PUBLIC HEALTH
OpenJournal

Openventio
PUBLISHERS

Original Research Article

Is Cigarette Smoking a Risk Factor for Temporomandibular Joint Dysfunction?

Mehmet Miçooğulları*, Batuhan İ. Derici oğlu, Cemaliye Hürer

Cyprus International University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Via Mersin 10, 99258, Lefkosa, Turkey

Corresponding Author: Mehmet Micoogullari
Email: mmicoogullari@ciu.edu.tr

Article Information:
Received: 25 July 2026 | Revised: 27 August 2026 | Accepted: 26 September 2026 | Published: October 25, 2026
Cite this article:
Mehmet Miçooğulları, Batuhan İ. Derici oğlu and Cemaliye Hürer (2026). Is Cigarette Smoking a Risk Factor for Temporomandibular Joint Dysfunction? *Public Health Open Journal*. 11(2):70–78. 10.17140/PHOJ-11-70

Abstract

Objective: The relationship between cigarette smoking and temporomandibular joint disorders (TMJDs) is not fully clarified. This study compared TMJD symptoms, mandibular functional impairment, and mouth-opening range between smokers and non-smokers among university students.

Methods: In this comparative cross-sectional study, 132 university students (66 smokers, 66 non-smokers; ages 18–30) were assessed. TMJD symptoms were measured with the Fonseca Anamnestic Index, mandibular function with the Mandibular Function Impairment Questionnaire (MFIQ), and maximum mouth opening with a bicondylar caliper. Data were analyzed using Mann–Whitney U tests; significance was set at $p < 0.05$.

Results: Smokers reported higher mean Fonseca scores than non-smokers ($p < 0.05$) and greater impairment on the MFIQ functional-capacity ($p < 0.05$), nutrition ($p < 0.05$) and total MFIQ ($p < 0.05$) scores. No significant difference was observed in maximum mouth opening ($p > 0.05$). TMJD severity categories showed higher proportions of moderate and severe TMJD among smokers ($p < 0.05$).

Conclusions: Cigarette smoking was associated with increased TMJD symptom burden and functional impairment but not with reduced maximal mouth opening. Clinicians should consider smoking status during TMJD assessment and management. Longitudinal studies with objective tobacco exposure measures and imaging/functional diagnostics are needed to establish causality and dose–response effects.

Keywords: Mandibular function, mouth opening, smoking, temporomandibular joint disorders, young adult

Introduction

Temporomandibular joint disorders (TMJDs) comprise a broad spectrum of musculoskeletal and neuromuscular conditions affecting the temporomandibular joint (TMJ), the masticatory structures, or both. TMJD is recognized as a major health problem, affecting approximately 31% of adults and the elderly, and 11% of children and adolescents [1]. TMJ dysfunction represents a multidimensional orofacial problem characterized by pain originating from the tissues surrounding the joint, disruption of optimal occlusion, and functional impairment of the joint [2]. This condition is complex, leading to orofacial pain, limitation of joint movement, clicking and crepitus sounds during joint motion, and disturbances in craniocervical posture and postural stability [3].

Disorders associated with the TMJ are generally divided into two subgroups: those of articular origin, where the signs and symptoms are related to the TMJ itself, and those of muscular origin, where the signs and symptoms are associated with the stomatognathic muscle system [4]. One of the most significant issues affecting individuals with TMJD is myalgia in the orofacial muscles. Two main triggering factors for myalgia observed in TMJDs include the formation of symptomatic myofascial trigger points and parafunctional habits, such as smoking [5].

In patients with TMDs, smoking is significant not only due to the direct harmful effects of cigarette smoke, but also because it may be associated with other TMJD risk factors, such as perceived stress, anxiety, and depression [6, 7]. There is evidence in the literature indicating that smoking can cause orofacial and TMJ pain, and that pain complaints may precede the onset of dysfunction [8]. It has also been observed that pain affects younger individuals at a higher rate than older individuals [7]. In TMJD research, smoking should be considered not only for its potential causal role, but also for its influence on other TMJD risk factors, such as perceived stress, anxiety, and lifestyle habits [9, 10]. Recent evidence from a cross-sectional study involving 909 university students demonstrated a higher prevalence of nicotine dependence among individuals with TMD, with nicotine dependence scores showing a weak but significant positive correlation with TMD symptom severity [11]. Furthermore, a Mendelian randomization analysis identified a significant association between daily cigarette consumption and TMD risk, suggesting that smoking may be a relevant factor in the multifactorial etiology of TMD [12].

