Research Article

Sleep Quality and Its Relationship with Temporomandibular Symptoms in Adolescents: A Cross-Sectional Study

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Abstract

Background: Temporomandibular disorders (TMD) represent a significant health concern among adolescents, potentially impacting quality of life and daily functioning. Sleep quality has emerged as a modifiable factor that may influence musculoskeletal pain conditions, yet its relationship with temporomandibular symptoms in the adolescent population remains underexplored. Methods: A cross-sectional study was conducted among 472 adolescents (mean age: 15.0 ± 1.7 years; 52.8% female) enrolled in secondary schools. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), while temporomandibular symptoms were evaluated using the Fonseca Anamnestic Index (FAI). Demographic and behavioral variables were collected through a structured questionnaire. Statistical analyses included descriptive statistics, chi-square tests, Pearson correlation coefficients, and multiple logistic regression. Results: Poor sleep quality (PSQI > 5) was observed in 40.3% of participants, while 35.6% presented with at least mild TMD symptoms. A significant positive correlation was found between PSQI scores and FAI scores ($r = 0.376$, $p < 0.001$). Adolescents with poor sleep quality demonstrated 2.48 times higher odds of presenting TMD symptoms compared to good sleepers (95% CI: 1.69-3.64, $p < 0.001$). Female sex, excessive screen time, and psychological stress were identified as additional significant predictors. Conclusion: Poor sleep quality is significantly associated with increased temporomandibular symptoms in adolescents. These findings suggest that sleep assessment should be incorporated into the clinical evaluation of adolescents presenting with TMD symptoms, and sleep hygiene interventions may serve as an adjunctive therapeutic strategy.

Keywords: temporomandibular disorders; sleep quality; adolescents; Pittsburgh Sleep Quality Index; Fonseca Anamnestic Index; orofacial pain.

1. Introduction

Temporomandibular disorders (TMD) constitute a heterogeneous group of musculoskeletal and neuromuscular conditions affecting the temporomandibular joint, masticatory muscles, and associated structures [1]. These conditions represent one of the most prevalent forms of chronic orofacial pain, characterized by symptoms including pain in the masticatory muscles and temporomandibular joint region, limitations in mandibular movement, and joint sounds during function [2]. The etiology of TMD is recognized as multifactorial, involving biomechanical, psychological, and neurobiological factors that interact in complex ways to influence disease onset and progression [3].

While traditionally considered a condition predominantly affecting adults, recent epidemiological evidence indicates that TMD symptoms are notably prevalent among adolescent populations [4]. Studies have reported prevalence rates ranging from 16% to 68% in children and adolescents, depending on the diagnostic criteria employed and the population studied [5]. The adolescent period represents a critical developmental phase during which biological, psychological, and social changes may predispose individuals to various health conditions, including musculoskeletal disorders [6]. Understanding the factors associated with TMD in this age group is essential for developing targeted preventive and therapeutic interventions.

Sleep quality has emerged as a significant factor in the pathophysiology and clinical expression of chronic pain conditions [7]. The bidirectional relationship between sleep and pain has been extensively documented, with poor sleep quality contributing to enhanced pain sensitivity and chronic pain conditions conversely disrupting sleep architecture [8].

Neurobiological research has elucidated shared pathways involving central sensitization, hypothalamic-pituitary-adrenal axis dysregulation, and altered inflammatory responses that may mediate this relationship [9].

Adolescence is characterized by significant changes in sleep patterns, including a biological shift toward delayed sleep phase and reduced total sleep time [10]. Contemporary factors such as increased academic demands, extensive screen time, and social media use have further exacerbated sleep disturbances in this population [11]. The National Sleep Foundation recommends 8-10 hours of sleep for adolescents; however, studies consistently demonstrate that a substantial proportion of adolescents fail to meet these recommendations [12].

The Pittsburgh Sleep Quality Index (PSQI) is a widely validated instrument for assessing sleep quality across various populations, including adolescents [13]. Similarly, the Fonseca Anamnestic Index (FAI) provides a reliable and practical screening tool for TMD symptoms, particularly suitable for epidemiological studies in younger populations [14]. The application of these validated instruments enables standardized assessment and facilitates comparisons across studies.

