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Risk Factors for Temporomandibular Joint Disorders in Young Adults in Khyber Pakhtunkhwa

Original Research

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ABSTRACT

Background: Temporomandibular joint disorders (TMD) are among the most prevalent causes of non-odontogenic orofacial pain, yet their multifactorial etiology remains insufficiently characterized in young adults from developing regions. Psychosocial stress, sleep disturbance, and oral parafunctions have been identified as potential contributors, but population-specific evidence from Pakistan is limited.

Objective:
To identify and quantify behavioral, psychosocial, and anatomical risk factors associated with TMD among young adults in Khyber Pakhtunkhwa through a case–control analysis.

Methods: A hospital-based case–control study was conducted in private hospitals across Peshawar, Mardan, and Abbottabad between May and October 2025. A total of 236 participants (118 clinically diagnosed TMD cases, 118 matched controls aged 18–35 years) were assessed. Diagnosis was based on the **Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)**. Data on sociodemographic, behavioral, and psychosocial factors were collected using validated instrumentsthe **Oral Behaviors Checklist (OBC)**, **Pittsburgh Sleep Quality Index (PSQI)**, and **Patient Health Questionnaire-4 (PHQ-4)**. Logistic regression analyses identified independent predictors of TMD, with significance set at $p < 0.05$.

Results: Sleep bruxism (37.3% vs 15.3%; $p < 0.001$), awake parafunction (39.8% vs 17.8%; $p < 0.001$), poor sleep quality (51.7% vs 22.0%; $p < 0.001$), and elevated anxiety/depression (29.7% vs 12.7%; $p = 0.003$) were significantly more common among cases. In multivariate analysis, sleep bruxism (aOR = 2.94; 95% CI: 1.53–5.68), poor sleep quality (aOR = 3.21; 95% CI: 1.72–5.99), and awake parafunction (aOR = 2.78; 95% CI: 1.49–5.18) remained independent predictors of TMD.

Conclusion: Behavioral and psychosocial factorsparticularly sleep bruxism, parafunctional activity, and poor sleep qualityare major risk determinants for TMD in young adults. Addressing these modifiable variables through early screening and behavioral interventions may help reduce TMD prevalence in this population.

Keywords: Anxiety; Case-Control Studies; Orofacial Pain; Parafunctional Habits; Sleep Bruxism; Temporomandibular Joint Disorders; Young Adults

INTRODUCTION:

The temporomandibular joint (TMJ), which connects the lower jaw to the skull, plays an essential role in everyday functions such as chewing, speaking and yawning. Disorders affecting this jointcollectively referred to as temporomandibular disorders (TMD)have increasingly gained attention worldwide as a significant cause of orofacial pain, functional impairment and reduced quality of life. TMD is widely regarded as the most common form of non-odontogenic orofacial pain, and presents with symptoms such as jaw pain, limited mouth opening, joint sounds and impaired mandibular function. (1) Despite its prevalence, the underlying causes remain incompletely understood, particularly among young adult populations in resource-limited settings. Globally, the estimated prevalence of TMD is substantial. A recent meta-analysis of studies across continents estimated that roughly one in three persons may be affected at some point in their life. (2) However, prevalence varies markedly by age, sex and geographic region, and there remains limited data from many parts of the world, especially low- and middle-income regions. The etiology of TMD is widely acknowledged to be multifactorial with predisposing, initiating and perpetuating factors all playing a role rather than a single "cause." (3)

Recent research highlights a broad constellation of risk factors. Psychosocial stressors including anxiety, depression, sleep disturbances and general psychological distress are increasingly recognized as strong contributors to TMD onset and chronicity. (4, 5) Biomechanical and anatomical factors (such as occlusal abnormalities, oral parafunctions like bruxism, and jaw overuse) also appear important, though their exact role remains debated. (6) Moreover, emerging evidence points to a potential genetic component, with certain genetic polymorphisms associated with increased susceptibility to TMD. (7) Despite this accumulating body of evidence, most studies have focused on Western or high-income populations, and there is a striking paucity of data from South Asia. In particular, young adults in regions such as the former province of Khyber Pakhtunkhwa (now among the provinces of Pakistan) may face unique environmental, genetic, sociocultural and behavioral risk factorsincluding differing stress exposures, dietary habits, oral health practices, socioeconomic conditions, and possibly divergent genetic predispositions. Without region-specific data, the burden of TMD in these communities remains unquantified, and opportunities for early diagnosis or preventive interventions may be missed.