Smoking has been shown to trigger systemic inflammation by inhibiting anti-inflammatory cytokines and promoting the production of pro-inflammatory cytokines. Evidence suggests that smoking affects the severity of chronic pain at the molecular level through systemic inflammation [13]. In particular, nicotine inhaled from cigarette smoke can trigger inflammatory processes, alter pain perception and threshold, and thereby contribute to pain associated with TMJDs [14]. Attention has focused on the hypothesis that cigarette smoking may trigger bruxism, which in turn could impose additional stress on the temporomandibular joint [7, 15]. Moreover, cigarette smoking has been shown to adversely affect the nutrition of the TMJ disc. Nicotine and other toxic substances in cigarette smoke induce vasoconstriction and impair microcirculation, thereby reducing the supply of essential nutrients and oxygen to the avascular regions of the TMJ disc. This compromised nutrition may contribute to disc degeneration and reduced healing capacity [16, 17].

In summary, cigarette smoking has been shown to exert detrimental effects on pain perception and intensity by inducing inflammatory responses. Furthermore, it has been observed that, among individuals who smoke, parafunctional habits such as bruxism may contribute to the development of myofascial trigger points in the orofacial muscles. Nevertheless, the effects of cigarette smoking on TMJDs have not yet been fully elucidated.**2. Methods**

Study design and subjects

This comparative cross-sectional study was conducted to compare TMJD, mandibular dysfunction and mouth opening in tobacco using university students aged 18–30 years with non-tobacco using students. The study was conducted in compliance with the principles outlined in the Declaration of Helsinki. All participants received detailed information regarding the study procedures and provided written informed consent prior to participation. Ethical approval was obtained from the Scientific Research and Publication Ethics Committee of Cyprus International University (Approval No: 020–11944; Date: 20.11.2022).

The study included 132 students aged over 18 years from Cyprus International University who fulfilled the eligibility criteria and provided voluntary consent to participate. Participants were divided into two groups based on their tobacco use: tobacco users (n = 66) and non-users (n = 66). Participation was voluntary. Verbal and written information about the purpose and assessment procedures of the study was provided, and informed consent was obtained. The study was conducted in the research laboratory of the Department of Physiotherapy and Rehabilitation at the Faculty of Health Sciences, Cyprus International University.

Individuals with history of injury to the upper extremity, head-neck, or jaw region and use of analgesics, anti-inflammatory drugs, muscle relaxants, antidepressants, etc., for TMJD treatment within the past year, presence of chronic diseases such as hypertension, diabetes mellitus, or cancer were excluded. Additionally, participants who had smoked regularly for at least 1 year were included in the smoker group

Sample size

The minimum sample size for this study was calculated using G*Power 3.1.9.2 software, based on an effect size of 0.5 as determined from previous study demonstrating clinically significant change [15]. For a statistical power of 80% (1-β), the required sample size was calculated to be 128 participants. Allowing for a potential 10% attrition rate, the target number of participants was set at 140. Of the 204 individuals screened, the study was ultimately completed with 132 participants who met the inclusion criteria.

Data collection and outcome measures

Demographic and physical characteristics of the participants, detailed information about tobacco use, and the parameters evaluated within the scope of the study were recorded using a standardized evaluation form. Temporomandibular joint dysfunction was assessed with the Fonseca Questionnaire, mandibular function impairment was assessed with the Mandibular Dysfunction Questionnaire, and mouth opening was assessed with the mandibular depression movement.

Temporomandibular joint disorders (TMJDs)

In the study, the Fonseca Questionnaire, which has proven validity and reliability, was used to assess TMJD [18]. The Fonseca Questionnaire is a measurement tool consisting of a total of 10 questions that allows individuals to subjectively evaluate TMJD symptoms. The questions cover TMJD-related parameters such as the presence of pain in the temporomandibular joint, head and neck region, pain during masticatory muscle activity, parafunctional habits, limitation in range of motion, occlusal disorders and emotional stress levels.