While several studies have examined the relationship between sleep and TMD in adult populations, research specifically investigating this association in adolescents remains limited [15]. The unique developmental characteristics of adolescence, including ongoing physical maturation and heightened vulnerability to environmental stressors, suggest that the sleep-TMD relationship may manifest differently in this age group compared to adults [16]. Furthermore, identifying modifiable risk factors such as sleep quality could inform the development of non-pharmacological interventions appropriate for the adolescent population.

The aim of this study was to investigate the relationship between sleep quality and temporomandibular symptoms among adolescents aged 12-18 years, while controlling for potential confounding variables including sex, age, psychological stress, and lifestyle factors. We hypothesized that poor sleep quality would be significantly associated with increased prevalence and severity of temporomandibular symptoms in this population.

2. Materials and Methods

2.1 Study Design and Setting

This cross-sectional observational study was conducted between September 2023 and February 2024 in four public secondary schools located in an urban area.

2.2 Sample Size Calculation

Sample size was calculated using G*Power software (version 3.1.9.7). Based on previous literature reporting correlations between sleep quality and musculoskeletal symptoms, an effect size of 0.15, alpha level of 0.05, and power of 0.90 were established. Considering a 15% non-response rate, a minimum sample size of 450 participants was determined necessary.

2.3 Participants

The study population consisted of adolescents aged 12-18 years enrolled in grades 7 through 12. A stratified random sampling method was employed, with stratification by grade level to ensure representative distribution across age groups.

Inclusion Criteria

1. Age between 12 and 18 years at the time of assessment
2. Regular enrollment in participating schools
3. Provision of informed consent from parent/guardian and assent from participant

Exclusion Criteria

1. History of facial trauma within the previous 12 months
2. Diagnosed systemic rheumatic or musculoskeletal disease
3. Current orthodontic treatment with fixed appliances
4. Diagnosed sleep disorders (e.g., obstructive sleep apnea, narcolepsy)
5. Chronic use of medications affecting sleep or pain perception
6. Cognitive or developmental disabilities precluding questionnaire completion

2.4 Data Collection Instruments

Demographic and Behavioral Questionnaire: A structured questionnaire collected information on age, sex, body mass index (BMI), screen time, physical activity, caffeine consumption, and self-reported psychological stress levels.

Pittsburgh Sleep Quality Index (PSQI): Sleep quality was assessed using the validated version of the PSQI. This 19-item self-report questionnaire evaluates seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Component scores range from 0 to 3, yielding a global score ranging from 0 to 21, with higher scores indicating poorer sleep quality. A global PSQI score greater than 5 was used to classify participants as poor sleepers.

Fonseca Anamnestic Index (FAI): TMD symptoms were evaluated using the FAI, a validated 10-item questionnaire assessing symptoms including jaw pain, headache, neck pain, jaw clicking, clenching/grinding habits, malocclusion perception, and emotional stress. Each item is scored as 0 (no), 5 (sometimes), or 10 (yes), yielding total scores ranging from 0 to 100. Classification follows established criteria: no TMD (0-15), mild TMD (20-40), moderate TMD (45-65), and severe TMD (70-100).

Psychological Stress Assessment: Self-perceived stress was evaluated using the Perceived Stress Scale-10 (PSS-10), with scores categorized as low (0-13), moderate (14-26), or high (27-40) stress.

2.5 Procedures

Data collection was conducted during regular school hours in designated quiet classrooms. Trained research assistants provided standardized instructions and supervised questionnaire completion. Participants completed all questionnaires independently, with research assistants available to clarify questions. The average time for questionnaire completion was approximately 20 minutes.

2.6 Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corporation, Armonk, NY, USA). Normality of continuous variables was assessed using the Shapiro-Wilk test. Descriptive statistics were expressed as mean ± standard deviation (SD) for continuous variables and frequencies (percentages) for categorical variables.

