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ORIGINAL RESEARCH

Functional and psychosocial impact of painful temporomandibular disorder on mandibular function and oral health-related quality of life: a cross-sectional observational study

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Abstract

Background: This study evaluated the association of pain in temporomandibular disorder (TMD) with mandibular function, perceived stress, and oral health-related quality of life (OHRQoL) in adults diagnosed using the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). It compared these outcomes between individuals with painful TMD (myalgia, arthralgia, or combined) and non-painful TMD (disc displacement or degenerative joint disease), with secondary analyses by sex and age. **Methods**: A comparative cross-sectional study was conducted with 65 adults diagnosed according to DC/TMD criteria at a university dental clinic in Portugal. Participants were classified as Painful TMD (n = 34) or Non-painful TMD (n = 31). Pain intensity was measured using a Visual Analogue Scale (VAS; 0–10 cm). Mandibular function (Jaw Functional Limitation Scale, JFLS-20), perceived stress (Perceived Stress Scale, PSS-10), and OHRQoL (Oral Health Impact Profile, OHIP-14) were compared between groups using Mann-Whitney U tests. Spearman correlations, rank-biserial effect sizes, and multivariable linear regressions adjusted for sex and age were performed. **Results**: Participants with painful TMD showed significantly greater mandibular functional limitation (JFLS-20: 1.28 ± 1.14 *vs.* 0.30 ± 0.61; $p < 0.001$) and poorer OHRQoL (OHIP-14: 11.71 ± 9.08 *vs.* 4.81 ± 6.08; $p < 0.001$). These differences remained significant after adjustment for sex and age (JFLS-20: $\beta = 0.93$, $p < 0.001$; OHIP-14: $\beta = 9.28$, $p = 0.001$). Perceived stress did not differ significantly between groups (PSS-10: $p = 0.514$). Women and participants >35 years exhibited higher functional and quality-of-life impairments. **Conclusions**: Painful TMD is associated with greater mandibular dysfunction and poorer OHRQoL compared to non-painful TMD, and these differences remained statistically significant after adjustment for sex and age. Although stress differences were nonsignificant, these findings support the importance of integrating functional and quality-of-life assessments into routine TMD care to identify patients requiring targeted pain management and functional follow-up, adopting interdisciplinary, biopsychosocial treatment strategies.

Keywords

Temporomandibular disorders; Oral health-related quality of life; Jaw function limitation; Perceived stress; Orofacial pain; DC/TMD

1. Introduction

Temporomandibular disorders (TMD) represent the most prevalent non-dental orofacial pain conditions, affecting approximately 34% of the global population [1]. Current understanding conceptualizes TMD as a multifactorial musculoskeletal pain and dysfunction disorder within a biopsychosocial model [2–4]. Recent reviews emphasize that TMD is a multifactorial biopsychosocial condition, and current evidence supports conservative, multidisciplinary management, including self-management, behavioral approaches, and physiotherapy [5, 6]. TMD occurs most frequently in individuals aged 18 to 60 years and disproportionately affects women, underscoring the influence of biological, psychological, and social factors [7]. Accurate diagnosis requires a standardized and validated protocol such as the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), which distinguishes between Axis I physical

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diagnoses (*e.g.*, myalgia, arthralgia, disc displacement) and Axis II psychosocial dimensions, including pain-related disability, perceived stress, and quality of life [8]. Current best-practice guidelines recommend prioritizing conservative, self-management-oriented interventions, such as cognitive-behavioral strategies and physiotherapy, to reduce pain and functional impairment [4]. Understanding the specific burden attributable to pain is essential for tailoring these multidisciplinary interventions, as pain is the primary motivator for treatment-seeking behavior in TMD [4, 9].

Chronic TMD-related pain often generates a self-perpetuating cycle in which stress and emotional distress amplify pain perception and further reduce functional capacity [3, 10, 11]. This cycle reflects interconnected physiological and emotional responses, including heightened parafunctional behaviors such as bruxism and muscle bracing [12, 13]. Recent evidence has identified nociceptive and nociplastic pain mechanisms as distinct subgroups within TMD populations, with the nociplastic subgroup characterized by central sensitization, exhibiting higher levels of anxiety, depression, and poorer quality of life [14]. Temporomandibular pain impairs oral health-related quality of life (OHRQoL), affecting physical, emotional, and social well-being, with patients frequently reporting limitations in daily activities and social interactions [6, 15]. The Perceived Stress Scale (PSS-10) captures perceived stress that may exacerbate pain mechanisms, while the Oral Health Impact Profile (OHIP-14) measures the resulting impact on OHRQoL, and the Jaw Functional Limitation Scale (JFLS-20) quantifies mandibular functional limitation [1–18]. Distinguishing between painful and non-painful TMD is crucial for clinical decision-making, as it determines whether interventions should prioritize pain management and psychosocial support or conservative monitoring of structural joint conditions.

This study does not seek to establish novelty through the discovery of new associations, but rather through the clinically grounded characterization of painful versus non-painful DC/TMD presentations in a Portuguese treatment-seeking population using harmonized measures of functional limitation (JFLS-20), oral health-related quality of life (OHIP-14), and perceived stress (PSS-10). The present study aims to (a) compare perceived stress levels between TMD patients with and without pain, (b) assess mandibular functional limitation in both groups, (c) evaluate oral health-related quality of life, and (d) explore potential differences according to sex and age. We hypothesized that participants with painful TMD would exhibit significantly greater mandibular functional limitation (JFLS-20) and poorer oral health-related quality of life (OHIP-14) than those with non-painful TMD, and that perceived stress (PSS-10) would be positively correlated with both functional limitation and reduced quality of life.

