

Original Article

## The relationship between temporomandibular dysfunction, sleep quality, perceived stress, and upper crossed syndrome in young adults: A cross-sectional study

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### Abstract

**Aim:** This study aims to examine the relationship between temporomandibular dysfunction (TMD), sleep quality, perceived stress level, and postural alignment in young adults.

**Materials and Methods:** A total of 168 university students aged 18-30 were included in the study. New York Posture Analysis Scale (NPA) for posture, the Fonseca Anamnestic Index (FAI) for TMD, the Pittsburgh Sleep Quality Index (PSQI) for sleep quality, and the Perceived Stress Scale (PSS) for stress level were used. Statistical analyses were conducted using parametric and nonparametric tests and multiple regression analysis.

**Results:** 63.1% of the participants were female, and the mean age was 20.66±2.22 years. According to the regression analysis, only orthodontic treatment history was found to have a significant effect on posture ( $p=0.032$ ). No statistically significant correlation was found between gender, age, grade, missing teeth, chronic disease, FAI, PSQI, or PSS scores, and posture ( $p>0.05$ ). Furthermore, a weak negative correlation was found between FAI and PSS ( $p<0.001$ ).

**Conclusion:** Our study revealed that orthodontic treatment history is associated with postural disorders. TMD, sleep quality, and perceived stress level were found to have no direct effect on posture. The findings suggest that postural disorders should be evaluated from a multifactorial, biopsychosocial perspective.

**Keywords:** Temporomandibular dysfunction, sleep quality, stress, upper crossed syndrome, university students

### INTRODUCTION

The human body consists of complex chain systems that enable multidirectional movements. According to Janda, one of these chains, the articular chain, is the product of the biomechanical interactions of different joints during a specific movement pattern and is divided into two substructures: the postural chain and the kinetic chain. The postural chain refers to the positional relationships between joints in an upright position of the body, while the kinetic chain refers to the functional flow of movement through open and closed chain movements [1]. The Janda approach defines these chain concepts as a fundamental framework for the

evaluation of muscle imbalances and motor control disorders [2]. Frank, Kobesová & Kolář (2013) emphasized that the functional integration of chain systems is critical for postural stability [3]; Kobesová & Kolář (2014) explained these structures with a three-layered motor control model that includes spinal, subcortical, and cortical levels [4]. Postural disorders are not limited to musculoskeletal problems but can also be associated with neurological and psychological systems.

Temporomandibular dysfunction (TMD) is a complex clinical condition characterized by pain and dysfunction of the masticatory muscles, temporomandibular joint (TMJ), and related structures.

### CITATION

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Electromyographic studies show that TMD alters the mandibular resting position, and abnormal activity of the masticatory muscles may increase the load on the TMJ [5,6]. The relationship between postural disorders and TMD gains clinical importance, especially when the biomechanical connections between the cervicocranial region and the mandibular structure are taken into consideration. In the study by Uritani et al. (2014), it was stated that the head position of individuals with TMD was more anterior compared to healthy individuals, and that this difference was both statistically and clinically significant [1]. Minervini et al. (2023) revealed a significant relationship between TMD and posture at the neuromuscular level, emphasizing that this interaction may also be shaped by biopsychosocial factors [5,7].

The literature emphasizes that TMD may be associated not only with postural parameters but also with psychophysiological factors such as sleep quality and perceived stress. A study conducted on university students found significant relationships between sleep quality and head-neck posture, demonstrating that postural control mechanisms may be linked to sleep quality [8]. Sleep disorders manifest with symptoms such as difficulty initiating sleep, nighttime awakenings, or sleep fragmentation, and are often associated with psychological problems such as anxiety, depression, and low self-esteem. This may lead to disruption of the circadian rhythm and dysregulation of the neuroendocrine system, resulting in negative effects on muscle tone and postural control [9,10].

This multidimensional interaction can play a decisive role not only at the biomechanical level but also on an individual's biopsychosocial functioning. The pain, muscle tension, sleep disturbance, and increased stress accompanying TMD can limit an individual's participation in daily activities, leading to functional impairment and disability.