Participants responded to each item using three response options: "Yes" (10 points), "Sometimes" (5 points), and "No" (0 points). The overall questionnaire score was then used to categorize the severity of TMJD. Accordingly, 0–15 points are considered as no TMJD, 20–40 points as mild TMJD, 45–65 points as moderate TMJD and 70–100 points as severe TMJD.

The validity and reliability study of the Turkish version of the Fonseca Questionnaire was conducted by Kaynak et al. and the Intraclass Correlation Coefficient (ICC) values were reported between 0.73 and 0.89 [19]. These findings support the usability of the Turkish version of the questionnaire in clinical and research contexts.

Mandibular function impairment questionnaire (MFIQ)

The mandibular function impairment questionnaire (MFIQ) was developed to assess the level of impairment in jaw function in individuals with TMJD. The questionnaire consists of a total of 17 questions measuring the difficulty in performing certain jaw functions, each of which is scored between 0 and 4. The scoring system is as follows: 0=no difficulty, 1=very little difficulty, 2=quite difficult, 3=very difficult, 4=very difficult or impossible without assistance. The questionnaire consists of two sub-dimensions: The first 11 items cover the "functional capacity" dimension, which measures the individual's capacity to fulfil jaw functions in daily life; the remaining 6 items cover the "nutrition" dimension, which assesses functional limitations related to nutrition. As the total score obtained from the questionnaire increases, the severity of the impairment in jaw function also increases. The validity and reliability of the Turkish version of the MFIQ have been evaluated, demonstrating high validity and reliability (ICC $>$ 0.90) in assessing functional disorders related to TMJD [20].

Measurement of mandibular depression range of motion

In this study, maximum mouth opening (MMO) was assessed through measurement of the mandibular depression movement. Participants were instructed to open their mouths as widely as possible, and the vertical distance between the incisal edges of the upper and lower central incisors was measured to determine the degree of mouth opening. Measurements were obtained using a bicondylar caliper (Holtain Ltd., UK), a device known for its high precision and accuracy. The results were recorded in centimetres (cm). For each participant, two consecutive measurements were taken, and the arithmetic mean of these values was used for subsequent analysis. This method has been validated in prior studies assessing TMJ function and mouth opening capacity [21, 22].

Statistical analysis

IBM Statistical Package for Social Sciences (SPSS) version 27.0 was utilised to analyse the data collected from smokers and non-smokers. The Shapiro-Wilk test was employed to assess the normality of the data for TMJD, mandibular function, and mandibular depression range of motion (ROM) parameters prior to group

comparisons. The results indicated that the data were not normally distributed. Therefore, the Mann-Whitney U test, a non-parametric statistical method, was applied to compare the groups. The significance level was set at $p < 0.05$.

Results

A total of 204 individuals were assessed for eligibility, of whom 132 fulfilled the inclusion criteria and were enrolled in the study. The present study was completed with a total of 132 individuals, 66 in the smokers and 66 in the non-smokers group (Figure 1).