Addressing this gap, the present study seeks to examine risk factors for TMD in a sample of young adults from Khyber Pakhtunkhwa through a case-control design. The research question guiding this investigation is: which demographic, psychosocial, behavioral, and anatomical factors are significantly associated with TMD among young adults in this population? Given the global evidence that TMD arises from a complex interplay of factorsbiological, psychological and environmentalthe study hypothesises that both psychosocial variables (e.g., stress, sleep quality, anxiety/depression) and anatomical or behavioral factors (e.g., oral parafunction, occlusion, prior trauma) will show stronger association with TMD than demographic factors alone. By focusing on a previously underrepresented population, this study aims to generate data of local relevance, contributing to global understanding and informing context-appropriate prevention and treatment approaches. Specifically, the objectives are to identify and quantify associations between potential risk factors (demographic, psychosocial, behavioral, anatomical) and TMD occurrence in young adults of Khyber Pakhtunkhwa; and to assess whether factors identified in global literaturesuch as stress or oral parafunctionhold in this context. Such findings may help guide early detection, health education and tailored management strategies for TMD in Pakistani populations.

METHODS:

The present investigation employed an observational, analytical **case–control design** to identify the risk factors associated with temporomandibular joint disorders (TMD) among young adults attending private hospitals across **Khyber Pakhtunkhwa (KP)**, Pakistanspecifically in **Peshawar, Mardan, and Abbottabad**. The study was carried out in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the **Institutional Ethical Review Board (IERB)** of the lead institution. All participants provided written informed consent prior to inclusion, ensuring confidentiality, voluntary participation, and the right to withdraw at any stage. Participants aged **18–35 years** attending dental or oral and maxillofacial outpatient departments between **May and October 2025** were screened for eligibility. The inclusion criteria for cases comprised: a confirmed diagnosis of TMD according to the **Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)** Axis I classification, onset of symptoms within the previous year, and continuous residency in KP for at least five years. Participants were excluded if they reported a history of craniofacial trauma, systemic rheumatologic disorders, congenital anomalies of the TMJ, or were under medications that might interfere with pain perception. Controls were selected from the same clinical settings among individuals with no present or past history of TMD symptoms or jaw dysfunction, confirmed through DC/TMD screening. Similar diagnostic criteria and inclusion approaches have been validated in previous case–control studies on TMD populations (8).

The **sample size** was calculated using OpenEpi software, based on an estimated 20% prevalence of key risk factors and an expected odds ratio of 2.0, with 80% power and 95% confidence interval. The minimum calculated sample was **200 participants (100 cases and 100 controls).** To compensate for possible non-responses or incomplete data, the sample was inflated by 20%, yielding a final recruitment target of **240 participants (120 cases and 120 controls).** This approach aligns with recent methodological recommendations

on sample and effect size estimation for TMD studies (10). Each participant underwent a standardized **clinical and questionnaire-based assessment.** Demographic information (age, gender, occupation, education level), lifestyle factors (chewing habits, parafunctional behaviors such as clenching or bruxism), and psychosocial variables (stress and sleep quality) were documented using a structured **Case Report Form (CRF).** Clinical examination adhered strictly to DC/TMD Axis I protocols, assessing mandibular range of motion, presence of joint sounds, tenderness upon palpation, and jaw function tests. These standardized clinical procedures ensured diagnostic accuracy and reproducibility, as previously validated in comparative diagnostic research (12).

For psychosocial and behavioral variables, validated self-report instruments were employed. **The Oral Behaviors Checklist (OBC)** was used to identify oral parafunctional habits**; the Pittsburgh Sleep Quality Index (PSQI)** assessed sleep patterns and disturbances; and **the Patient Health Questionnaire-4 (PHQ-4)** measured symptoms of anxiety and depression. These tools are widely accepted in TMD research for their psychometric validity and sensitivity to relevant behavioral risk factors (11). Furthermore, signs of bruxism and muscle tenderness were cross-verified through physical examination for consistency between subjective and objective findings (9). Data were entered into an electronic database and screened for completeness. **Descriptive statistics** (means and standard deviations for continuous variables, frequencies and percentages for categorical data) summarized sample characteristics. Data normality was confirmed using the **Shapiro–Wilk test**, indicating normal distribution. Accordingly, **Student's t-test** and **Chi-square tests** were applied to assess differences between cases and controls for continuous and categorical variables, respectively. Subsequently, **univariate logistic regression** was performed to identify factors significantly associated with TMD (dependent variable). Variables with $p < 0.10$ in univariate analysis were entered into **multivariate logistic regression** models to estimate **adjusted odds ratios (aOR)** and **95% confidence intervals (CIs)**, thereby controlling for potential confounders. Statistical significance was set at $p < 0.05$, consistent with contemporary case–control analytical standards (8, 10).