In addition to their clinical significance, postural alignment and temporomandibular function play a crucial role in forensic assessments. Posture, craniofacial alignment, and temporomandibular joint characteristics are important parameters in forensic identification, trauma analysis, and the interpretation of musculoskeletal injuries. Furthermore, stress and sleep disturbances, common in individuals exposed to trauma, violence, or legal stress, can affect muscle tone and posture, thus impacting forensic assessments. In this context, health status should be assessed not only by the presence of the disease but also by the individual's level of physical, psychological, and social participation. The coexistence of postural control, muscle function, and psychophysiological balance disorders provides important clues that can be considered early indicators of disability in young individuals.

However, multidimensional analyses that evaluate these variables simultaneously, particularly those conducted on young individuals, are limited in the literature. Therefore, the aim of our study is to examine the relationship between the level of postural impairment and temporomandibular dysfunction, sleep quality, perceived stress level, and postural alignment in young individuals and to reveal the potential effects of these variables on individuals' functional participation and disability levels.

## MATERIAL AND METHOD

This is a cross-sectional study examining the relationships between postural level, temporomandibular dysfunction, perceived stress, and sleep quality in young adults. The study was conducted with volunteer students studying at Alanya Alaaddin Keykubat University.

**Ethical Approval:** The study was approved by the Clinical Research Ethics Committee of the Faculty of Medicine, Alanya Alaaddin Keykubat University (Date: 25/09/2024; Decision No. 21-03). The research process was conducted in accordance with the Declaration of Helsinki. Participants were informed about the study and their written consent was obtained. Assessments were conducted by the researcher through face-to-face interviews.

**Power Analysis:** The effect size obtained in the reference study was found to be of a weak level ( $\rho=0.183$ ) [8]. Based on the assumption that a higher effect size could be achieved, a power analysis was conducted. With a confidence level of 95% and a power of 90%, it was determined that with a sample size of 168 participants, the effect size would be  $\rho=0.35$ .

**Inclusion Criteria:** Being between 18 and 30 years old, being a university student, not having had orthopedic, neurological, or dental surgery in the last 3 months, voluntary participation in the study.

**Exclusion Criteria:** Having had previous trauma or surgery to the TMJ region, being diagnosed with a neurological or systemic disease, being pregnant, filling out the questionnaires incompletely or incorrectly

### Data Collection Tools

The study used the New York Posture Analysis Scale (NPAS) for posture analysis, the Fonseca Anamnestic Index (FAI) to determine the presence of TMD, the Pittsburgh Sleep Quality Index (PSQI) to determine sleep quality, and the Perceived Stress Index (PSI) to assess perceived stress.

**Posture Analysis:** The New York Posture Analysis (NPA) monitors postural changes that may occur in 13 different parts of the body, including the head, neck, shoulder, back, waist, hip, and ankle. Based on the observation results, if the individual has good posture, they are given five (5) points; if their posture is moderately impaired, they are given three (3) points; and if there is a severe impairment, they are given one (1) point. The total score obtained from the test ranges from 13 to 65. Standard evaluation criteria developed for this test are defined as "very good" if the total score is  $\geq 45$ , "good" if it is 40-44, "moderate" if it is 30-39, "poor" if it is 20-29, and "poor" if it is  $\leq 19$  [11].

**Fonseca Anamnestic Index (FAI):** The FAI was developed to identify TMD based on signs and symptoms. This index consists of 10 items and has three response options: "yes" (10 points), "sometimes" (5 points), and "no" (0 points). The result is determined by the sum of the scores for all items and is classified as follows: no signs and symptoms of TMD (0-15 points), mild TMD (20-45 points), moderate TMD (50-65 points), and severe TMD (70-100 points) [12,13].