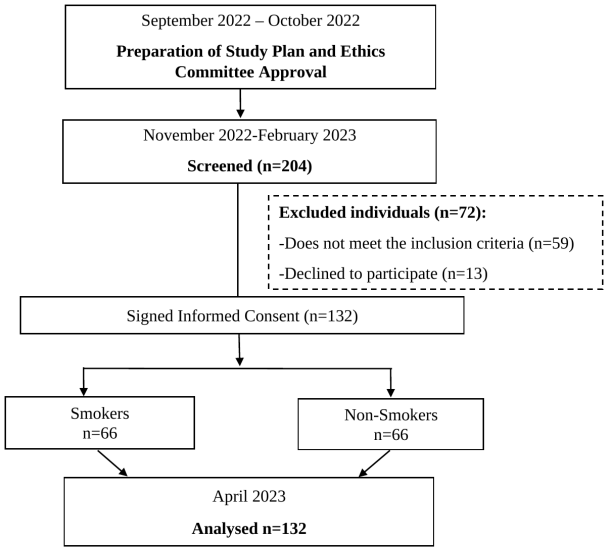


Figure 1. Flow chart of the individuals included in the study

Figure 1. Flow chart of the individuals included in the study

The results of the Mann-Whitney U test conducted to compare age and anthropometric measurements between the groups are presented in Table 1. No statistically significant differences were observed in age, body weight, height, or body mass index (BMI) between smokers and non-smokers ($p > 0.05$). In the smokers group, the average duration of smoking was 6.18±2.87 years, and the mean cigarette consumption was 18.06±8.77 cigarettes per day.

§ Mann Whitney U test, *$p < 0.05$, BMI: Body mass index

Table 2 presents the comparison of demographic and clinical characteristics between smokers and non-smokers. There were no statistically significant differences between the groups in terms of gender distribution, parafunctional habits, presence of chronic disease, or medication use ($p > 0.05$). However, a significant difference was observed in the dominant chewing side, with a higher proportion of smokers chewing predominantly on the right side, while non-smokers more frequently chewed on the left ($p < 0.001$). Additionally, exposure to passive smoking was significantly more common among smokers, with 75.8% reporting very frequent exposure compared to 30.3% of non-smokers ($p < 0.001$).

χ^2: Chi-squared test, **$p < 0.001$

The results of the Mann-Whitney U test comparing smokers and non-smokers are presented in Table 3. Smokers had significantly higher Fonseca scores, indicating greater levels of TMJD, compared to non-smokers ($p = 0.021$, $r = -0.20$). Similarly, smokers demonstrated significantly higher scores in the functional capacity and nutrition subscales of the MFIQ, as well as in the total MFIQ score ($p < 0.05$, $r = -0.21$). No significant difference was observed between the groups in mandibular depression ROM ($p = 0.654$, $r = -0.04$).

§ Mann Whitney U test. *$p < 0.05$, r: Effect size, ROM: Range of motion, MFIQ: Mandibular function impairment questionnaire

The distribution of TMJD severity according to Fonseca categories between smokers and non-smokers is presented in Figure 2. According to the chi-square analysis (χ^2 =7.106, $p = 0.012$), there was a statistically significant difference in the prevalence of TMJD severity between the two groups. Specifically, a higher proportion of non-smokers were classified as having no TMJD (31.9%) and mild TMJD (54.5%) compared to smokers (21.2% and 47%, respectively). In contrast, moderate and severe TMJD were more prevalent among smokers (24.2% and 7.6%, respectively) than non-smokers (12.1% and 1.5%, respectively).

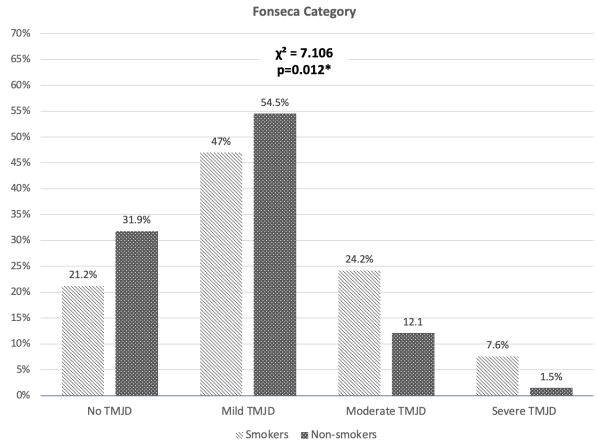


Figure 2. Distribution of TMJD severity according to Fonseca categories between smokers and non-smokers

Table 1. Comparison of Participants' Age, Anthropometric Measurements, and Smoking Status

	Group	*n*	$\bar{x} \pm$ SD	Median (Min–Max)	$p^{\S}$
Average age (years)	Smokers	66	21.97±2.69	21 (18–30)	0.717
	Non-smokers	66	21.59±2.14	22 (18–27)	
Body weight (kg)	Smokers	66	69.95±12.92	68.50 (46–95)	0.899
	Non-smokers	66	70.47±15.41	67 (47–117)	
Height (m)	Smokers	66	1.73±0.09	1.75 (1.52–1.92)	0.194
	Non-smokers	66	1.72±0.09	1.70 (1.55–1.95)	
BMI (kg/m^2)	Smokers	66	23.25±3.69	23.13 (16.5–33.9)	0.706
	Non-smokers	66	23.86±4.40	22.59 (17.3–34.1)	
Duration of Smoking (years)	Smokers	66	6.18±2.87	6 (1–13)	-
	Non-smokers	66	-	-	
Cigarette Consumption (per day/pieces)	Smokers	66	18.06±8.77	20 (2–40)	-
	Non-smokers	66	-	-	

Table 2. Comparison of Demographic and Clinical Characteristics Between Smokers and Non-Smokers

	Smokers		Non-smokers		χ^2	*p*
	n	%	*n*	%		
Gender						
Female	28	42.4	34	51.5	1.095	0.192
Male	38	57.6	32	48.5		
Dominant Chewing Side						
Right	51	77.3	21	31.8	27.500	<**0.001****
Left	15	22.7	45	68.2		
Parafunctional Habits						
None	25	37.9	30	45.5	2.832	0.586
Bruxism	20	30.3	14	21.2		
Lip biting	7	10.6	9	13.6		
Nail biting	7	10.6	4	6.1		
2 habits	7	10.6	9	13.6		
Chronic Disease						
Yes	11	16.7	7	10.6	1.029	0.224
No	55	83.3	59	89.4		
Medication						
Yes	12	18.2	10	15.2	0.218	0.816
No	54	81.8	56	84.8		
Smoking						
Yes	66	100	0	0	-	-
No	0	0	66	100		
Exposure to Passive Smoking						
Very Frequently	50	75.8	20	30.3	30.549	<**0.001****
Occasionally	16	24.2	10	15.2		
Rarely	0	0	36	54.5		

Discussion

In the present study we compared TMJD severity, mandibular functional impairment, and mouth-opening parameters between smoking and non-smoking university students. Smokers demonstrated significantly higher Fonseca scores and greater mandibular function impairment compared with non-smokers, while no significant differences were observed in mouth-opening measurements between the two groups. Furthermore, TMJD severity was more pronounced among smokers. These findings indicate that cigarette smoking may be associated with an increased frequency and severity of TMJD symptoms. Clinically, smoking status should be considered when evaluating and managing patients with TMJD, and further longitudinal research is warranted to clarify

Table 3. Comparison of Temporomandibular Disorder Symptoms, Mandibular Functional Impairment, and Mouth-Opening Range of Motion Between Smokers and Non-Smokers

	Group	*n*	$\bar{x} \pm$ SD	Median (Min–Max)	*r*	$p^{\S}$
Fonseca score	Smokers	66	33.41±19.28	30 (0–80)	−0.20	**0.021***
	Non-smokers	66	25.76±16.88	25 (0–75)		
Mandibular Depression ROM (cm)	Smokers	66	3.88±0.81	3.67 (2.5–6.2)	−0.04	0.654
	Non-smokers	66	3.77±0.71	3.72 (2.3–5.5)		
Functional Capacity (MFIQ subscale)	Smokers	66	0.59±1.30	0 (0–5)	−0.21	**0.017***
	Non-smokers	66	0.15±0.64	0 (0–4)		
Nutrition (MFIQ subscale)	Smokers	66	0.47±1.01	0 (0–4)	−0.21	**0.018***
	Non-smokers	66	0.12±0.51	0 (0–3)		
MFIQ Total Score	Smokers	66	1.06±2.29	0 (0–8)	−0.21	**0.017***
	Non-smokers	66	0.27±1.14	0 (0–7)		

causality and underlying mechanisms.