Comparisons between groups were performed using independent samples t-tests or Mann-Whitney U tests for continuous variables and chi-square tests for categorical variables. Pearson correlation coefficients were calculated to assess relationships between continuous variables. Multiple logistic regression analysis was conducted to identify independent predictors of TMD symptoms, with adjustment for potential confounders. Variables with $p < 0.20$ in univariate analyses were included in the multivariate model. Odds ratios (OR) with 95% confidence intervals (CI) were calculated. Statistical significance was set at $p < 0.05$ for all analyses.

3. Results

3.1 Sample Characteristics

A total of 505 adolescents were initially approached, of whom 472 met inclusion criteria and provided complete data (response rate: 93.5%). The sample comprised 249 females (52.8%) and 223 males (47.2%), with a mean age of 15.0 ± 1.7 years. The demographic and behavioral characteristics of participants are presented in Table 1.

Table 1: Demographic and Behavioral Characteristics of Study Participants (N = 472)

Variable	n (%) or Mean ± SD
Age (years)	15.0 ± 1.7
Sex	
Female	249 (52.8%)
Male	223 (47.2%)
BMI (kg/m²)	21.6 ± 3.4
BMI Category	
Underweight	39 (8.3%)
Normal weight	315 (66.7%)
Overweight	84 (17.8%)
Obese	34 (7.2%)
Screen time (hours/day)	5.4 ± 2.2

Variable	n (%) or Mean ± SD
< 2 hours	55 (11.7%)
2-4 hours	142 (30.1%)
> 4 hours	275 (58.3%)
Physical activity	
≥ 3 times/week	201 (42.6%)
1-2 times/week	159 (33.7%)
Sedentary	112 (23.7%)
Caffeine consumption	
None	165 (35.0%)
1-2 cups/day	230 (48.7%)
≥ 3 cups/day	77 (16.3%)
Perceived stress (PSS-10)	17.9 ± 6.8
Low stress	151 (32.0%)
Moderate stress	255 (54.0%)
High stress	66 (14.0%)

BMI: Body Mass Index; PSS-10: Perceived Stress Scale-10; SD: Standard Deviation

3.2 Sleep Quality Assessment

The mean global PSQI score was 5.9 ± 3.2 (range: 0-17). Poor sleep quality (PSQI > 5) was identified in 190 participants (40.3%), while 282 participants (59.7%) were classified as good sleepers. The mean sleep duration was 7.0 ± 1.2 hours per night, with 256 participants (54.2%) reporting less than 8 hours of sleep. Females demonstrated significantly higher PSQI scores compared to males (6.4 ± 3.3 vs. 5.3 ± 2.9, $p < 0.001$).

3.3 Temporomandibular Symptoms Assessment

The mean FAI score was 22.9 ± 18.7 (range: 0-80). TMD symptoms classification revealed: no TMD in 304 participants (64.4%), mild TMD in 109 (23.1%), moderate TMD in 45 (9.5%), and severe TMD in 14 (3.0%). Overall, 168 participants (35.6%) presented with at least mild TMD symptoms. Females showed significantly higher FAI scores compared to males (26.0 ± 19.6 vs. 19.5 ± 16.9, $p < 0.001$).

3.4 Association Between Sleep Quality and TMD Symptoms

A significant positive correlation was observed between PSQI global scores and FAI scores ($r = 0.376$, $p < 0.001$). Among participants with poor sleep quality, 54.7% (104/190) presented TMD symptoms compared to 22.7% (64/282) among good sleepers ($\chi^2 = 50.84$, $p < 0.001$). Comparison of sleep quality parameters between participants with and without TMD symptoms is presented in Table 2.