**Pittsburg Sleep Quality Index (PSQI):** It consists of seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medications, and daytime dysfunction [14]. The Turkish version of the PSQI was used in this study [15]. The score for each subgroup ranges from 0 to 3. The sum of these component scores provides an overall score for subjective sleep quality (range: 0–21). Sleep quality is considered "good" for those with a total score of  $\leq 5$ , and "poor" for those with a total score of  $>5$  [14].

**Perceived Stress Scale (PSS):** The PSS consists of 14 items and is designed to measure the perceived stress level in specific situations in a person's life [16]. PSS scores range from 0 to 56. A high total score indicates a high level of perceived stress [17].

### Statistical Analysis

Statistical analyses were performed using SPSS for Windows, version 22 software. The conformity of the variables to a normal distribution was examined using visual (histogram

and probability plots) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). Demographic data and the results of the parameters to be evaluated were presented as mean (Mean)  $\pm$  standard deviation (SD) when the parameters were normally distributed, and using the median and interquartile range when the parameters were not normally distributed. Parameters affecting postural alignment were examined using multiple linear regression analysis, and the relationships between the parameters were examined using the Pearson test when the data were normally distributed and the Spearman test when they were not normally distributed. The significance level for statistical analyses was accepted as 0.05.

### RESULTS

A total of 168 participants aged 18-30 (mean age= 20.66 $\pm$ 2.22 years) were included in the study. 63.1% of the participants were female (n=106) and 36.9% (n=62) were male. Demographic characteristics are detailed in Table 1.

**Table 1.** Demographic and clinical characteristics of participants

| Variables                                | Category      | n                | %    |
|--|---------------|------------------|------|
| Gender                                   | Female        | 106              | 63.1 |
|  | Male          | 62               | 36.9 |
| Age (year)                               | Mean $\pm$ SD | 20.66 $\pm$ 2.22 |      |
|  | Med (IQR)     | 20 (20-21)       |      |
|  | Min-Max       | 18-28            |      |
| Grade                                    | 1             | 68               | 40.5 |
|  | 2             | 52               | 31.0 |
|  | 3             | 31               | 18.5 |
|  | 4             | 17               | 10.1 |
| Have you received orthodontic treatment? | Yes           | 42               | 25.0 |
|  | No            | 126              | 75.0 |
| Is there a missing tooth?                | Yes           | 43               | 25.6 |
|  | No            | 125              | 74.4 |
| Do you have a chronic illness?           | Yes           | 18               | 10.7 |
|  | No            | 150              | 89.3 |
| FAI total score                          | Mean $\pm$ SD | 23.91 $\pm$ 3.9  |      |
|  | Med (IQR)     | 25 (22-27)       |      |
|  | Min-Max       | 12-30            |      |
| PSQI                                     | Mean $\pm$ SD | 11.85 $\pm$ 2.77 |      |
|  | Med (IQR)     | 12 (9.25-14)     |      |
|  | Min-Max       | 6-19             |      |
| PSS                                      | Mean $\pm$ SD | 28.94 $\pm$ 8.79 |      |
|  | Med (IQR)     | 30 (25-34)       |      |
|  | Min-Max       | 0-52             |      |
| NPA                                      | Mean $\pm$ SD | 53.52 $\pm$ 5.42 |      |
|  | Med (IQR)     | 53 (49.25-57)    |      |
|  | Min-Max       | 37-65            |      |

FAI: Fonseca Anamnestic Index, PSQI: Pittsburgh Sleep Index, PSS: Perceived Stress Scale, NPA: New York Posture Analysis, SD: Standard Deviation; Med (IQR): Median (25th-75th percentiles); Min-Max: Minimum-maximum values