Several biological mechanisms have been proposed by which cigarette smoking may contribute to the development of TMJD. Nicotine and other toxic constituents of tobacco can potentiate inflammation by stimulating the release of proinflammatory cytokines, which may lower pain thresholds and predispose individuals to chronic pain. In addition, smoking-induced vasoconstriction can compromise the microcirculation and nutrition of the temporomandibular joint disc, leading to degenerative changes. At the psychosocial level, higher rates of stress, anxiety, and parafunctional habits such as bruxism observed among smokers have been reported in the literature as additional factors that may increase TMJD risk [5, 23, 24, 25]. A recent scoping review of longitudinal cohort studies further highlighted that psychosocial distress, sleep disturbances, parafunctional behaviors, and co-occurring pain conditions are associated with TMD onset and persistence, reinforcing the multifactorial and biopsychosocial nature of these disorders [26]. In the present study, smokers exhibited significantly higher Fonseca scores and greater mandibular functional impairment than non-smokers. These findings are consistent with previous research suggesting that smoking may increase the risk of TMJD [5, 6, 7, 13, 15]. Sanders et al. (2012) observed a significantly elevated risk of TMJD associated with cigarette smoking in young adults, indicating excess odds of disorder onset among smokers [7]. A recent systematic review and meta-analysis by Shetty et al. (2025) demonstrated that tobacco smoking was associated with higher TMD-related pain intensity, although substantial heterogeneity was observed across the included studies [15]. More recently, a population-based study involving 7,103 individuals reported that smoking initiation before the age of 15 was associated with a higher prevalence of TMD symptoms later in life, further supporting the potential relevance of smoking history in TMD assessment [27]. However, some studies found no significant differences in TMJD symptoms between smokers and non-smokers [15, 28]. Nonetheless, findings across studies remain contradictory, underscoring the need for further longitudinal, well-controlled research to clarify causality.

In the present study, according to the MFIQ results, the smoking group had significantly higher scores on the functional-capacity and nutrition subscales, as well as a higher total mandibular functional-impairment score, compared with non-smokers. This finding suggests that cigarette smoking may adversely affect mandibular function. Smoking is associated with increased jaw-muscle tension and parafunctional behaviors such as bruxism, which raise mechanical load on the TMJ and masticatory muscles [25]. In addition, nicotine alters pain modulation and may promote central sensitization and withdrawal-related hyperalgesia, while higher levels of stress, anxiety, and sleep disturbance among smokers can further amplify perceived dysfunction and disability [7, 15]. Together, these pathways provide biologically and psychosocially plausible explanations for the higher functional-capacity and nutrition-subscale scores and the greater total mandibular impairment observed in smokers in our study. However, an integrative review highlights that, while smoking clearly affects pain perception and related psychosocial factors, high-quality evidence specifically measuring biomechanical or jaw-function outcomes is scarce and heterogeneous [5]. When applied clinically, standard functional tools often show limited discrimination between diagnostic groups or no clear differences in calculated impairment scores, underscoring variability in how function is measured and reported across studies [29]. To strengthen inference, future studies should combine MFIQ data with objective functional tests and standardized reporting of potential confounders (psychological status, parafunctional habits) and objective measures of smoking exposure.

According to our findings, there was no difference in mouth-opening (mandibular depression) between smokers and non-smokers despite higher TMJD severity and greater mandibular functional impairment among smokers. The proinflammatory effects of nicotine and other tobacco constituents, smoking-related vascular changes, and psychosocial factors such as increased stress and bruxism are more likely to mediate heightened pain perception and joint dysfunction than to produce immediate, measurable reductions in joint range of motion. These pathophysiological and psychosocial processes may therefore precede structural changes that would affect mouth opening, particularly in a young population in which long-term degenerative changes may not yet have developed [30, 31]. Moreover, patients often adopt compensatory movement strategies to maintain maximal mouth opening despite pain, so preserved range of motion does not necessarily indicate absence of dysfunction [32, 33, 34]. Notably, the literature that specifically compares maximal mouth opening between smokers and non-smokers is sparse. An integrative review concluded that existing studies are insufficient to establish an association between smoking and biomechanical aspects of TMJD [5]. A recent systematic review and meta-analysis that focused on smoking and TMJD emphasized that most evidence addresses pain rather than structural or motion outcomes [15]. In addition, consensus diagnostic papers and normative studies show poor correlation between pain and objective structural measures and that maximal mouth opening varies with age, supporting the possibility that young smokers may show increased symptoms without measurable restriction of mouth opening [35, 36]. Taken together, these considerations suggest that smoking may primarily amplify symptom burden and functional difficulty rather than produce early detectable restrictions in mandibular depression; longitudinal studies and objective functional measures are needed to determine whether smoking leads to progressive range-of-motion loss over time.

Limitations

This study has several limitations. Its cross-sectional design prevents causal inference and leaves open the possibility of reverse causation. The sample consisted of volunteer university students aged 18–30 from a single institution, which limits generalizability to older adults and other populations. Important potential confounders including validated measures of psychological status, sleep quality, and objectively measured parafunctional behaviors were not comprehensively controlled for.

Conclusion

In this cross-sectional study, cigarette smokers exhibited significantly higher TMJD symptom scores and greater mandibular functional impairment than non-smokers, while maximal mouth opening did not differ between groups. Clinically, these findings suggest that smoking status should be considered when assessing orofacial pain and TMJ dysfunction—clinicians should screen for tobacco use, counsel patients on smoking cessation as part of multimodal management, and evaluate coexisting psychosocial and parafunctional contributors (e.g., stress, bruxism). For future research, longitudinal and interventional studies with biochemical verification of tobacco exposure, standardized measures of nicotine dependence, objective assessments (imaging, electromyography, ambulatory bruxism monitoring), and more diverse age and clinical samples are needed to clarify causality, dose–response relationships, and whether smoking cessation reduces TMJD risk or symptom burden.

Acknowledgements

The authors would like to thank the participants who took part in the study.

Funding

The authors report no funding.

Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contributions

MM, BID and CH participated in the conception and design of the study. MM was responsible for data acquisition. MM, BID and CH analyzed and interpreted the data. MM drafted the manuscript and MM, BID and CH critically revised the manuscript for important intellectual content. All authors approved the final version of the manuscript.

References

1. List T, Jensen RH. Temporomandibular disorders: Old ideas and new concepts. *Cephalalgia*. 2017;37(7):692–704.
2. Hatfield E. An Overview of Diagnosis and Management of Temporomandibular Disorders. *Journal of the California Dental Association*. 2024;52(1):2400419.