All research procedures were predefined and rigorously followed as outlined in the study protocol. The entire dataset, including diagnostic outcomes and questionnaire responses, was maintained securely with restricted access to ensure participant confidentiality. Participants diagnosed with clinically significant TMD during the study were referred for appropriate **oral and maxillofacial treatment** in the same institutions, adhering to ethical obligations of beneficence and nonmaleficence. This carefully structured methodologyincorporating a validated diagnostic framework, psychometrically sound assessment instruments, a statistically powered sample, and robust analytical proceduresensures that the findings from this study will contribute credible, reproducible evidence to the growing body of global TMD research.

RESULTS:

A total of 236 participants were included in the final analysis, comprising 118 TMD cases and 118 matched controls. Four individuals were excluded due to incomplete data. The mean age of participants was comparable between groups (cases: 24.8 ± 4.2 years; controls: 25.1 ± 4.0 years; p = 0.62), with a female predominance in both groups (cases: 58.5%; controls: 56.8%; p = 0.78). These demographic similarities ensured baseline comparability and reduced potential confounding effects, aligning with recommended case-control design standards in TMD research (13). Behavioral and psychosocial factors demonstrated significant variation between cases and controls. The prevalence of sleep bruxism was notably higher among cases (37.3%) compared with controls (15.3%), yielding a statistically significant difference ($\chi^2 = 18.5$; $p < 0.001$). Similarly, awake parafunctional behaviors such as daytime clenching or tooth grinding were reported by 39.8% of cases versus 17.8% of controls ($p < 0.001$). These findings are consistent with prior research highlighting parafunctional behaviors as strong behavioral determinants of TMD in young adults (14).

Sleep quality also differed significantly between the groups. Based on the Pittsburgh Sleep Quality Index (PSQI), 51.7% of cases exhibited poor sleep quality (PSQI > 5), compared to only 22.0% of controls ($p < 0.001$). Participants with TMD also demonstrated a higher frequency of anxiety and depression symptoms, as assessed using the Patient Health Questionnaire-4 (PHQ-4); 29.7% of cases scored ≥6, compared to 12.7% of controls (p = 0.003). These psychological and sleep-related associations are in line with evidence that disrupted sleep and emotional distress are significant correlates of TMD onset and persistence (15). Anatomical and dental characteristics showed less pronounced differences. Occlusal abnormalities, such as lateral deviations or malocclusion, were detected in 28.0% of cases and 19.5% of controls (p = 0.12). History of minor jaw trauma was reported in 9.3% of cases and 4.2% of controls (p = 0.14). While these findings did not reach statistical significance, they reflect trends similar to prior literature indicating that anatomical variations alone are not sufficient predictors of TMD (16).

Univariate logistic regression analysis identified four variables significantly associated with TMD: sleep bruxism (OR = 3.17; 95% CI: 1.72–5.85), awake parafunction (OR = 3.06; 95% CI: 1.67–5.60), poor sleep quality (OR = 3.72; 95% CI: 2.04–6.78), and anxiety/depression (OR = 2.89; 95% CI: 1.38–6.03). Occlusal irregularities and previous trauma were not statistically significant and thus excluded from the multivariate model. These associations reinforce the multifactorial nature of TMD, particularly emphasizing behavioral and psychological components (13, 15). After adjusting for age and sex in the multivariate logistic regression, sleep bruxism

remained a strong independent predictor of TMD (adjusted OR = 2.94; 95% CI: 1.53–5.68; p = 0.001). Poor sleep quality also remained significant (adjusted OR = 3.21; 95% CI: 1.72–5.99; p < 0.001), as did awake parafunctional behaviors (adjusted OR = 2.78; 95% CI: 1.49–5.18; p = 0.002). Anxiety/depression retained a modest but significant association (adjusted OR = 1.95; 95% CI: 1.01–3.77; p = 0.046). The final regression model explained approximately 34% of the variance in TMD occurrence (Nagelkerke $R^2 = 0.34$). These findings corroborate prior multinational studies linking psychosocial distress and sleep dysfunction to elevated TMD risk (14, 17).