Twenty-five percent (n=42) of the participants had a history of orthodontic treatment, 25.6% (n=43) had missing teeth, and 10.7% (n=18) had a chronic health problem. Clinical data revealed a mean Fonseca score of  $23.91 \pm 3.9$ , a mean Pittsburgh Sleep Quality Index (PSQI) of  $11.85 \pm 2.77$ , and a mean Perceived Stress Scale (PSS) of  $28.94 \pm 8.79$ . The mean New York Posture Analysis Test score was  $53.52 \pm 5.42$ . Multiple linear regression analysis was performed to determine the factors affecting NPA scores. Among the independent variables, only history of orthodontic treatment was found to be a statistically significant factor ( $\beta=0.165$ ;  $p=0.032$ ). Participants who had

received orthodontic treatment had higher NPA scores, which was associated with greater postural deterioration. No statistically significant correlation was found between the NPA scores and other variables (gender, age, grade, missing teeth, presence of chronic disease, FAI, PSQI, and PSS) ( $p>0.05$ ) (Table 2). A weak, positive, statistically significant correlation was found between the FAI and PSS scores ( $r=0.287$ ;  $p=0.0001$ ). No statistically significant correlation was found between the NPA and other variables (FAI, PSQI, and PSS) ( $p>0.05$ ). Furthermore, no significant correlation was found between the PSQI and PSS ( $p=0.335$ ) (Table 3).

**Table 2.** Multiple linear regression analysis of factors affecting postural alignment

| Dependent variable: New York posture analysis |           |        |        |                         |
|---|-----------|--------|--------|-------------------------|
| Independent Variables                         | Std. Beta | t      | p      | 95% C.I.<br>Lower–Upper |
| Gender  | 0.065     | 0.839  | 0.403  | -0.985–2.44             |
| Grade   | 0.022     | 0.279  | 0.781  | -0.713–0.948            |
| Age   | 0.070     | 0.907  | 0.366  | -0.202–0.546            |
| Have you received orthodontic treatment?      | 0.165     | 2.160  | 0.032* | 0.177–3.950             |
| Is there a missing tooth?                     | 0.044     | 0.569  | 0.570  | -1.349–2.442            |
| Do you have a chronic illness?                | 0.105     | 1.364  | 0.174  | -0.822–4.502            |
| FAI   | 0.040     | 0.514  | 0.608  | -0.157–0.268            |
| PSQI  | -0.129    | -1.678 | 0.095  | -0.551–0.045            |
| PSS   | 0.093     | 1.205  | 0.230  | -0.037–0.151            |

\* $p<0.05$  statistically significant effect; Std. Beta: Standardized Beta Coefficient; 95% C.I.: 95% Confidence Interval FAI: Fonseca Anamnestic Index, PSQI: Pittsburgh Sleep Index, PSS: Perceived Stress Scale

**Table 3.** Correlations between fonseca score, sleep quality, perceived stress, and posture score

| Variables |   | FAI   | PSQI   | PSS    | NPA    |
|-----------|---|-------|--------|--------|--------|
| FAI       | r | 1.000 | -0.087 | 0.287* | 0.013  |
|           | p |       | 0.264  | 0.0001 | 0.868  |
| PSQI      | r |       | 1.000  | 0.075  | -0.097 |
|           | p |       |        | 0.335  | 0.211  |
| PSS       | r |       |        | 1.000  | 0.130  |
|           | p |       |        |        | 0.094  |
| NPA       | r |       |        |        | 1.000  |
|           | p |       |        |        |        |

\* $p<0.05$  indicates a statistically significant correlation; r: Spearman correlation coefficient FAI: Fonseca Anamnestic Index, PSQI: Pittsburgh Sleep Index, PSS: Perceived Stress Scale, NPA: New York Posture Analysis

## DISCUSSION

Our study investigating the relationship between TMD, sleep quality, perceived stress level, and postural alignment in young adults found that postural disorders were more prevalent in those receiving orthodontic treatment. However, TMD, sleep quality, and perceived stress level were not associated with postural alignment. Postural alignment and TMD are frequently assessed in forensic cases involving trauma, physical assault,

occupational injuries, and disability assessments. Therefore, these results should be interpreted not only clinically but also within a forensic context.

Karahan (2024) reported that poor sleep quality can negatively affect postural control, especially under eyes-closed conditions [18]. However, Stemplewski et al. (2023) stated that sleep deprivation did not significantly impair postural stability, emphasizing that the relationship between sleep and posture

may be influenced by individual factors [19]. Dolina (2025) demonstrated that the effects of TMD subtypes on posture and balance may differ, and this may explain the diversity of findings in our study [20].

In our study, no statistically significant relationship was found between gender, age, grade level, tooth deficiency, presence of chronic disease, FAI, PSQI and PSS and NPA scores. This suggests that these factors do not have a significant effect on posture. According to a TMD risk model developed for university students and including factors such as stress, oral habits, and malocclusion, stress has been reported as an important factor in determining the risk of TMD [10]. Studies conducted in Turkiye show that approximately 50–60% of university students have poor sleep quality and high stress levels, which can have negative effects on physical and musculoskeletal health [21,22]. While Karahan (2024) reported that sleep quality, especially in eye-closed conditions, can affect postural control [18], Badau et al. (2024) found significant relationships between sleep quality and head and neck posture [8]. However, Özsoy et al. (2022) found that these parameters had no significant direct effect on posture, supporting some conflicting results in the literature [23]. Therefore, these relationships are complex, and a unidimensional assessment may be insufficient. Our study found a weak but statistically significant correlation between FAI and PSS scores, suggesting that higher stress levels are associated with increased TMD severity. However, the low correlation strength suggests that stress alone is not a primary determinant of TMD. These findings suggest that stress acts as a contributing factor rather than a determining factor, supporting the multifactorial and biopsychosocial nature of TMD.

The most important feature of our study that will contribute to the literature is the conclusion that supports the fact that postural disorders are more common, especially in those who receive orthodontic treatment. Orthodontic interventions can influence craniofacial structure and musculoskeletal alignment, potentially affecting forensic identification, facial reconstruction, and interpretation of antemortem records. Therefore, dental and orthodontic history should be carefully considered during forensic assessments. In the study conducted by Zieliński et al. (2018), where they examined the relationship between TMD, sleep quality, and postural alignment in young adults, a similar conclusion was reached with our study, revealing that individuals receiving orthodontic treatment had higher rates of postural disorders and that there was no direct relationship between TMD and sleep quality [7]. Gault (2008) emphasized in his studies that orthodontic interventions can affect the postural system [24]. This prediction was supported by the finding of Parrini et al. (2018) that clear aligner treatment can create changes in pelvic tilt, kyphosis, and lordosis angles [25]. In addition, Klostermann et al. (2021) reported that overjet correction with early orthodontic treatment led to significant improvement in pelvic torsion, demonstrating that these postural changes can be observed as a result of treatment [26]. More broadly, a systematic review by Róžańska-Perlińska et al. (2024) strengthens the

consistency in the literature by revealing significant relationships between malocclusion and posture, balance, head posture, and gait parameters [27].

## CONCLUSION

Considering all these results and the literature, our results contribute to the literature because there is no consensus in the literature and because this study examines both physical and emotional factors simultaneously. In future studies, a multidisciplinary approach to assessing physical and emotional factors such as temporomandibular dysfunction, stress, and sleep quality, which may be associated with postural disorders, based on a biopsychosocial model, is crucial for defining the problem. Following the analysis process, multifaceted planning of therapeutic approaches will increase treatment success. Furthermore, it should be noted that these factors can have long-term impacts on individuals' functional capacity, participation in daily activities, and quality of life, thus potentially contributing to disability. In this regard, postural disorders and TMD are believed to play a decisive role not only in musculoskeletal health but also in an individual's level of functionality and participation. Therefore, conducting future research within a holistic approach that includes disability will contribute to both clinical practice and public health policies.

### Conflict of Interests

*The authors declare that there is no conflict of interest in the study.*

### Financial Disclosure

*The authors declare that they have received no financial support for the study.*

### Ethical Approval

*Ethics committee approval for our study was obtained from the Clinical Researches Ethics Committee of Alanya Alaaddin Keykubat University (Date: 25.09.2024, Decision number: 21-03).*

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