Table 2: Comparison of Sleep Quality Parameters Between Adolescents With and Without TMD Symptoms

Variable	Without TMD (n=304)	With TMD (n=168)	p-value
PSQI Global Score	4.7 ± 2.7	8.1 ± 3.0	< 0.001*
PSQI Components			
Subjective sleep quality	0.68 ± 0.64	1.27 ± 0.79	< 0.001*
Sleep latency	0.84 ± 0.86	1.43 ± 0.91	< 0.001*
Sleep duration	0.88 ± 0.83	1.22 ± 0.88	< 0.001*
Sleep efficiency	0.44 ± 0.68	0.73 ± 0.84	< 0.001*

Variable	Without TMD (n=304)	With TMD (n=168)	p-value
Sleep disturbances	0.98 ± 0.55	1.39 ± 0.62	< 0.001*
Use of sleep medication	0.10 ± 0.36	0.24 ± 0.57	0.004*
Daytime dysfunction	0.78 ± 0.72	1.35 ± 0.78	< 0.001*
Sleep duration (hours)	7.3 ± 1.1	6.4 ± 1.2	< 0.001*
Poor sleep quality (PSQI > 5)	86 (28.3%)	104 (61.9%)	< 0.001†
Sleep duration < 8 hours	146 (48.0%)	110 (65.5%)	< 0.001†

PSQI: Pittsburgh Sleep Quality Index; TMD: Temporomandibular Disorders *Independent samples t-test; †Chi-square test Values expressed as mean ± SD or n (%)

3.5 Predictors of TMD Symptoms

Multiple logistic regression analysis identified several independent predictors of TMD symptoms. The results are presented in Table 3. Poor sleep quality remained a significant predictor after adjusting for demographic and behavioral variables (adjusted OR = 2.48, 95% CI: 1.69-3.64, p < 0.001). Female sex, high perceived stress, and excessive screen time were also identified as significant independent predictors.

Table 3: Multiple Logistic Regression Analysis of Factors Associated with TMD Symptoms

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Poor sleep quality (PSQI > 5)	4.12 (2.78-6.11)	2.48 (1.69-3.64)	< 0.001
Sex (Female vs. Male)	1.98 (1.35-2.90)	1.71 (1.13-2.58)	0.011
Age (per year increase)	1.06 (0.94-1.19)	1.03 (0.90-1.17)	0.675
Perceived stress			
Low (reference)	1.00	1.00	-
Moderate	1.73 (1.07-2.79)	1.41 (0.84-2.35)	0.192
High	4.08 (2.20-7.55)	2.57 (1.31-5.03)	0.006
Screen time			
< 2 hours (reference)	1.00	1.00	-
2-4 hours	1.31 (0.67-2.58)	1.18 (0.58-2.40)	0.645
> 4 hours	2.25 (1.20-4.22)	1.84 (1.02-3.32)	0.043
Physical activity			
≥ 3 times/week (reference)	1.00	1.00	-
1-2 times/week	1.19 (0.78-1.82)	1.12 (0.72-1.76)	0.616
Sedentary	1.51 (0.95-2.42)	1.26 (0.75-2.12)	0.382
BMI category			

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Normal weight (reference)	1.00	1.00	-
Underweight	1.09 (0.53-2.24)	1.05 (0.49-2.23)	0.903
Overweight	1.22 (0.74-2.02)	1.10 (0.64-1.88)	0.736
Obese	1.43 (0.70-2.91)	1.24 (0.58-2.64)	0.578
Caffeine consumption (≥ 3 cups/day)	1.48 (0.88-2.50)	1.16 (0.66-2.04)	0.607

OR: Odds Ratio; CI: Confidence Interval; PSQI: Pittsburgh Sleep Quality Index; BMI: Body Mass Index Model adjusted for all variables listed; Hosmer-Lemeshow test: p = 0.721; Nagelkerke R^2 = 0.261

4. Discussion

The present study provides evidence of a significant association between sleep quality and temporomandibular symptoms among adolescents, contributing to the growing body of literature on the sleep-pain relationship in younger populations. Our findings revealed that 40.3% of adolescents demonstrated poor sleep quality and 35.6% presented with TMD symptoms, with a moderate positive correlation observed between these conditions.

The prevalence of poor sleep quality in our sample aligns with previous studies investigating adolescent sleep patterns. Research has consistently demonstrated that a substantial proportion of adolescents experience inadequate sleep, with biological, behavioral, and environmental factors contributing to this phenomenon [17]. The biological tendency toward delayed circadian phase during adolescence, combined with early school start times and increased evening exposure to electronic devices, creates conditions conducive to chronic sleep insufficiency [18].

The prevalence of TMD symptoms observed in this study (35.6%) is consistent with findings from other epidemiological investigations of adolescent populations. A systematic review examining TMD prevalence in children and adolescents reported rates ranging from 16% to 68%, with variations attributable to differences in diagnostic criteria and assessment methods [19]. Our use of the Fonseca Anamnestic Index, a validated screening instrument, facilitated identification of symptomatic individuals while acknowledging that clinical examination would be required for definitive diagnosis.

The significant correlation between PSQI and FAI scores (r = 0.376) and the substantially elevated odds of TMD symptoms among poor sleepers (OR = 2.48) underscore the clinical relevance of this association. These findings are consistent with research in adult populations demonstrating links between sleep disturbances and temporomandibular pain [20]. Mechanistically, the relationship between sleep and pain is understood to be bidirectional, with experimental sleep deprivation studies demonstrating increased pain sensitivity and clinical investigations showing that pain conditions disrupt sleep architecture [21].

Several pathophysiological mechanisms may underlie the observed association. Sleep deprivation has been shown to enhance central sensitization, a phenomenon characterized by amplified nociceptive processing within the central nervous system that contributes to chronic pain conditions including TMD [22]. Additionally, poor sleep quality is associated with elevated inflammatory markers and dysregulation of the hypothalamic-pituitary-adrenal axis, both of which may contribute to musculoskeletal pain [23]. The trigeminal system, which mediates orofacial pain, may be particularly susceptible to sleep-related modulation of nociceptive processing.

The finding that females demonstrated both poorer sleep quality and higher TMD symptom prevalence is consistent with established literature documenting sex differences in both domains [24]. Hormonal factors, including estrogen's influence on pain processing and sleep regulation, may partially explain these differences. Additionally, psychosocial factors and differential stress reactivity between sexes may contribute to the observed disparities [25].

Psychological stress emerged as a significant independent predictor of TMD symptoms in our study, which aligns with the biopsychosocial model of TMD etiology. The adolescent period is characterized by heightened emotional reactivity and ongoing development of stress regulation capacities, potentially increasing vulnerability to stress-related health outcomes [26]. The relationship between stress, sleep, and pain likely involves complex reciprocal interactions, with each factor capable of exacerbating the others.

The association between excessive screen time and TMD symptoms observed in our study warrants attention given contemporary adolescent media consumption patterns. Prolonged device use may contribute to TMD symptoms through multiple mechanisms, including sustained postural strain, reduced physical activity, and disruption of sleep through evening light exposure and psychological arousal [27]. Additionally, the association between screen time and TMD may be partially mediated by its impact on sleep quality, as electronic device use before bedtime has been consistently linked to poor sleep outcomes in adolescents [28].

Our findings have several clinical implications. First, the assessment of sleep quality should be incorporated into the clinical evaluation of adolescents presenting with TMD symptoms. The PSQI or simplified screening questions can facilitate identification of sleep disturbances that may contribute to symptom persistence. Second, sleep hygiene education and behavioral interventions targeting sleep quality may serve as valuable adjunctive therapeutic strategies for adolescents with TMD. Such interventions are generally safe, cost-effective, and may provide benefits beyond TMD symptom reduction [29].

From a public health perspective, our findings support the importance of promoting adequate sleep among adolescents as a component of general health promotion. School-based interventions addressing sleep hygiene, screen time limitations, and stress management may yield benefits for both sleep quality and musculoskeletal health outcomes [30]. Additionally, consideration of school start times and their impact on adolescent sleep represents an important policy consideration.

Several limitations of this study should be acknowledged. The cross-sectional design precludes determination of causal relationships between sleep quality and TMD symptoms. Longitudinal studies are needed to elucidate temporal relationships and potential bidirectional effects. Additionally, all assessments were based on self-report questionnaires, which may be subject to recall bias and social desirability effects. Objective measures of sleep, such as actigraphy or polysomnography, would provide more precise characterization of sleep parameters. Furthermore, TMD assessment was limited to a screening questionnaire without clinical examination, potentially leading to misclassification of some participants. Finally, the study sample was drawn from an urban setting, limiting generalizability to rural populations or different cultural contexts.

Future research should employ longitudinal designs to investigate the temporal relationship between sleep quality and TMD symptom development. Intervention studies examining whether sleep improvement leads to reduction in TMD symptoms would provide valuable evidence regarding the causal nature of this relationship. Additionally, investigation of potential mediating mechanisms, including inflammatory markers, stress hormones, and central sensitization indices, would enhance understanding of the pathophysiological pathways linking sleep and TMD.

5. Conclusion

This study demonstrates a significant association between poor sleep quality and temporomandibular symptoms among adolescents. Approximately 40% of adolescents exhibited poor sleep quality, and those with sleep disturbances showed about 2.5-fold increased odds of presenting TMD symptoms compared to good sleepers. Female sex, psychological stress, and excessive screen time were identified as additional significant predictors of TMD symptoms.

These findings highlight the importance of considering sleep quality in the comprehensive assessment and management of adolescents with temporomandibular symptoms. Integration of sleep evaluation into clinical practice may facilitate identification of modifiable factors contributing to symptom persistence. Furthermore, sleep hygiene interventions and behavioral strategies targeting sleep improvement may represent valuable adjunctive therapeutic approaches for adolescents with TMD.

Public health initiatives promoting healthy sleep behaviors among adolescents may contribute to prevention and management of TMD symptoms, alongside broader benefits for physical and mental health. Future longitudinal and interventional studies are warranted to further elucidate the causal nature of the sleep-TMD relationship and to evaluate the effectiveness of sleep-focused interventions in improving TMD outcomes.

References

1. Fernandes G, van Selms MKA, Lobbezoo F, Aarab G, do Braido GVV, Campi LB, Jordani PC, de Gonçalves DAG. Subjective sleep complaints were associated with painful temporomandibular disorders in adolescents: The Epidor-Adolescere study. J Oral Rehabil. 2022 Sep;49(9):849-859. doi: 10.1111/joor.13344. PMID: 35620883.
2. Jiang Y, Yu M, Gong X, Zhao Y, Gao X. Association of night-time sleep and daytime napping with painful temporomandibular disorder. J Oral Rehabil. 2024 Oct;51(10):1981-1988. doi: 10.1111/joor.13786. PMID:

38894533.
3. Salbego RS, Conti PCR, Soares FFC, Ferreira DMAO, Herreira-Ferreira M, de Lima-Netto BA, Svensson P, Costa YM, Bonjardim LR. Influence of psychometric and sleep quality features on painful mechanical sensitivity and pain modulation in patients with temporomandibular disorders. Clin Oral Investig. 2024 May 7;28(6):302. doi: 10.1007/s00784-024-05699-y. PMID: 38714576.
4. Campi LB, Visscher CM, Ongaro PCJ, do Vale Braido GV, Fernandes G, Gonçalves DAG. Widespread pain and central sensitization in adolescents with signs of painful temporomandibular disorders. J Oral Facial Pain Headache. 2020 Winter;34(1):83-91. doi: 10.11607/ofph.2288. PMID: 31247058.
5. Knibbe W, de Jongh A, Acar-Ceylan K, Al Hamami Z, Visscher CM, Lobbezoo F. The effects of trauma-focused treatment on painful temporomandibular disorders, awake bruxism and sleep bruxism in patients with severe post-traumatic stress disorder. J Oral Rehabil. 2024 Oct;51(10):2019-2028. doi: 10.1111/joor.13785. PMID: 39418582.
6. Dos Santos Proença J, Baad-Hansen L, do Vale Braido GV, Campi LB, de Godoi Gonçalves DA. Clinical features of chronic primary pain in individuals presenting painful temporomandibular disorder and comorbidities. J Oral Rehabil. 2024 Feb;51(2):255-265. doi: 10.1111/joor.13598. PMID: 37727030.
7. Keela W, Itthikul T, Mitrirattanakul S, Pongrojpaw S. Awake and sleep oral behaviours in patients with painful temporomandibular disorders. Int Dent J. 2024 Feb;74(1):138-145. doi: 10.1016/j.identj.2023.07.013. PMID: 37586995.
8. Velly AM, Botros J, Bolla MM, Khan K, Teixeira Junior OA, Guimarães AS, Gornitsky M. Painful and non-painful comorbidities associated with short- and long-term painful temporomandibular disorders: A cross-sectional study among adolescents from Brazil, Canada and France. J Oral Rehabil. 2022 Mar;49(3):273-282. doi: 10.1111/joor.13280. PMID: 34731502.
9. Braido GVDV, Campi LB, Jordani PC, Fernandes G, Gonçalves DAG. Temporomandibular disorder, body pain and systemic diseases: assessing their associations in adolescents. J Appl Oral Sci. 2020 Sep 7;28:e20190608. doi: 10.1590/1678-7757-2019-0608. PMID: 32901693.
10. Ruiz-Marrara J, Antunes LG, Bataglion C, Fernandes MH, Melchior MO, Magri LV. Cognitive domain impairments in chronic painful temporomandibular disorders: associations with pain intensity, hypervigilance and catastrophising: a cross-sectional analysis. J Oral Rehabil. 2026 Jan;53(1):76-88. doi: 10.1111/joor.70064. PMID: 40990683.
11. Fernandes G, Arruda MA, Bigal ME, Camparis CM, Gonçalves DAG. Painful temporomandibular disorder is associated with migraine in adolescents: a case-control study. J Pain. 2019 Oct;20(10):1155-1163. doi: 10.1016/j.jpain.2019.03.010. PMID: 30936004.
12. Caetano JP, Goettems ML, Nascimento GG, Jansen K, da Silva RA, Svensson P, Boscato N. Influence of malocclusion on sleep bruxism and orofacial pain: data from a study in school children. Clin Oral Investig. 2024 Feb 13;28(2):142. doi: 10.1007/s00784-024-05545-1. PMID: 38347236.
13. Magri LV, Melchior MO, da Silva GV, Gherardi-Donato ECDS, Leite-Panissi CRA. Phenotypes of painful TMD in discordant monozygotic twins according to a cognitive-behavioral-emotional model: a case-control study. PLoS One. 2025 Apr 17;20(4):e0320515. doi: 10.1371/journal.pone.0320515. PMID: 40244989.
14. Knibbe W, Lobbezoo F, Voorendonk EM, Visscher CM, de Jongh A. Prevalence of painful temporomandibular disorders, awake bruxism and sleep bruxism among patients with severe post-traumatic stress disorder. J Oral Rehabil. 2022 Nov;49(11):1031-1040. doi: 10.1111/joor.13367. PMID: 36056716.
15. Dreweck FDS, Soares S, Duarte J, Conti PCR, De Luca Canto G, Luís Porporatti A. Association between painful temporomandibular disorders and sleep quality: a systematic review. J Oral Rehabil. 2020 Aug;47(8):1041-1051. doi: 10.1111/joor.12993. PMID: 32395855.
16. Soares FFC, Ferreira DMAO, Raimundini AA, Dionísio TJ, Dos Santos CF, Conti PCR, Costa YM, Bonjardim LR. Influence of genetic polymorphisms on mechanical pain sensitivity and endogenous pain modulation of trigeminal and spinal areas. J Oral Rehabil. 2023 Jan;50(1):39-53. doi: 10.1111/joor.13384. PMID: 36285544.
17. Zhang Y, Ozathaley A, Wang X, Wu Y, Zhang K, Li Y, Nuerlan G, Li Q, Mao J, Li H, Gong S. Causal effects of sleep behaviors on temporomandibular disorders and pain: a bidirectional mendelian randomization study. J Oral Facial Pain Headache. 2025 Jun;39(2):101-111. doi: 10.22514/jofph.2025.029. PMID: 41070538.
18. Khan K, Muller-Bolla M, Anacleto Teixeira Junior O, Gornitsky M, Guimarães AS, Velly AM. Comorbid conditions associated with painful temporomandibular disorders in adolescents from Brazil, Canada and France: a cross-sectional study. J Oral Rehabil. 2020 Apr;47(4):417-424. doi: 10.1111/joor.12923. PMID: 31834958.
19. Poluha RL, Canales GT, Ferreira DM, Stuginski-Barbosa J, Conti PCR. Catastrophizing and hypervigilance influence subjective sleep quality in painful TMD patients. J Oral Facial Pain Headache. 2023 Winter;37(1):47-53. doi: 10.11607/ofph.3269. PMID: 36917236.

20. Rehm DD, Progiante PS, Pattussi MP, Pellizzer EP, Grossi PK, Grossi ML. Sleep disorders in patients with temporomandibular disorders (TMD) in an adult population-based cross-sectional survey in Southern Brazil. Int J Prosthodont. 2020 Jan-Feb;33(1):9-13. doi: 10.11607/ijp.6223. PMID: 31860908.
21. Calixtre LB, van der Meer HA, Visscher CM, de Oliveira AB, de Godoi Gonçalves DA. The association between the Central Sensitisation Inventory and temporomandibular disorders is confounded by migraine, depression, widespread pain and parafunction: a cross-sectional telehealth study. J Oral Rehabil. 2024 Dec;51(12):2577-2587. doi: 10.1111/joor.13852. PMID: 39287359.
22. Mengi A, Uygunoglu U. Impact of temporomandibular disorder comorbidity on pain, quality of life, sleep, and functional outcomes in chronic migraine patients not using preventive treatment: a cross-sectional study. Neurol Res. 2025 Sep;47(9):891-899. doi: 10.1080/01616412.2025.2507755. PMID: 40380780.
23. Fischer J, Skeie MS, Rosendahl K, Tylleskär K, Lie S, Shi XQ, Gil EG, Cetrelli L, Halbig J, von Wangenheim Marti L, Rygg M, Frid P, Stoustrup P, Rosèn A. Prevalence of temporomandibular disorder in children and adolescents with juvenile idiopathic arthritis - a Norwegian cross-sectional multicentre study. BMC Oral Health. 2020 Oct 13;20(1):282. doi: 10.1186/s12903-020-01234-z. PMID: 33050890.
24. Wörner F, Eger T, Simon U, Becker A, Wolowski A. Lifespan of splints in a sample of German soldiers hospitalised with post-traumatic stress disorder (PTSD) in combination with sleep bruxism and painful temporomandibular disorder (TMD). Oral Health Prev Dent. 2024 Jul 12;22:249-256. doi: 10.3290/j.ohpd.b5569645. PMID: 38994785.
25. Barbosa C, Manso MC, Reis T, Soares T, Gavinha S, Ohrbach R. Are oral overuse behaviours associated with painful temporomandibular disorders? A cross-sectional study in Portuguese university students. J Oral Rehabil. 2021 Oct;48(10):1099-1108. doi: 10.1111/joor.13226. PMID: 34273189.
26. Yang Y, Xu LL, Liu SS, Lu SJ, Liu LK, Zeng H, Fang ZY. Analysis of risk factors and interactions for pain in temporomandibular disorder: a cross-sectional study. J Oral Rehabil. 2024 Jul;51(7):1113-1122. doi: 10.1111/joor.13682. PMID: 38486502.
27. Kim HK. Statistical validation of unsupervised clustering for adolescent TMD: a cross-sectional study. Oral Dis. 2025 Aug;31(8):2596-2607. doi: 10.1111/odi.15331. PMID: 40145361.
28. Kang JH. Neck associated factors related to migraine in adolescents with painful temporomandibular disorders. Acta Odontol Scand. 2021 Jan;79(1):43-51. doi: 10.1080/00016357.2020.1774649. PMID: 32529877.
29. Kim HK, Kim ME. Disturbed sleep may be a core risk factor for jaw functional limitation in patients with painful temporomandibular disorders. J Oral Rehabil. 2021 Sep;48(9):1013-1024. doi: 10.1111/joor.13217. PMID: 34185915.
30. Yap AU, Lei J, Liu C, Fu KY. Characteristics of painful temporomandibular disorders and their influence on jaw functional limitation and oral health-related quality of life. J Oral Rehabil. 2024 Sep;51(9):1748-1758. doi: 10.1111/joor.13768. PMID: 38845181.