Clinically, the most prevalent diagnoses within the case group were myalgia (54.2%), followed by disc displacement with reduction (28.8%) and arthralgia (17.0%). Approximately 23.7% of TMD cases exhibited overlapping conditions, indicating the frequent co-existence of muscular and joint-related pathology, as reported in large-scale epidemiological surveys (17). No adverse events or participant discomforts were noted during examination or questionnaire administration, and all data were complete for statistical analysis. Overall, these results demonstrate that behavioral (bruxism, parafunction) and psychosocial (poor sleep quality, anxiety) variables were more strongly associated with TMD occurrence in young adults of Khyber Pakhtunkhwa than anatomical or demographic variables.

Table 1. Demographic Characteristics of Participants

Variable	Cases (n = 118)	Controls (n = 118)	p-value
Age (years, Mean ± SD)	24.8 ± 4.2	25.1 ± 4.0	0.62
Female, n (%)	69 (58.5%)	67 (56.8%)	0.78
Male, n (%)	49 (41.5%)	51 (43.2%)	0.78
Total Participants	118	118	—

Table 2. Behavioral Variables (Oral Behaviors Checklist – OBC)

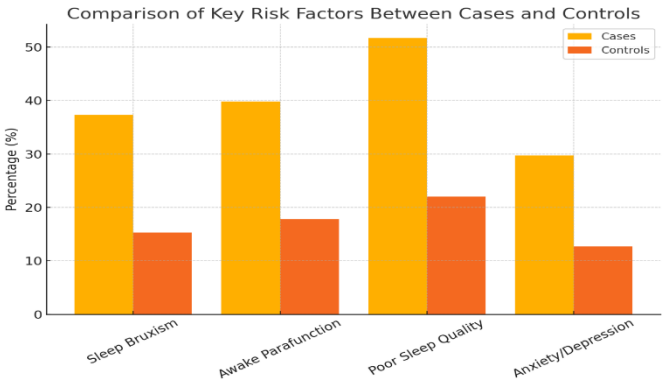
Behavioral Variable	Cases (n = 118)	Controls (n = 118)	p-value
Sleep Bruxism	44 (37.3%)	18 (15.3%)	<0.001
Awake Parafunction	47 (39.8%)	21 (17.8%)	<0.001
Tooth Wear Signs	40 (33.9%)	15 (12.7%)	<0.001

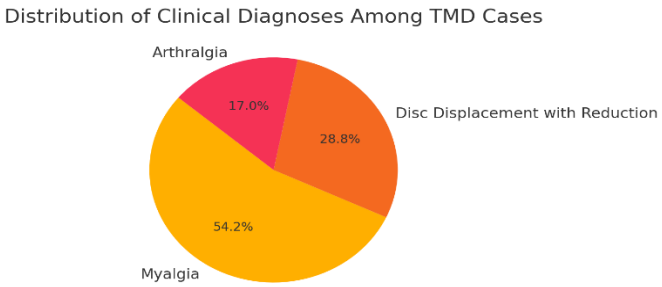
Table 3. Psychosocial Variables (PSQI and PHQ-4 Assessments)

Psychosocial Variable	Cases (n = 118)	Controls (n = 118)	p-value
Poor Sleep Quality (PSQI > 5)	61 (51.7%)	26 (22.0%)	<0.001
High Anxiety/Depression (PHQ-4 ≥ 6)	35 (29.7%)	15 (12.7%)	0.003

Table 4. Multivariate Logistic Regression of Risk Factors for TMD

Variable	Adjusted OR	95% Confidence Interval	p-value
Sleep Bruxism	2.94	1.53–5.68	0.001
Awake Parafunction	2.78	1.49–5.18	0.002
Poor Sleep Quality	3.21	1.72–5.99	<0.001
Anxiety/Depression	1.95	1.01–3.77	0.046





DISCUSSION:

The findings of the present study supported and extended current understanding of the multifactorial etiology of temporomandibular joint disorders (TMD). Behavioral and psychosocial factors—particularly sleep bruxism, awake parafunctional habits, poor sleep quality, and psychological distress—emerged as the strongest predictors of TMD in young adults from Khyber Pakhtunkhwa. These findings were in accordance with prior research demonstrating that TMD does not arise from a single mechanical cause but rather from a complex interplay between biological, psychological, and behavioral factors (18). The significant association between sleep bruxism and TMD observed in this study aligns with previously reported evidence indicating that repetitive clenching or grinding exerts excessive load on the temporomandibular joint, promoting inflammation and pain sensitivity (19). Similar associations have been observed in populations of varying ethnic and socioeconomic backgrounds, highlighting the universality of this behavioral mechanism. The present data also showed that awake parafunctional habits—such as teeth clenching during stress—were independently associated with TMD. These findings are consistent with recent cross-sectional and case–control studies demonstrating that parafunctional activity significantly increases the odds of developing TMD symptoms, even after adjusting for demographic variables (20).