2. Materials and methods

2.1 Study design

This study followed a comparative cross-sectional observational design, in which all data were collected at a single point in time. Participants were classified into two groups based on their DC/TMD Axis I diagnosis: a Painful TMD group (pain-related diagnoses) and a Non-painful TMD group (intra-articular diagnoses only). The study was designed and reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for cross-sectional studies, ensuring methodological transparency and reproducibility [19]. The project was approved by the Ethics Committee of Egas Moniz School of Health and Science (PT-546/24) before data collection, in accordance with the principles stated in the Declaration of Helsinki. All participants received clear information about the study objectives and signed an informed consent form.

2.2 Sample

A consecutive sampling method was used to enroll eligible patients presenting to the clinic during the study period. During this period, 82 patients were initially screened for eligibility. Of these, 8 declined to participate because of time constraint, and 9 were excluded based on the established criteria (4 due to chronic pain in other body regions, 3 due to recent use of psychotropic medications, and 2 due to insufficient proficiency in Portuguese), resulting in a final sample of 65 participants (Fig. 1). The participation rate was 79.3%.

Inclusion Criteria: Participants were included if they had a diagnosis of temporomandibular disorder (TMD) according to DC/TMD criteria, were 18 years or older, provided informed consent, and were active patients at the University Dental Clinic of Egas Moniz. Clinical examinations and DC/TMD diagnoses were conducted by a single examiner, a calibrated dentist undergoing postgraduate training in orofacial pain, and all diagnoses were subsequently verified by a senior specialist in Temporomandibular Disorders and Orofacial Pain (the second author). All participants in the painful TMD group reported pain duration exceeding 3 months, consistent with chronic TMD criteria.

Exclusion Criteria: Participants were excluded if they had chronic pain in other body regions, operationally defined as any self-reported persistent pain lasting longer than 3 months outside the orofacial region, including diagnosed fibromyalgia or widespread pain disorders; concurrent non-TMD orofacial pain conditions such as active odontogenic pain, trigeminal neuralgia, or burning mouth syndrome; current use of psychotropic medications or opioids, as self-reported, or discontinuation of such medications within the previous three months; or insufficient proficiency in Portuguese to complete the validated Portuguese versions of the study instruments (PSS-10, OHIP-14, JFLS-20).

Group Allocation: Participants were classified into two groups based on their DC/TMD Axis I diagnosis (see Fig. 1). The Painful TMD group comprised participants diagnosed with pain-related conditions (myalgia, arthralgia, or combined myalgia/arthralgia). The Non-painful TMD group comprised participants diagnosed exclusively with intra-articular disorders without a pain component (disc displacement with or without reduction, degenerative joint disease). Of the 34 participants in the Painful TMD group, 6 also had concurrent disc displacement; these participants were classified in the Painful TMD group based on their primary pain-related diag-

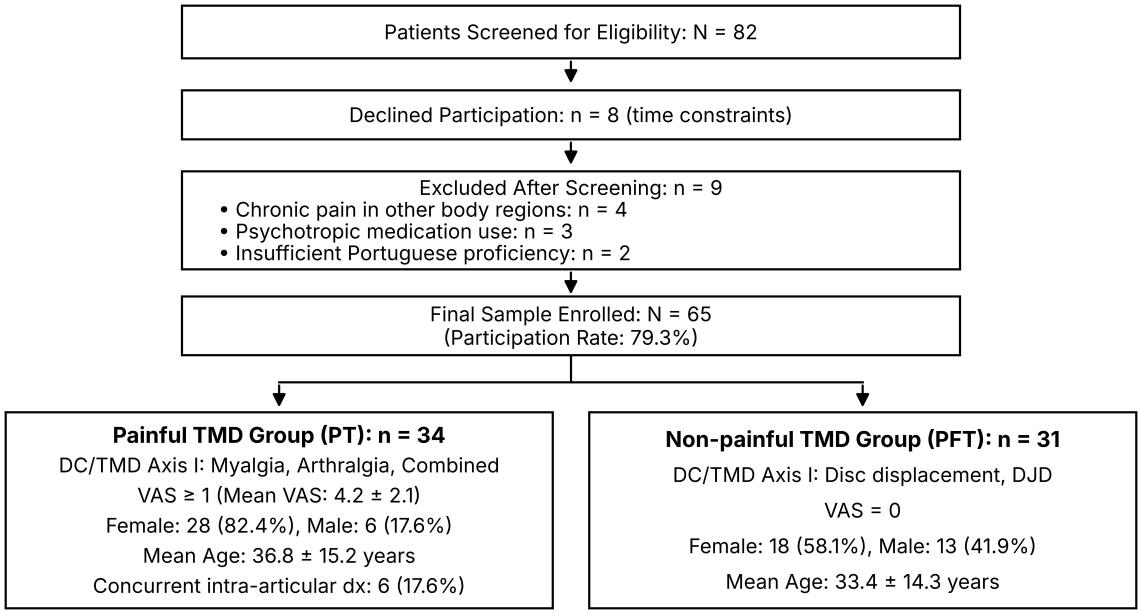


FIGURE 1. Strobe flow diagram: sample recruitment, screening, and group allocation. TMD: temporomandibular disorder; VAS: Visual Analogue Scale; DC/TMD: Diagnostic Criteria for Temporomandibular Disorders; PT: Painful TMD Group; PFT: Non-painful TMD Group; DJD: degenerative joint disease.

nosis, and their concurrent intra-articular findings are noted in Table 1. Pain intensity was additionally characterized using a Visual Analogue Scale (VAS; 0–10 cm) reflecting average pain over the past 30 days. All participants in the Painful TMD group reported VAS ≥1, confirming the presence of clinical pain, whereas all participants in the Non-painful TMD group reported VAS = 0.

2.3 Measures

Sociodemographic Questionnaire: Collected data on sex, age, marital status, occupation, smoking habits, current medical conditions, and ongoing treatments. These data were collected for descriptive purposes only and were not controlled for in the primary univariate statistical analysis due to sample size constraints.