3. Valesan LF, et al. Prevalence of temporomandibular joint disorders: a systematic review and meta-analysis. *Clinical oral investigations*. 2021;25(2):441–453.
4. Miçooğulları M, Yüksel İ, Angın S. Effect of pain on cranio-cervico-mandibular function and postural stability in people with temporomandibular joint disorders. *The Korean Journal of Pain*. 2024;37(2):164–177.
5. Oliveira-Souza A, et al. Repercussions of smoking habit on orofacial pain and temporomandibular dysfunction: integrative review. *Int J Physiatry*. 2019;5:016.
6. Melis M, et al. Effect of cigarette smoking on pain intensity of TMD patients: a pilot study. *Cranio*. 2010;28(3):187–192.
7. Sanders AE, et al. Excess risk of temporomandibular disorder associated with cigarette smoking in young adults. *The Journal of Pain*. 2012;13(1):21–31.
8. Rozen TD. A history of cigarette smoking is associated with the development of cranial autonomic symptoms with migraine headaches. *Headache: The Journal of Head and Face Pain*. 2011;51(1):85–91.
9. Chaiton MO, et al. A systematic review of longitudinal studies on the association between depression and smoking in adolescents. *BMC public health*. 2009;9(1):356.
10. Custodio L, et al. The impact of cigarette smoking on sleep quality of patients with masticatory myofascial pain. *J Oral Facial Pain Headache*. 2015;29(1):15–23.
11. Kaynak BA, et al. The prevalence of smartphone, nicotine, and alcohol addiction among university students with temporomandibular disorders. *BMC Oral Health*. 2026;26(1):276.
12. Yan Q, Liao L, He D. Risk factors associated with temporomandibular joint disorder: a mendelian randomization analysis. *Journal of Oral Rehabilitation*. 2024;51(11):2239–2247.
13. Lee Y-H, Auh Q-S. Are Smokers More Susceptible to Temporomandibular Disorders?. *Journal of Oral Medicine and Pain*. 2024;49(4):79–82.
14. Shrivastava M, Battaglino R, Ye L. A comprehensive review on biomarkers associated with painful temporomandibular disorders. *International journal of oral science*. 2021;13(1):23.
15. Shetty AA, et al. Tobacco smoking and its impact on pain intensity of temporomandibular disorders: A systematic review and metanalysis. *Journal of Oral Rehabilitation*. 2025;52(2):266–273.
16. Miettinen O, et al. Prevalence of temporomandibular disorder symptoms and their association with alcohol and smoking habits. *J Oral Facial Pain Headache*. 2017;31(31):30–36.
17. Murphy MK, et al. Temporomandibular joint disorders: a review of etiology, clinical management, and tissue engineering strategies. *The International journal of oral & maxillofacial implants*. 2013;28(6):e393.
18. dos Santos Berni KC, Dibai-Filho AV, Rodrigues-Bigaton D. Accuracy of the Fonseca anamnestic index in the identification of myogenous temporomandibular disorder in female community cases. *Journal of bodywork and movement therapies*. 2015;19(3):404–409.
19. Kaynak BA, Taş S, Salkın Y. The accuracy and reliability of the Turkish version of the Fonseca anamnestic index in temporomandibular disorders. *Cranio*. 2023;41(1):78–83.
20. Yıldız NT, Alkan A, Külünkoğlu BA. Validity and reliability of the Turkish version of mandibular function impairment questionnaire. *CRANIO*. 2024;42(2):160–170.
21. Günay C, et al. Effect of adenoidectomy/tonsillectomy on temporomandibular joint (TMJ) function and mouth opening in early period. *Medeniyet Medical Journal*. 2017;32(1):1–6.
22. Kilinç HE, Ulusoy B, Ergun N. Acute effect of created muscle fatigue in cervical region on temporomandibular joint in healthy women. *Turk J Physiother Rehabil*. 2015;26(1):3.
23. Elisia I, et al. The effect of smoking on chronic inflammation, immune function and blood cell composition. *Scientific reports*. 2020;10(1):19480.
24. Elmasry S, et al. Effects of tobacco smoking on the degeneration of the intervertebral disc: a finite element study. *PloS one*. 2015;10(8):e0136137.
25. Katyayan PA, Katyayan MK. Effect of smoking status and nicotine dependence on pain intensity and outcome of treatment in Indian patients with temporomandibular disorders: A longitudinal cohort study. *The Journal of Indian Prosthodontic Society*. 2017;17(2):156–166.
26. Cao Z, et al. Mapping the Global Landscape of Temporomandibular Disorder Research across Longitudinal Cohorts: A Scoping Review. *Journal of Dentistry*. 2026:107083.
27. Machado Oliveira L, Machado Oliveira JP, Regina Pelissari T. Early smoking onset and temporo-

mandibular disorder symptoms later in life. *CRANIO*. 2026:1–8.

28. Wänman A. Temporomandibular disorders among smokers and nonsmokers: a longitudinal cohort study. *Journal of orofacial pain*. 2005;19(3).
29. Su N, et al. Clinical application of the mandibular function impairment questionnaire. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology*. 2022;133(5):e119.
30. Wang H, et al. Effects of smoking on inflammatory-related cytokine levels in human serum. *Molecules*. 2022;27(12):3715.
31. Zhang W, et al. Nicotine in inflammatory diseases: anti-inflammatory and pro-inflammatory effects. *Frontiers in immunology*. 2022;13:826889.
32. De Leeuw R, Klasser GD. Orofacial pain: guidelines for assessment, diagnosis, and management. *Am J Orthod Dentofacial Orthop*. 2008;134(1):171.
33. Ingawale S, Goswami T. Temporomandibular joint: disorders, treatments, and biomechanics. *Annals of biomedical engineering*. 2009;37(5):976–996.
34. Scrivani SJ, Keith DA, Kaban LB. Temporomandibular disorders. *New England Journal of Medicine*. 2008;359(25):2693–2705.
35. Park Y, et al. An analysis of the temporomandibular joint range of motion and related factors in children and adolescents. *Children*. 2021;8(6):515.
36. Schiffman E, et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. *Journal of oral & facial pain and headache*. 2014;28(1):6.