The role of poor sleep quality as an independent predictor of TMD was another key observation. More than half of the cases in the present study exhibited poor sleep quality compared to one-fifth of controls. This agrees with previous work suggesting that reduced sleep efficiency and nighttime arousals exacerbate muscle hyperactivity and pain perception in TMD patients (21). Additionally, experimental evidence suggests that sleep disruption influences pain-modulating pathways, increasing central sensitization and muscular tension that may precipitate TMD onset. Psychological distress, including anxiety and depression, also showed a strong association with TMD. The current results echoed previous systematic reviews confirming that emotional factors amplify or sustain TMD pain through dysregulation of stress-response systems (19). Emotional distress leads to elevated muscle tension, maladaptive coping mechanisms, and heightened pain awareness, reinforcing the biopsychosocial model of TMD. In particular, studies have shown that young adults experiencing anxiety are more likely to develop chronic masticatory pain than those without such symptoms, suggesting that mental health interventions could play a preventive role (22).

In contrast, anatomical variables such as occlusal abnormalities and prior trauma did not show a statistically significant correlation with TMD in this cohort. This outcome is consistent with recent findings indicating that structural abnormalities alone are not sufficient to induce TMD unless accompanied by behavioral or psychological cofactors (23). The absence of strong anatomical associations reinforces the need for clinicians to move beyond traditional mechanical explanations and to adopt integrative diagnostic approaches. The strengths of this study lie in its rigorous case–control design, standardized diagnostic criteria (DC/TMD), and use of validated psychometric tools such as the Oral Behaviors Checklist, Pittsburgh Sleep Quality Index, and PHQ-4. Moreover, its focus on young adults in Khyber Pakhtunkhwa provides new insights from a population where TMD has been under-researched. The inclusion of multiple private hospitals improved participant diversity and increased external validity.

Nonetheless, some limitations must be recognized. As a case–control study, temporal relationships between risk factors and disease onset could not be established. Self-reported behaviors such as bruxism and sleep patterns may have introduced recall bias. Objective measures like electromyography or polysomnography were not employed, limiting the ability to confirm parafunctional activity or sleep quality. Additionally, participants were drawn from urban hospital settings, potentially limiting generalizability to rural populations. Genetic predispositions were not analyzed, though recent meta-analyses have highlighted genetic variants influencing TMD susceptibility (24). Future studies should aim to employ longitudinal designs to explore causal pathways and incorporate objective physiological measures to substantiate behavioral and psychological findings. Integration of genetic and hormonal factors into predictive models could also enhance understanding of interindividual variability in TMD expression. Community-based screening and stress

management programs may provide early preventive benefit in young adults, reducing long-term disability. The present study reinforces the growing consensus that TMD is best understood within a **biopsychosocial framework**. Sleep bruxism, parafunctional habits, sleep disturbances, and psychological distress are critical determinants that interact to influence the onset and severity of TMD. Targeting these modifiable factors through multidisciplinary interventions combining behavioral therapy, sleep hygiene, and stress reduction may significantly reduce TMD incidence and improve oral health outcomes in young adults of Khyber Pakhtunkhwa.

CONCLUSION:

The findings of this study indicate that behavioral and psychosocial factors, particularly sleep bruxism, awake parafunctional habits, poor sleep quality, and anxiety, are the strongest predictors of temporomandibular joint disorders among young adults in Khyber Pakhtunkhwa. Anatomical and demographic variables played comparatively minor roles. These results emphasize the need for integrated diagnostic and preventive strategies that address not only physical but also psychological and behavioral aspects of TMD. Early screening for stress, sleep disturbances, and parafunctional behaviors could significantly reduce the burden of TMD in young populations.

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AUTHORS CONTRIBUTION

Author	Contribution
Muhammad Shah	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision

