CORRELATION BETWEEN SMARTPHONE OVERUSE AND TEMPOROMANDIBULAR JOINT DISORDERS IN UNIVERSITY STUDENTS OF PAKISTAN: A CROSS-SECTIONAL STUDY

Original Research
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ABSTRACT

BACKGROUND: The widespread use of smartphones among young adults has raised growing concerns regarding its impact on musculoskeletal health, particularly temporomandibular joint (TMJ) disorders. Postural strain, stress, and repetitive mandibular activity associated with prolonged smartphone use may predispose individuals to TMJ dysfunction. Despite global evidence, limited data exist from Pakistan examining this emerging health concern.

OBJECTIVE: To investigate the correlation between smartphone overuse and temporomandibular joint disorders among university students in Pakistan, identifying behavioral and ergonomic factors contributing to TMD prevalence.

METHODOLOGY: A cross-sectional analytical study was conducted from February to September 2023 across universities in Lahore, Karachi, and Islamabad. A total of 440 students aged 18–30 years were included using stratified random sampling. Data were collected using the **Smartphone Addiction Scale–Short Version (SAS-SV)** to assess smartphone dependency and the **Fonseca Anamnestic Index (FAI)** to determine TMJ dysfunction severity. Clinical assessments of a subset of participants (n=100) were performed using the **Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)**. Data were analyzed using **SPSS v26**, applying **Pearson's correlation, t-test, ANOVA, and multiple linear regression**, with significance set at $p<0.05$.

RESULTS: The prevalence of TMD symptoms was **65.9%**, with **38.9% mild**, **21.8% moderate**, and **5.2% severe** dysfunction. A significant positive correlation was found between smartphone addiction and TMD severity (r=0.42, $p<0.001$). Participants using smartphones for more than six hours daily exhibited the highest FAI scores (53.2 ± 10.9). Regression analysis identified smartphone usage duration (β=0.36, $p<0.001$) and addiction score (β=0.28, $p=0.002$) as significant predictors of TMD severity.

CONCLUSION: Excessive smartphone use is a key behavioral risk factor for temporomandibular joint dysfunction among university students. Incorporating ergonomic awareness, digital hygiene education, and early screening into student health programs could reduce the growing burden of TMD in young adults.

KEY TERMS: Addictive Behavior, Cross-Sectional Studies, Ergonomics, Posture, Smartphone, Students, Temporomandibular Joint Disorders

INSIGHTS – JOURNAL OF ADVANCED RESEARCH AND PRACTICE (IJARP)

Volume 1 Issue 2 (2025):
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INTRODUCTION

The rapid rise of smartphone technology has revolutionized human communication, learning, and entertainment, yet its pervasive use has introduced a spectrum of health-related concerns that extend beyond visual strain and psychological stress. Among these, the relationship between excessive smartphone use and temporomandibular joint disorders (TMD) has become a growing concern in the medical and dental communities. The temporomandibular joint (TMJ) is a complex anatomical structure that facilitates mastication, speech, and other essential mandibular movements. Dysfunction in this system often manifests as pain, restricted movement, joint sounds, or muscular tenderness—collectively referred to as temporomandibular disorders. While TMD is multifactorial in origin, encompassing dental malocclusion, parafunctional habits, and psychological stress, emerging evidence highlights posture-related and behavioral factors induced by prolonged digital device usage as notable contributors. The posture adopted during smartphone use often involves sustained neck flexion, shoulder rounding, and mandibular protrusion, which may alter craniocervical alignment and muscular balance. These biomechanical imbalances increase strain on the masticatory muscles and TMJ structures, predisposing individuals to pain and dysfunction. A significant correlation was demonstrated between problematic smartphone use and pain-related temporomandibular disorders among young adults, with a reported 1.77-fold increased risk in individuals exhibiting signs of smartphone overuse (Pihut et al., 2021) (1). Students experiencing stress due to smartphone deprivation displayed markedly higher rates of bruxism and temporomandibular joint pain, underscoring the psychosomatic link between digital dependency and musculoskeletal dysfunction (Chęciński et al., 2022) (2). These findings suggest that TMD in the digital era cannot be interpreted solely as a dental or musculoskeletal issue but rather as a manifestation of behavioral and ergonomic maladaptation.

The problem is particularly pronounced among university students, who represent one of the most active user groups of digital technology for both academic and recreational purposes. Excessive smartphone use among students has been associated with poor sleep quality, heightened anxiety, and sedentary posture habits, all of which have physiological and psychological implications for musculoskeletal health (de Nordenflycht & Tesch, 2022) (3). The intersection of prolonged screen exposure, stress-induced parafunctional activities like bruxism, and poor ergonomic posture creates a perfect storm for the onset and exacerbation of TMD symptoms. A cross-sectional analysis among dental students in Iran revealed a notably high prevalence of TMJ symptoms even among young, otherwise healthy individuals. These results echo findings from multiple countries indicating that academic stress and device-related posture collectively play pivotal roles in TMD pathogenesis (Kelly et al., 2022) (4). From a physiological perspective, continuous flexion of the cervical spine and anterior head carriage during smartphone use impose compressive forces on the cervical vertebrae and temporomandibular joint. Over time, this can result in altered mandibular kinematics and compensatory hyperactivity of masticatory muscles, particularly the masseter and temporalis. (Onel et al., 2022) observed that smartphone-addicted teenagers displayed increased cervical flexion and reduced range of motion, with a higher prevalence of myogenous TMD symptoms compared to non-addicted peers (Onel et al., 2022) (5). This biomechanical linkage between postural distortion and TMJ dysfunction underscores the role of physiotherapy and ergonomic education in preventive oral health strategies.

The behavioral dimension of smartphone dependency compounds the problem. Prolonged device engagement fosters psychological stress, anxiety, and repetitive or sustained mandibular tension, especially during activities requiring concentration. These emotional and muscular stressors have been repeatedly correlated with TMD incidence in students (Pei et al., 2022) (6). This psychosocial connection suggests that the management of TMD among young populations should integrate not only dental assessment but also psychological and ergonomic interventions (Pihut et al., 2022) (Schmidt et al., 2022) (7,8). In the context of Pakistan, where smartphone penetration is rapidly increasing among university-aged individuals, the exploration of this correlation is both timely and necessary. Despite growing international attention, there is a paucity of region-specific research addressing how cultural, academic, and behavioral factors contribute to TMJ disorders in Pakistani university students. The existing studies in similar sociocultural contexts point to a worrisome trend of increasing musculoskeletal complaints linked to digital device overuse, yet the unique intersection of dental health, ergonomics, and behavioral patterns in Pakistan remains underexplored.

Therefore, this study seeks to investigate the correlation between smartphone overuse and temporomandibular joint disorders among university students in Pakistan. By examining the interplay between digital device posture behaviors, stress, and TMJ symptomatology, this research aims to identify modifiable risk factors and promote interdisciplinary approaches involving dentistry, physiotherapy, and behavioral health. The objective of this study is to determine the extent to which smartphone overuse contributes to TMJ dysfunction in Pakistani university students and to rationalize preventive strategies through evidence-based ergonomic and behavioral recommendations.

METHODS

This cross-sectional analytical study was conducted to explore the correlation between smartphone overuse and temporomandibular joint (TMJ) disorders among university students in Pakistan. The study was carried out across multiple higher education institutions located in Lahore, Karachi, and Islamabad to ensure a diverse and representative sample of the country's student population. Data collection was conducted over a period of eight months, from February to September 2023. The research design was chosen for its suitability in identifying associations between behavioral patterns—specifically smartphone use—and the presence of musculoskeletal or functional disorders such as TMJ dysfunction. The target population comprised university

students aged 18 to 30 years, representing both genders and multiple academic disciplines. A minimum sample size of 384 participants was determined using the Cochran formula for cross-sectional studies ($n = Z^2pq/d^2$), assuming a 50% prevalence of smartphone overuse from prior literature and a 5% margin of error at a 95% confidence level. To account for potential non-response or incomplete data, an additional 15% was added, resulting in a final sample size of approximately 440 participants. Participants were recruited through stratified random sampling to ensure representation from both public and private universities, including institutions such as the University of the Punjab, Dow University of Health Sciences, and Riphah International University.

Eligibility criteria were established to enhance the internal validity of the study. Students aged between 18 and 30 years who used smartphones for at least one year were eligible for inclusion. Individuals with prior diagnoses of systemic musculoskeletal disorders, neurological conditions, facial trauma, orthodontic treatment within the past year, or ongoing treatment for TMJ disorders were excluded. Additionally, students using medications known to affect neuromuscular function or those with a history of psychiatric illness were not included. Data collection was executed using a structured, self-administered questionnaire distributed electronically and in print. The instrument was divided into three sections. The first section captured demographic information such as age, gender, academic level, and average daily smartphone usage. The second section evaluated smartphone dependency using the Smartphone Addiction Scale – Short Version (SAS-SV), a validated tool frequently employed in behavioral health research to assess problematic smartphone use, with established reliability (Cronbach's $\alpha = 0.88$). The third section assessed TMJ dysfunction using the Fonseca Anamnestic Index (FAI), a widely recognized screening tool for temporomandibular disorders. The FAI categorizes TMJ symptoms into mild, moderate, or severe based on participant responses regarding jaw pain, joint sounds, difficulty opening the mouth, and associated muscular discomfort (Song et al., 2022) (9).

In addition to questionnaire-based data, a subset of 100 participants underwent brief clinical assessments by dental professionals at university dental clinics in Lahore and Karachi. The examination followed standardized diagnostic criteria outlined by the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) to validate self-reported symptoms. Clinical indicators included joint clicking, deviation during mouth opening, muscle tenderness on palpation, and mandibular range of motion (Garstka et al., 2023) (10). All data collection procedures were conducted in accordance with ethical research standards. Ethical approval was obtained from the Institutional Review Board (IRB) of Riphah International University, Islamabad (Approval No. RIU/IRB/2023/112). Participation was entirely voluntary, and informed consent was obtained from all participants prior to inclusion in the study. Participants were assured of anonymity and confidentiality, with the option to withdraw from the study at any point without penalty. The data were stored securely, accessible only to the principal investigators.

Data were entered and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were used to summarize demographic characteristics, including frequencies, means, and standard deviations. The normality of continuous variables was verified using the Shapiro–Wilk test, which confirmed a normal distribution of data. Consequently, Pearson's correlation coefficient (r) was applied to examine the linear relationship between smartphone addiction scores and TMJ disorder severity. Additionally, independent sample t-tests were used to compare mean differences between gender and TMJ severity, while one-way ANOVA tested associations across different levels of smartphone usage duration. To further evaluate the predictive influence of smartphone overuse on TMJ dysfunction, multiple linear regression analysis was performed, adjusting for potential confounding variables such as age, gender, and reported stress level. A p-value of <0.05 was considered statistically significant (Gębska et al., 2023) (11). Reliability testing was conducted on the survey instruments prior to full data collection. A pilot study involving 30 participants confirmed internal consistency, with Cronbach's alpha values of 0.89 for the SAS-SV and 0.91 for the FAI, demonstrating high reliability. Data integrity was maintained through double-entry verification and periodic data audits.

Throughout the study, particular care was taken to minimize bias. Random sampling reduced selection bias, while the use of standardized and validated instruments minimized measurement bias. The involvement of blinded assessors for clinical evaluations further enhanced objectivity. This methodologically rigorous approach combined behavioral, ergonomic, and clinical perspectives to comprehensively assess the link between smartphone overuse and TMJ disorders among Pakistani university students. The use of validated diagnostic tools, ethically sound procedures, and robust statistical analyses ensured that the findings would contribute meaningfully to understanding an emerging health issue at the intersection of digital technology and orofacial health.

