scientific Research and Publication Ethics Committee of the Faculty of Health Sciences at Karamanoğlu Mehmetbey University (Date: 17 June 2025, No: 07-2025/107).

**Conflict of Interest:** The author(s) declare that there is no financial conflict of interest related to this article.

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