Visual Analogue Scale—VAS [20]: Participants assessed their pain intensity using a continuous 10-cm horizontal line, on which they marked a point corresponding to their pain intensity. The distance from the zero anchor was measured in centimeters, rounded to the nearest millimeter to yield a score from 0 to 10. This assessment referred specifically to the average pain over the past 30 days, consistent with the timeframe used in the DC/TMD symptom questionnaire. The scale is divided into three levels: mild (0–2), moderate (3–7), and severe (8–10).

Perceived Stress Scale-10 items (PSS-10) [17]: Measured subjective perception of stress. The instrument includes 10 items, rated on a 5-point Likert scale, referring to the past month. Higher scores indicate higher levels of stress. Total scores range from 0 to 40, calculated as the sum of all items after reverse-scoring positively worded items. The validated Portuguese version was used [21].

Oral Health Impact Profile-14 items (OHIP-14) [16]: Measured the impact of oral health conditions on quality of life. The questionnaire consists of 14 items distributed across seven domains: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. Responses are rated on a 5-point Likert scale (0–4). Higher scores indicate poorer oral health-related quality of life. Total scores range from 0 to 56, calculated as the sum of all 14 items. The validated Portuguese version was used [22].

Jaw Functional Limitation Scale-20 items (JFLS-20) [18]: Measured functional limitations associated with TMD. The instrument covers three domains: mastication, jaw mobility, and verbal/emotional expression. Responses are rated on a numerical scale from 0 (no limitation) to 10 (severe limitation). Higher scores indicate greater functional limitation. In accordance with the International RDC/TMD Consortium Network (INFORM) scoring manual, the JFLS-20 total score was calculated as the mean of the 20 items, yielding a valid range of 0–10. Subscale scores were similarly calculated as the mean of items within each domain. The validated Portuguese version was used [23].

The digital survey was administered via Google Forms, and data were exported immediately to a secure, password-protected, encrypted database accessible only to the primary investigators. All items on the primary outcome measures (PSS-10, OHIP-14, and JFLS-20) were set as mandatory, preventing missing data on these scales.

2.4 Data collection and ethical procedures

The study was conducted at the University Dental Clinic of Egas Moniz, a university-based general dentistry and specialty training clinic located in Almada, Caparica, Portugal. Data were collected between February and April 2025. All assessments were conducted in person; after the clinical examination, participants completed the self-administered digital question-

TABLE 1. Distribution of participants by sex, age group, DC/TMD Axis I, and comorbidities according to the presence of pain (Painful TMD *vs.* Non-painful TMD).

Category	Painful TMD (n = 34)	Non-painful TMD (n = 31)	Total (N = 65)	*p*-value
Sex				
Female	28 (82.4%)	18 (58.1%)	46 (70.8%)	0.032[a]
Male	6 (17.6%)	13 (41.9%)	19 (29.2%)	
Age (yr)				
Mean ± SD	36.8 ± 15.2	33.4 ± 14.3	35.2 ± 14.8	
Median (IQR)	30.0 (22–51)	25.0 (21–47)	28.0 (22–49)	
• 18–25	15 (44.1%)	16 (51.6%)	31 (47.7%)	
• 26–35	3 (8.8%)	3 (9.7%)	6 (9.2%)	0.145[b]
• 36–45	4 (11.8%)	1 (3.2%)	5 (7.7%)	
• 46–55	6 (17.6%)	8 (25.8%)	14 (21.5%)	
• 56–65	4 (11.8%)	2 (6.5%)	6 (9.2%)	
• 65+	2 (5.9%)	1 (3.2%)	3 (4.6%)	
DC/TMD Axis I Diagnosis				
Myalgia	18 (52.9%)	—		
Arthralgia	8 (23.5%)	—		
Combined myalgia/arthralgia	8 (23.5%)	—		
Disc displacement with reduction	—	22 (71.0%)		—
Disc displacement without reduction	—	5 (16.1%)		
Degenerative joint disease	—	4 (12.9%)		
Concurrent intra-articular dx[e]	6 (17.6%)	—		
Comorbidities[d]				
Yes	8 (23.5%)	4 (12.9%)	12 (18.5%)	0.277[c]

Painful TMD: pain-related DC/TMD diagnoses; Non-painful TMD: intra-articular diagnoses without pain component. Values are presented as n (%) unless otherwise indicated. [a]Chi-square test. [b]Mann-Whitney U test (continuous age). [c]Chi-square test. [d]Most common self-reported comorbidities included mild gastrointestinal issues, controlled hypertension, and mild respiratory allergies. [e]Six participants in the Painful TMD group also had a concurrent intra-articular diagnosis (disc displacement); they were classified based on their primary pain-related diagnosis. TMD: temporomandibular disorder; DC/TMD: Diagnostic Criteria for Temporomandibular Disorders; SD: standard deviation; IQR: interquartile range.

naire on a tablet. The data collection period was intentionally limited because the study was integrated into the first author's Master's Dissertation and therefore had to fit within a restricted timeframe.

Participants were recruited consecutively among all eligible patients attending the clinic during the study period. This approach was used to minimize selection bias. However, because the study was conducted in a university dental clinic, the sample may have overrepresented individuals actively seeking treatment or those with greater awareness of their symptoms. No washout period for non-steroidal anti-inflammatory drugs (NSAIDs) or muscle relaxants was required, because the aim was to capture patients' functional and psychosocial status in their naturalistic, treatment-seeking state; this should be considered a methodological limitation.

All participants received clear information about the study aims and provided written informed consent. Anonymity was guaranteed throughout the study. The project was approved by the Ethics Committee of Egas Moniz School of Health and Science (PT-546/24) before data collection and was conducted in accordance with the Declaration of Helsinki.