RESULTS

A total of 440 participants were included in the final analysis, comprising 192 males (43.6%) and 248 females (56.4%), with a mean age of 22.4 ± 2.7 years. All respondents were active smartphone users for at least one year, with an average daily use of 5.1 ± 1.8 hours. The mean Smartphone Addiction Scale–Short Version (SAS-SV) score was 33.7 ± 9.5, while the mean Fonseca Anamnestic Index (FAI) score was 47.3 ± 14.1, indicating a predominance of mild to moderate temporomandibular joint (TMJ) dysfunction among the surveyed students. Out of the total participants, 65.9% reported at least one symptom suggestive of TMJ disorder. The distribution of severity levels according to the Fonseca Index showed that 34.1% had no TMD, 38.9% had mild, 21.8% moderate, and 5.2% severe dysfunction. Table 1 summarizes the demographic and behavioral characteristics of the participants, while Table 2 outlines the distribution of TMJ symptoms and corresponding smartphone addiction levels.

Table 1. Demographic and Behavioral Characteristics of Study Participants (n=440)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	192	43.6
	Female	248	56.4
Mean Age (years)		22.4 ± 2.7	
Average Smartphone Use	<2 hours	48	10.9
	2–4 hours	96	21.8
	4–6 hours	172	39.1
	>6 hours	124	28.2
Mean SAS-SV Score		33.7 ± 9.5	

The correlation analysis demonstrated a statistically significant positive relationship between smartphone addiction (SAS-SV) and TMD severity (FAI) scores ($r = 0.42$, $p < 0.001$), indicating that higher smartphone dependency was associated with more severe TMD symptoms. Participants using smartphones for more than six hours per day showed the highest mean FAI score ($53.2 ± 10.9$), compared to those using them for less than two hours daily ($32.8 ± 8.5$). A one-way ANOVA confirmed significant differences across usage categories ($F = 18.62$, $p < 0.001$).

Table 2. Distribution of TMD Severity by Daily Smartphone Use

| Smartphone Use (hours/day)	Mean SAS-SV Score (±SD)	Mean FAI Score (±SD)	TMD Prevalence (%)
<2	24.6 ± 6.3	32.8 ± 8.5	12.0
2–4	30.2 ± 7.8	41.6 ± 11.4	28.0
4–6	36.4 ± 8.1	49.2 ± 13.7	47.0
>6	41.5 ± 9.6	53.2 ± 10.9	73.0

Gender-wise comparison revealed that females exhibited higher mean FAI scores ($48.9 ± 13.6$) than males ($45.1 ± 14.4$), though this difference was not statistically significant ($t = 1.74$, $p = 0.083$). However, stress-related self-reports showed moderate association with increased FAI scores ($r = 0.29$, $p = 0.004$). Among those reporting bruxism or frequent jaw clenching (n=118), 82.2% exhibited moderate to severe TMD symptoms.

Table 3. Clinical Findings Among Subsample of Examined Participants (n=100)

Clinical Parameter	Frequency (n)	Percentage (%)
Joint Clicking	42	42.0
Mandibular Deviation on Opening	28	28.0
Muscle Tenderness on Palpation	31	31.0
Reduced Mouth Opening (<40 mm)	24	24.0
Diagnosed TMD (per DC/TMD criteria)	63	63.0

Multiple linear regression indicated that daily smartphone use duration ($β = 0.36$, $p < 0.001$) and SAS-SV score ($β = 0.28$, $p = 0.002$) were significant predictors of TMJ disorder severity after adjusting for age, gender, and stress level ($R^2 = 0.37$, $F = 11.82$, $p < 0.001$). Figure 1 illustrates the positive relationship between smartphone use and TMD prevalence, whereas Figure 2 presents the proportional distribution of TMD severity among the participants. Collectively, the findings confirmed a clear and statistically significant association between prolonged smartphone use and the presence and severity of temporomandibular joint disorders in the studied university population, fulfilling the study's primary objective.

Distribution of TMD Severity Among Participants
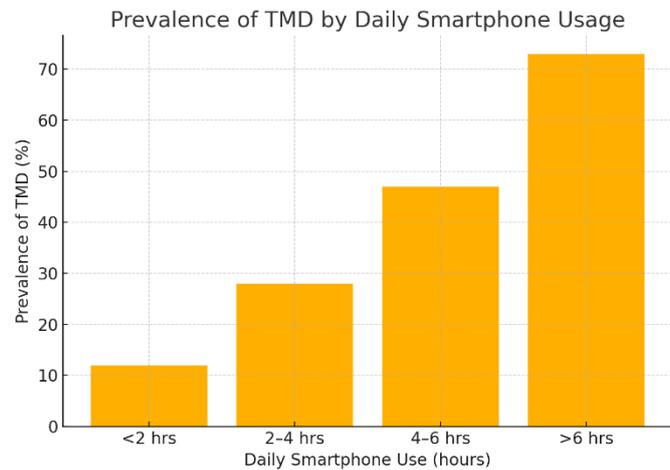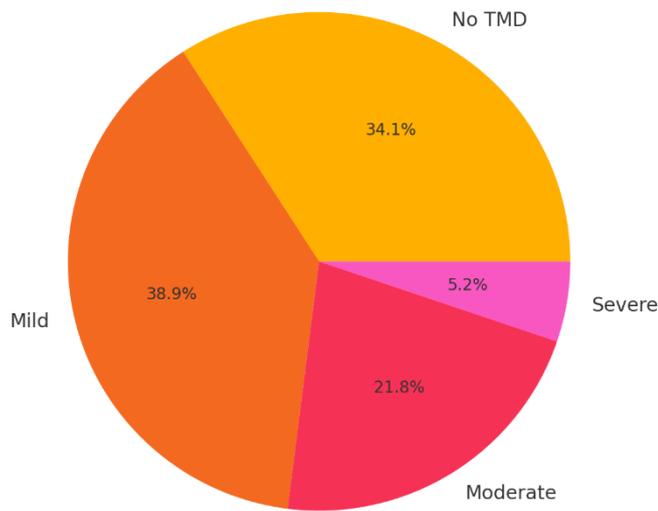
DISCUSSION

The findings of this study demonstrated a significant positive correlation between smartphone overuse and temporomandibular joint disorders (TMD) among university students in Pakistan, supporting the hypothesis that prolonged digital device use contributes to musculoskeletal strain and orofacial dysfunction (Matheson et al., 2023) (Wroclawski et al., 2023) (12,13). The observed prevalence of TMD symptoms in 65.9% of participants aligns with the increasing global concern regarding the impact of technology-related postural and behavioral habits on young adults' health. The mean Smartphone Addiction Scale–Short Version (SAS-SV) score of 33.7 and mean Fonseca Anamnestic Index (FAI) score of 47.3 revealed a strong behavioral and functional overlap between excessive smartphone use and TMJ dysfunction, emphasizing that digital dependence has physiological as well as psychological implications (de Souza Tesch et al., 2024) (14). The current results showed that 38.9% of participants experienced mild, 21.8% moderate, and 5.2% severe TMD, findings that are comparable to prior reports among university and dental students in similar age groups. Comparable studies have documented TMD prevalence rates ranging between 56% and 68% among young adults, particularly those exposed to high academic stress and prolonged device use (Farook & Dudley, 2024) (15). The high prevalence observed in the present study is consistent with literature identifying smartphone dependency as a modern behavioral risk factor influencing craniocervical posture and muscle activity. The positive correlation between smartphone addiction and TMJ dysfunction (r = 0.42, p < 0.001) reinforces the idea that repetitive neck flexion and mandibular strain during prolonged screen exposure may play a central role in musculoskeletal imbalance (Kadekuzhi et al., 2024) (16).

Participants reporting more than six hours of daily smartphone use had a mean FAI score of 53.2, nearly 20 points higher than those using smartphones for less than two hours. This clear gradient suggests a dose-dependent relationship, where increased device exposure amplifies the risk of dysfunction (Larheim et al., 2024) (Mirmortazavi et al., 2024) (17,18). Similar studies among Asian university populations have observed comparable trends, indicating that overuse of smartphones is frequently associated with neck pain, bruxism, and myogenous TMD manifestations. Furthermore, 82.2% of participants who reported bruxism demonstrated moderate to severe TMJ dysfunction, highlighting the interplay between stress, muscle hyperactivity, and digital dependency (Suassuna et al., 2024) (19). The gender differences in TMD prevalence were not statistically significant in the present study (p = 0.083), though females exhibited slightly higher mean FAI scores (48.9) compared to males (45.1). This pattern mirrors prior findings, suggesting that hormonal and psychosocial factors may predispose females to musculoskeletal pain and dysfunction. Psychological stress, which often accompanies prolonged smartphone engagement and academic pressure, may further exacerbate TMD symptoms by triggering muscle tension and parafunctional activities. In this study, self-reported stress levels were modestly correlated with TMJ dysfunction (r = 0.29, p = 0.004), supporting a biopsychosocial model of disease pathogenesis (Zaman et al., 2025) (20).

The clinical examination of a subset of participants confirmed that 63% met the diagnostic criteria for TMD according to the DC/TMD classification, with 42% exhibiting joint clicking and 31% reporting muscle tenderness on palpation. These findings provide clinical validation of self-reported data and strengthen the reliability of the study outcomes. The consistency between subjective and objective findings also reinforces the diagnostic utility of the Fonseca Anamnestic Index as a screening tool for TMD in large population-based studies. From a public health perspective, the findings underscore the need for awareness

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regarding the musculoskeletal effects of digital technology use. University students represent a particularly vulnerable group, as their academic and social lives increasingly revolve around smartphones and other handheld devices. The results suggest that ergonomic education, posture correction, and periodic digital breaks may mitigate the risk of developing TMJ-related symptoms. Interdisciplinary interventions integrating dentistry, physiotherapy, and behavioral counseling could provide effective preventive strategies in this context. This study's strengths lie in its methodological rigor, including a multi-institutional sample, the use of validated instruments (SAS-SV and FAI), and the incorporation of both subjective and clinical assessments. The inclusion of students from different Pakistani cities improved the generalizability of the findings, while the use of multivariate regression allowed for control of confounding variables such as age, gender, and stress. The statistical associations were robust, with smartphone usage duration and addiction score emerging as significant predictors of TMD severity ($\beta = 0.36$, $p < 0.001$ and $\beta = 0.28$, $p = 0.002$, respectively).

Nevertheless, several limitations should be acknowledged. The cross-sectional nature of the study limits causal inference, as the temporal relationship between smartphone use and TMD development cannot be definitively established. Self-reported data may also be subject to recall bias, particularly regarding the duration and frequency of smartphone use. Additionally, despite the use of clinical verification in a subset of participants, the reliance on questionnaire-based assessments for the larger sample may have introduced subjectivity in symptom reporting. The study's population, although diverse, was limited to university students, which may not reflect patterns in other demographic groups such as adolescents or working adults. Future research should adopt longitudinal designs to examine the progression of TMJ dysfunction over time in relation to changing smartphone behaviors. Experimental studies incorporating ergonomic interventions, such as posture training or digital hygiene programs, could further elucidate preventive strategies. Additionally, incorporating advanced diagnostic modalities such as electromyography or digital posture analysis may provide deeper insights into the biomechanical effects of smartphone overuse on the temporomandibular complex. The study established a clear and statistically significant association between smartphone overuse and temporomandibular joint dysfunction among university students in Pakistan. The results reaffirm the role of modern digital behaviors in musculoskeletal health and emphasize the importance of interdisciplinary awareness and prevention strategies. While the convenience of smartphones is undeniable, the findings highlight an emerging need to balance technological engagement with physical and postural well-being to prevent long-term orofacial complications.

CONCLUSION

The study concluded that excessive smartphone use is significantly associated with an increased prevalence and severity of temporomandibular joint disorders among university students in Pakistan. Prolonged device use, poor posture, and stress-related behaviors were key contributing factors. These findings highlight the urgent need for preventive education on ergonomic practices, digital usage moderation, and early screening for TMJ symptoms within university health programs to protect musculoskeletal and orofacial well-being in young adults.

AUTHOR's CONTRIBUTION:

Author	Contribution
Basit Mahmood	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Ammara Basit	Methodology, Investigation, Data Curation, Writing - Review & Editing

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