A formal a priori power calculation was not conducted. Instead, the sample size was determined pragmatically by the number of eligible patients available during the predefined data collection period and the time constraints associated with the Master's Dissertation. Although no a priori power calculation was conducted, all eligible patients were consecutively invited to participate to minimize selection bias. In response to reviewer feedback, *post-hoc* power analyses were conducted for all three primary outcomes using the observed rank-biserial correlation coefficients as effect size estimates, with N = 65 (n_1 = 34, n_2 = 31) and α = 0.05 (two-tailed). Effect sizes were converted to Cohen's *d* equivalents to estimate power via normal approximation, and 95% confidence intervals (CI) were derived from the standard error of the rank-biserial *r*. Results indicated that the study was adequately powered to detect the large effects observed for JFLS-20 (r = 0.63; *post-hoc* power >99.9%; 95% CI (99.3%, 100%)) and OHIP-14

(r = 0.50; *post-hoc* power = 99.6%; 95% CI (76.6%, 100%)). Conversely, *post-hoc* power for PSS-10 was markedly low (r = 0.09; *post-hoc* power = 11.3%; 95% CI (5.0%, 81.9%)), confirming that the null finding for perceived stress should be interpreted with considerable caution. To achieve 80% power for an effect of this magnitude, approximately 964 participants (482 per group) would be required, a sample size that was not feasible within the study's constraints. These *post-hoc* estimates are summarised in **Supplementary Table 1**.

2.5 Data analysis

The dependent variables were the JFLS-20, OHIP-14, and PSS-10 scores; the independent variable was the presence or absence of TMD-related pain (pain group based on DC/TMD Axis I diagnosis); and age, sex, and comorbidities were considered potential confounders.

Data were analyzed using IBM® SPSS® version 30 (IBM Corp., Armonk, NY, USA). Descriptive analyses included frequencies and percentages for categorical variables and mean ± standard deviation (SD) or median (interquartile range (IQR)) for continuous variables, as appropriate. Normality was assessed using the Shapiro-Wilk test, which indicated non-normal distributions; therefore, nonparametric tests were used.

The Mann-Whitney U test was used to compare scores between groups. Age was dichotomized into two clinically relevant groups (18–35 years and >35 years), based on previous epidemiological studies indicating that the peak incidence of TMD symptoms often occurs in early adulthood, and to ensure adequate statistical power given the sample's demographic distribution. Accordingly, the Mann-Whitney U test was used for this comparison. Chi-square tests were used to compare categorical variables (sex, comorbidities) between groups. Spearman's correlation was used to assess associations among continuous variables (PSS-10, OHIP-14, and JFLS-20), with coefficients interpreted as weak (0.10–0.29), moderate (0.30–0.49), or strong (≥0.50). Rank-biserial correlation (r) was used as the effect size for Mann-Whitney U tests. Statistical significance was set at $p < 0.05$. Because this was an exploratory study, no correction for multiple comparisons was applied, and the results should be interpreted cautiously. Ninety-five percent confidence intervals are reported for the primary outcomes and Spearman's *rho* values.

Multivariable regression analyses were conducted as exploratory secondary analyses to assess whether the observed associations persisted after adjustment for sex and age. To address potential confounding by sex and age, we performed multivariable linear regression analyses with OHIP-14 total score and JFLS-20 mean score as dependent variables, and pain group (painful *vs.* non-painful TMD), sex, and age as independent variables. Given the non-normal distribution of residuals, bootstrapped 95% confidence intervals (1000 resamples) were computed.

3. Results

3.1 Sample characteristics

The recruitment flow is presented in Fig. 1. Of 82 patients initially screened, 8 declined participations, and 9 were excluded (4 for chronic pain in other body regions, 3 for psychotropic medication use, 2 for insufficient Portuguese proficiency), yielding a final sample of 65 participants. Of these, 70.8% (n = 46) were women and 29.2% (n = 19) were men. The overall mean age was 35.2 ± 14.8 years (Median: 28.0 (IQR: 22.0–49.0)). Most participants were between 18 and 25 years old (n = 31; 47.7%), followed by those aged 46–55 years (n = 14; 21.5%). Only 4.6% of the sample (n = 3) were older than 65 years.

Participants were classified based on their DC/TMD Axis I diagnosis. The Painful TMD group (n = 34, 52.3%) comprised participants with pain-related diagnoses, whereas the Non-painful TMD group (n = 31, 47.7%) included participants with exclusively intra-articular diagnoses. Physical or psychological comorbidities were reported in 23.5% of the Painful TMD group (n = 8) and 12.9% of the Non-painful TMD group (n = 4), with no significant between-group difference (χ^2 = 1.18, p = 0.277). Sex distribution differed significantly between groups (p = 0.032), with a higher proportion of females in the Painful TMD group (82.4%) than in the Non-painful TMD group (58.1%). A Mann-Whitney U test showed that Age did not differ significantly between groups (p = 0.145).

In the painful TMD group, DC/TMD Axis I diagnoses included myalgia (n = 18, 52.9%), arthralgia (n = 8, 23.5%), and combined myalgia/arthralgia (n = 8, 23.5%). Six of the 34 participants in this group also presented a concurrent intra-articular diagnosis (disc displacement); these participants were classified in the Painful TMD group based on their primary pain-related diagnosis, and their concurrent intra-articular findings are noted in Table 1. In the non-painful TMD group, diagnoses consisted of disc displacement with reduction (n = 22, 71.0%), disc displacement without reduction (n = 5, 16.1%), and degenerative joint disease (n = 4, 12.9%).

Table 1 presents the distribution of participants by sex, age group, DC/TMD Axis I diagnoses, and comorbidities, according to pain status.

3.2 Group comparison analyses

Patients with painful TMD presented significantly greater impairment in oral health-related quality of life and mandibular function compared with non-painful TMD participants (Table 2). The OHIP-14 total score was significantly higher in the painful TMD group (Mean = 11.71 ± 9.08; Median = 9.50 (IQR: 4.00–18.25)) compared with the non-painful TMD group (Mean = 4.81 ± 6.08; Median = 2.00 (IQR: 0.00–7.00); U = 265, $p < 0.001$, r = 0.50). Higher scores were observed in six of the seven OHIP-14 domains; the handicap domain did not differ significantly (U = 599.0, p = 0.273).

The corrected JFLS-20 mean score (0–10 range) was significantly higher in the painful TMD group (Mean = 1.28 ± 1.14; Median = 0.95 (IQR: 0.30–1.98)) compared with the non-painful TMD group (Mean = 0.30 ± 0.61; Median = 0.00 (IQR: 0.00–0.35); U = 195.5, $p < 0.001$, r = 0.63). Among the JFLS-20 subscales, mastication showed the largest difference (Painful TMD: 1.65 ± 1.42 *vs.* Non-painful TMD: 0.38 ±

TABLE 2. Descriptive statistics and comparison of PSS-10, OHIP-14, and JFLS-20 scores between Painful TMD (Painful TMD) and Non-painful TMD groups.

Variable	Painful TMD Mean ± SD Median (IQR)	Non-painful TMD Mean ± SD Median (IQR)	U	*p*	*r*	95% CI of diff.
PSS-10	19.41 ± 4.08 19.50 (17.00–22.00)	18.03 ± 6.46 18.00 (13.00–23.00)	477.5	0.514	0.09	−1.85–4.61
OHIP-14 Total	11.71 ± 9.08 9.50 (4.00–18.25)	4.81 ± 6.08 2.00 (0.00–7.00)	265.0	<0.001*	0.50	2.97–10.83
Functional Limitation	1.06 ± 1.57 0.00 (0.00–2.00)	0.45 ± 1.12 0.00 (0.00–0.00)	658.5	0.037*	0.25	0.04–1.18
Physical Pain	3.32 ± 2.09 3.00 (2.00–5.00)	1.10 ± 1.30 1.00 (0.00–2.00)	848.0	<0.001*	0.61	1.33–3.11
Psychological Discomfort	2.00 ± 1.83 2.00 (0.00–3.25)	0.94 ± 1.53 0.00 (0.00–2.00)	721.5	0.007*	0.37	0.21–1.91
Physical Disability	1.65 ± 2.02 1.00 (0.00–2.25)	0.58 ± 1.09 0.00 (0.00–1.00)	683.0	0.022*	0.30	0.22–1.92
Psychological Disability	1.91 ± 1.80 2.00 (0.00–3.00)	1.00 ± 1.84 0.00 (0.00–2.00)	686.0	0.028*	0.30	0.01–1.81
Social Disability	0.88 ± 1.22 0.00 (0.00–1.25)	0.23 ± 0.62 0.00 (0.00–0.00)	682.5	0.009*	0.29	0.18–1.12
Handicap	1.06 ± 1.50 0.00 (0.00–2.00)	0.52 ± 0.96 0.00 (0.00–1.00)	599.0	0.273	0.14	−0.10–1.18
JFLS-20 Total (0–10)	1.28 ± 1.14 0.95 (0.30–1.98)	0.30 ± 0.61 0.00 (0.00–0.35)	195.5	<0.001*	0.63	0.51–1.45
Mastication	1.65 ± 1.42 1.25 (0.42–2.50)	0.38 ± 0.72 0.00 (0.00–0.50)	201.0	<0.001*	0.62	0.72–1.82
Mobility	0.92 ± 1.08 0.50 (0.00–1.50)	0.25 ± 0.55 0.00 (0.00–0.25)	340.0	0.003*	0.36	0.24–1.10
Verbal/Emotional Expression	0.78 ± 1.01 0.38 (0.00–1.13)	0.18 ± 0.48 0.00 (0.00–0.00)	355.0	0.005*	0.33	0.20–1.00

*Painful TMD: pain-related DC/TMD diagnoses; Non-painful TMD: intra-articular diagnoses without pain component; U: Mann-Whitney U test statistic; r: rank-biserial correlation effect size; CI: confidence interval; TMD: temporomandibular disorder; PSS: Perceived Stress Scale; OHIP: Oral Health Impact Profile; JFLS: Jaw Functional Limitation Scale; SD: standard deviation; IQR: interquartile range; diff.: difference. OHIP-14 subscales are indented under the total score. JFLS-20 scores are reported as mean scores (0–10 range) per the INFORM scoring manual. *$p < 0.05$.*

0.72; $p < 0.001$), followed by mobility (Painful TMD: 0.92 ± 1.08 *vs.* Non-painful TMD: 0.25 ± 0.55; $p = 0.003$) and verbal/emotional expression (Painful TMD: 0.78 ± 1.01 *vs.* Non-painful TMD: 0.18 ± 0.48; $p = 0.005$).

No statistically significant difference in perceived stress was observed between groups (PSS-10: painful TMD: Mean = 19.41 ± 4.08, Median = 19.50 (IQR: 17.00–22.00); non-painful TMD: Mean = 18.03 ± 6.46, Median = 18.00 (IQR: 13.00–23.00); U = 477.5, $p = 0.514$, $r = 0.09$); however, the small effect size and modest sample size suggest that this study may have been underpowered to detect clinically meaningful differences in perceived stress.

3.3 Sex and age comparisons analyses

The following sex and age subgroup analyses are exploratory and unadjusted. Women reported significantly greater impairment in both mandibular function (JFLS-20: mean rank females = 36.13 *vs.* males = 25.42; U = 293.0, $p = 0.034$) and oral health-related quality of life (OHIP-14: mean rank females = 37.73 *vs.* males = 21.55; U = 219.5, $p = 0.002$) compared with men. No sex-related differences were observed for perceived stress (U = 378.5, $p = 0.397$). Participants older than 35 years also showed significantly higher OHIP-14 scores (mean rank = 40.16 *vs.* 27.58; U = 317.5, $p = 0.008$) and JFLS-20 scores (mean rank = 38.20 *vs.* 29.07; U = 372.5, $p = 0.049$) than younger participants. No age-related differences were observed for perceived stress (U = 508.0, $p = 0.894$). Detailed results are presented in Table 3.

3.4 Correlation analysis

A moderate positive correlation was observed between JFLS-20 and OHIP-14 total scores ($\rho = 0.45$, 95% CI: 0.22–0.63, $p < 0.001$), indicating that greater mandibular functional limitation corresponded to poorer oral health-related quality of life (Table 4). Among the JFLS-20 subscales, mastication showed the strongest correlation with OHIP-14 ($\rho = 0.48$, $p < 0.001$), fol-

TABLE 3. Sex and age subgroup comparisons for PSS-10, OHIP-14, and JFLS-20 scores (exploratory, unadjusted).

Comparison	Subgroup 1 Mean Rank	Subgroup 2 Mean Rank	U	*p*
Sex: PSS-10	F: 34.27	M: 29.92	378.5	0.397
Sex: OHIP-14	F: 37.73	M: 21.55	219.5	0.002*
Sex: JFLS-20	F: 36.13	M: 25.42	293.0	0.034*
Age: PSS-10	≤35: 32.62	>35: 33.62	508.0	0.894
Age: OHIP-14	≤35: 27.58	>35: 40.16	317.5	0.008*
Age: JFLS-20	≤35: 29.07	>35: 38.20	372.5	0.049*

*F: Female; M: Male; U: Mann-Whitney U test statistic; PSS: Perceived Stress Scale; OHIP: Oral Health Impact Profile; JFLS: Jaw Functional Limitation Scale. *p < 0.05. These subgroup analyses are exploratory and unadjusted.*

TABLE 4. Spearman correlation matrix among PSS-10, OHIP-14, and JFLS-20 scores (N = 65).

Variable Pair	ρ	95% CI	*p*
JFLS-20 Total—OHIP-14 Total	0.45	0.22–0.63	<0.001*
JFLS-20 Mastication—OHIP-14 Total	0.48	0.26–0.65	<0.001*
JFLS-20 Mobility—OHIP-14 Total	0.35	0.11–0.55	0.004*
JFLS-20 Verbal/Emotional—OHIP-14 Total	0.32	0.08–0.53	0.009*
PSS-10—OHIP-14 Total	0.18	−0.07–0.40	0.152
PSS-10—JFLS-20 Total	0.12	−0.13–0.35	0.348
OHIP-14 Total—JFLS-20 Total	0.45	0.22–0.63	<0.001*

*ρ: Spearman's rho; CI: confidence interval. Interpretation: 0.10–0.29 = weak, 0.30–0.49 = moderate, ≥0.50 = strong. *p < 0.05. PSS: Perceived Stress Scale; OHIP: Oral Health Impact Profile; JFLS: Jaw Functional Limitation Scale.*

lowed by mobility ($\rho = 0.35$, $p = 0.004$) and verbal/emotional expression ($\rho = 0.32$, $p = 0.009$). No significant correlations were observed between perceived stress (PSS-10) and either functional or quality-of-life measures (all $p > 0.05$).

3.5 Multivariable linear regression

Multivariable regression analyses were conducted as exploratory secondary analyses to assess the persistence of association in exploratory models. To address potential confounding by sex and age, multivariable linear regression models were fitted with OHIP-14 total score (Model A) and JFLS-20 mean score (Model B) as dependent variables, and pain group, sex, and age as independent variables. Bootstrapped 95% confidence intervals (1000 resamples) are reported in Table 5.

In Model A (OHIP-14), the pain group remained a significant predictor after adjustment ($\beta = 9.28$, bootstrapped 95% CI: 4.12–14.44, $p = 0.001$), indicating that participants in the Painful TMD group scored approximately 9.3 points higher on the OHIP-14 than those in the Non-painful TMD group, after adjustment for sex and age. Female sex showed a non-significant positive trend ($\beta = 2.85$, 95% CI: −1.98–7.68, $p = 0.243$), and age was not a significant predictor ($\beta = 0.08$, 95% CI: −0.06–0.22, $p = 0.261$). The adjusted R^2 was 0.27.

In Model B (JFLS-20), the pain group was again a significant predictor ($\beta = 0.93$, bootstrapped 95% CI: 0.50–1.36, $p < 0.001$), indicating that participants in the Painful TMD group scored approximately 0.93 points higher on the JFLS-20 (0–10 scale) than those in the Non-painful TMD group, after adjustment for sex and age. Female sex ($\beta = 0.22$, 95% CI: −0.28–0.72, $p = 0.382$) and age ($\beta = 0.005$, 95% CI: −0.01–0.02, $p = 0.548$) were not significant predictors. The adjusted R^2 was 0.24.

4. Discussion

This cross-sectional study examined the association between TMD-related pain, mandibular function, oral health-related quality of life, and perceived stress in a Portuguese clinical sample. Participants with painful TMD reported greater mandibular functional limitation and poorer oral health-related quality of life than those with non-painful TMD. These findings are consistent with the current biopsychosocial understanding of TMD, in which pain is a central determinant of functional impairment and reduced quality of life [2–4, 9]. No statistically significant difference in perceived stress was observed between groups.

This study does not attempt to establish novelty through the discovery of new associations, but rather through the clinically grounded characterization of painful versus non-painful DC/TMD presentations in a Portuguese treatment-seeking population using harmonized measures of mandibular function (JFLS-20), oral health-related quality of life (OHIP-14), and perceived stress (PSS-10). The unexpected finding that perceived stress did not differ between groups despite marked functional and quality-of-life differences adds a nuanced perspective to the existing literature. Importantly, multivariable linear regression suggested that the pain group effect on both OHIP-14 and JFLS-20 remained significant

TABLE 5. Multivariable linear regression results for OHIP-14 total score (Model A) and JFLS-20 mean score (Model B).

Model/Predictor	β	SE	Bootstrapped 95% CI	p
Model A: OHIP-14 (Adj. $R^2 = 0.27$)				
Pain group (Painful *vs.* Non-painful)	9.28	2.60	4.12–14.44	0.001*
Sex (Female *vs.* Male)	2.85	2.42	−1.98–7.68	0.243
Age (continuous, yr)	0.08	0.07	−0.06–0.22	0.261
Model B: JFLS-20 (Adj. $R^2 = 0.24$)				
Pain group (Painful *vs.* Non-painful)	0.93	0.22	0.50–1.36	<0.001*
Sex (Female *vs.* Male)	0.22	0.25	−0.28–0.72	0.382
Age (continuous, yr)	0.005	0.008	−0.01–0.02	0.548

*β: unstandardized regression coefficient; SE: standard error; CI: bootstrapped confidence interval (1000 resamples); OHIP: Oral Health Impact Profile; JFLS: Jaw Functional Limitation Scale. Reference categories: Non-painful TMD group, Male. *$p < 0.05$.*

after adjustment for sex and age (Table 5), supporting the consistency of these associations in this sample.

Perceived stress did not differ significantly between groups in this sample, despite the well-documented bidirectional relationship between stress and TMD-related pain [11]. Notably, absolute PSS-10 scores were high in both groups (means of 19.41 and 18.03), which may reflect a uniformly elevated baseline level of perceived stress in this predominantly young, university-aged sample. This possible ceiling effect may have reduced our ability to detect significant stress differences specifically attributable to the presence or absence of TMD pain. This contrasts with Wieckiewicz *et al.* [24], who observed significant associations in a larger, more diverse population. One hypothesis in the literature is that emotional load may be expressed as sustained low-level muscle activation or mandibular bracing, which transmits psychological tension to the masticatory muscles without necessarily increasing perceived stress [13, 25]. However, this remains a speculative explanation that warrants further investigation, as awake bruxism and mandibular bracing were not objectively measured in this study. The absence of a statistically significant difference in PSS-10 scores should not be interpreted as evidence of equivalence. The small observed effect size ($r = 0.09$), together with the modest sample size, provides insufficient power to exclude a clinically meaningful difference, and this null finding should therefore be interpreted with caution.

Our exploratory, unadjusted findings indicate that women and older participants reported greater impairment in mandibular function and oral health-related quality of life. These subgroup analyses should be interpreted with caution and considered hypothesis-generating rather than confirmatory. The pronounced sex imbalance (82.4% female in the painful group *vs.* 58.1% in the non-painful group; $p = 0.032$) represents a significant confounding factor. The higher proportion of women in the painful group may have independently contributed to the poorer functional and quality-of-life outcomes observed in that cohort. Furthermore, the small number of male participants (n = 19 total, and only n = 6 in the painful group) severely limits the statistical power and reliability of sex-stratified analyses. Regarding age, participants older than 35 years exhibited greater functional limitation and poorer quality of life. Potential explanations warranting future investigation include the role of estrogen fluctuations in modulating orofacial pain sensitivity in women and the contribution of cumulative mechanical wear and age-related degenerative joint processes to functional limitations in older adults [7]. The predominance of participants aged 18–25 years also limits the generalizability of the results to older adults.

The moderate positive correlation between JFLS-20 and OHIP-14 ($\rho = 0.45$, $p < 0.001$) indicates that greater functional limitation is associated with poorer oral health-related quality of life. Among the subscales, mastication showed the strongest correlation ($\rho = 0.48$), suggesting that chewing-related difficulties may be particularly impactful on daily quality of life. The observed between-group differences are not only statistically significant but also clinically meaningful, exceeding the established Minimal Clinically Important Difference (MCID) thresholds by a substantial margin. The OHIP-14 difference of approximately 7 points exceeds the established MCID of approximately 3 points by more than twofold, and the JFLS-20 difference of approximately 1.0 point exceeds the MCID of approximately 0.5 points by twofold, confirming that these differences represent clinically meaningful impairment rather than being fully explained by sex or age in this model. From a clinical perspective, these findings suggest that patients with painful TMD may require earlier identification of functional limitation and OHRQoL impairment, even in routine dental or orofacial pain settings. The results also support the value of including patient-reported outcome measures in clinical assessment, as these tools may help identify patients who could benefit from more targeted pain management, functional rehabilitation, and interdisciplinary follow-up [5]. However, given the cross-sectional and exploratory nature of the study, these implications should be interpreted as clinically informative rather than prescriptive. The heterogeneity of diagnostic subtypes within the painful group (myalgia, arthralgia, and combined diagnoses) may have differentially influenced functional limitation and quality of life outcomes; however, our sample size precluded robust subgroup analyses based on

specific diagnoses.

The pronounced functional limitation observed in the painful TMD group, particularly in the mastication domain (ρ = 0.48 with OHIP-14), may reflect pain- related guarding and avoidance behaviors consistent with a biopsychosocial model of chronic pain. Fear of pain or reinjury during function may lead patients to consciously or unconsciously limit jaw movement, contributing to reduced range of motion, altered chewing patterns and progressive avoidance of mastication-related activities [3, 4, 12, 13]. This protective motor adaptation, while initially beneficial, can become maladaptive over time, perpetuating a cycle of disuse, muscle deconditioning, and progressive functional decline. The resulting limitation in mastication, a fundamental daily activity, directly impairs nutritional intake, social participation during meals, and overall oral health-related quality of life, as reflected in the moderate correlation between JFLS-20 mastication scores and OHIP-14 total scores observed in this study. These findings suggest that pain management strategies targeting not only pain intensity but also motor rehabilitation (*e.g.*, jaw exercises, graded exposure to function) may be particularly relevant for improving quality-of-life outcomes in patients with painful TMD.

The multivariable regression analyses (Table 5) demonstrated that the association between pain group and both OHIP-14 and JFLS-20 scores remained statistically significant after adjustment for sex and age. Given the modest sample size and the imbalance in sex distribution, these adjusted findings should be interpreted as suggestive rather than definitive. In Model A, the pain group accounted for the largest share of explained variance in OHIP-14 scores (β = 9.28, p = 0.001), while sex and age did not reach significance as independent predictors. Similarly, in Model B, the pain group was the dominant predictor of JFLS-20 scores (β = 0.93, $p < 0.001$). These results suggest that the observed differences in functional limitation and oral health-related quality of life between the painful and non-painful TMD groups may persist in part after adjustment. However, the sample size, sex imbalance, and exploratory nature of the models limit stronger inference. Nevertheless, the modest adjusted R^2 values (0.27 and 0.24) indicate that substantial variance remains unexplained, likely attributable to unmeasured factors such as pain duration, pain intensity, coping strategies, and specific diagnostic subtypes. These findings highlight the potential value of integrating patient-reported outcome measures, including functional and quality-of-life tools, into routine TMD assessment, while the role of psychosocial screening instruments such as the PSS-10 in differentiating painful from non-painful TMD subgroups remains to be clarified in adequately powered future studies.

This study has several limitations that warrant consideration. First, the small sample size (N = 65) limited the scope of multivariate analyses and increased the risk of Type II errors, particularly for subgroup comparisons. A formal a priori power calculation was not conducted. *Post-hoc* power analyses (N = 65; α = 0.05, two-tailed) indicated adequate power for the two primary outcomes with large effects, JFLS-20 (>99.9%; 95% CI (99.3%, 100%)) and OHIP-14 (99.6%; 95% CI (76.6%, 100%)), but markedly insufficient power for PSS-10 (11.3%; 95% CI (5.0%, 81.9%)), consistent with the negligible effect size observed (r = 0.09). The null finding for perceived stress should therefore be interpreted with considerable caution; achieving 80% power for an effect of this magnitude would require approximately 964 participants. Future studies should employ formal a priori sample size justifications. Second, the cross-sectional design precludes causal inference; only associations can be reported. Third, although the primary grouping criterion was the DC/TMD Axis I diagnosis, the VAS $\geq$1 threshold used as supporting characterization is highly sensitive and may include patients with very mild pain (VAS 1–2); future studies should consider a higher, clinically meaningful threshold (*e.g.*, VAS $\geq$3). Fourth, all primary outcomes were self-reported, introducing potential response bias. Individuals experiencing chronic TMD-related pain may exhibit heightened somatic vigilance, leading them to over-report or be more acutely conscious of functional limitations and emotional stress compared to pain-free individuals. Fifth, while multivariable regression adjusting for sex and age was performed, additional potential confounders such as comorbidities, pain duration, and bruxism were not controlled due to sample size constraints. The significant sex imbalance between groups (p = 0.032) remains a concern despite the adjusted analyses. Sixth, no washout period for NSAIDs or muscle relaxants was required, which could have attenuated reported pain intensity and functional limitation scores. Seventh, the predominantly young, university-clinic population limits generalizability to the broader TMD population and to non-Portuguese populations. Eighth, no formal correction for multiple comparisons was applied given the exploratory nature of the study. Finally, the study did not include objective measures of muscle activity (*e.g.*, electromyography (EMG) for bruxism assessment). Residual confounding cannot be excluded due to the significant sex imbalance between groups (p = 0.032) and the very small number of male participants in the painful TMD group (n = 6), which limits the reliability of sex-adjusted analyses. The regression models, while informative, should be interpreted as exploratory given these constraints.

Future research should address these limitations by conducting longitudinal studies with larger, more diverse populations, incorporating objective measures of muscle activity alongside validated psychosocial instruments, and employing multivariate modeling with a broader set of covariates to isolate the independent effects of pain, sex, age, and psychosocial variables on functional and quality-of-life outcomes.

5. Conclusions

Painful TMD, defined by DC/TMD Axis I pain-related diagnoses, is associated with significantly greater mandibular functional limitation and poorer oral health-related quality of life compared to non-painful TMD. These associations remained significant after adjustment for sex and age in exploratory analysis. No statistically significant difference in perceived stress was detected, though the study may have been underpowered for this outcome. Women and older adults may represent more vulnerable subgroups, though these exploratory findings require confirmation in larger, adequately powered studies. The observed differences exceeded established MCID thresholds, confirming clinically meaningful impairment. These

findings support the integration of functional and quality-of-life assessments into routine TMD management as tools to help identify patients with greater clinical burden and potential need for targeted, interdisciplinary care, and highlight the need for interdisciplinary, biopsychosocial strategies as a standard component of care for patients with painful TMD.

ABBREVIATIONS

TMD, temporomandibular disorder; DC/TMD, Diagnostic Criteria for Temporomandibular Disorders; VAS, Visual Analog Scale; PSS-10, 10-item Perceived Stress Scale; OHIP-14, 14-item Oral Health Impact Profile; OHRQoL, oral health-related quality of life; JFLS-20, 20-item Jaw Functional Limitation Scale; SPSS, Statistical Package for the Social Sciences; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; CI, confidence interval; MCID, Minimal Clinically Important Difference; INFORM, International RDC/TMD Consortium Network; NSAIDs, non-steroidal anti-inflammatory drugs; SD, standard-deviation; IQR, interquartile range; EMG, electromyography.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and analyzed during the current study are not publicly available due to their origin from a single-center clinical setting, which involves sensitive patient health information. Data are available from the corresponding author upon reasonable request, subject to institutional ethics committee approval (PT-546/24) and compliance with confidentiality requirements.

AUTHOR CONTRIBUTIONS

ACdGdR—conceptualization, data collection, formal analysis, writing, original draft. AMA—supervision, diagnostic verification, writing, review, and editing. EKdC—supervision, methodology, writing, review, and editing. All authors have read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Ethics Committee of Egas Moniz School of Health and Science (PT-546/24) before data collection, in accordance with the principles stated in the Declaration of Helsinki. All participants received clear information about the study objectives and signed an informed consent form. Anonymity was ensured.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://files.jofph.com/files/article/2120760485546475520/attachment/Supplementary%20material.docx.

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