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Psychosocial, Behavioral, and Quality of Life Insights in TMDs: A Comparative Exploration of Young and Mature Patients

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Objective: Despite its global adoption and translation, studies reporting age-stratified Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) Axis I and II findings remain scarce. This study aimed to 1) compare TMD diagnostic categories, psychosocial/behavioral profiles, and Oral Health-related Quality of Life (OHRQoL) across age groups, 2) explore correlations between psychosocial/behavioral variables and OHRQoL, and 3) identify factors associated with low OHRQoL among Chinese adult TMD patients.

Methods: A total of 798 participants were recruited from a dental hospital and categorized into: young (YA: 18–44), mature patients (MA: 45–64), and old patients (OA: ≥65 years). They were assessed using DC/TMD Axis I procedures and Axis II measures for depression, anxiety, oral behaviors, and jaw function. OHRQoL was evaluated with the Oral Health Impact Profile for TMDs. Statistical analyses were performed using Chi-square/non-parametric tests and logistic regression ($\alpha = 0.05$).

Results: The final sample included 798 participants (79.6% women), of whom 88.0%, 11.0%, and 1.0% were YA, MA, and OA, respectively. Significant differences in education level (YA > MA/OA), intra-articular TMDs (YA > MA), jaw overuse behaviors (YA > MA/OA), jaw functional limitation (MA > YA), and OHRQoL (MA > YA) were observed. Moderate correlations were noted between OHRQoL and depression, anxiety, and jaw functional limitation ($r_s = 0.50–0.61$) across all groups, as well as between jaw overuse behavior and both depression and anxiety ($r_s = 0.43–0.45$) for the MA group.

Conclusion: Mature (MA/OA) TMD patients exhibited reduced oral behaviors but experienced greater jaw function and OHRQoL impairments. TMD pain doubled the likelihood of low OHRQoL.

Clinical Relevance: Age-related differences in physical diagnosis, oral behaviors, jaw function, and OHRQoL are evident among TMD patients. Older individuals exhibit fewer oral behaviors but face greater jaw limitations and poorer OHRQoL, highlighting the importance of tailored management across age group.

Keywords: temporomandibular disorders, age, psychosocial, oral behaviors, oral health-related quality of life

Introduction

Temporomandibular disorders (TMDs) are a major public health issue, impacting up to 34% of the general population, with a higher prevalence in females.[1,2] They encompass a wide range of musculoskeletal conditions affecting the temporomandibular joints (TMJs), masticatory muscles, and contiguous structures.[2,3] As outlined in the Diagnostic Criteria for TMDs (DC/TMD), the current dual-axis standard for assessing and diagnosing TMDs, TMDs can be classified into intra-articular (IT) and pain-related (PT) conditions.[4] IT conditions mainly consist of TMJ disc displacements, degenerative joint disease, and subluxation,

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while the primary PT conditions are TMJ arthralgia, masticatory muscle myalgia, and headaches attributed to TMDs.[4,5] TMDs, particularly when pain-related, can adversely affect oral health-related quality of life (OHRQoL), which refers to the impact of oral health and conditions on a person's overall well-being and daily activities.[6,7] In contrast, therapeutic interventions for TMDs have the potential to enhance OHRQoL.[8] The multifactorial etiology of TMDs adheres to the "biopsychosocial model of illness", with risk factors encompassing genetics, age, gender, sex hormones, trauma, oral behaviors, psychological distress, somatic symptoms, and sleep quality.[9–11]

TMD symptoms include facial and preauricular pain, TMJ sounds, as well as both closed and open locking, which causes limitations in jaw movement and impaired jaw function.[3,4] Symptoms are typically more pronounced during late adolescence and early adulthood, peak in middle age, and are less frequent in children and the elderly. Correspondingly, the majority of TMD patients are young or middle-aged adults.[12–14] Research on age-related differences among TMD patients remains scarce, with most studies focusing on Axis I (physical) diagnostic or symptom distributions.[12–17] Studies on East Asian TMD patients, including those from China, suggest that IT conditions are more common in young adults, whereas PT conditions are more prevalent in mature patients.[13–15] Furthermore, young adults are less likely to experience PT conditions alone, while mature patients typically have IT conditions accompanied by pain.[13,14] Age-related variations in Axis II psychosocial and behavioral aspects, as well as OHRQoL, are rarely investigated, and available studies show divergent findings regarding psychological distress.[12,13] Beyond depression and anxiety, other Axis II measures involve assessing sleeping-state and waking-state oral activities, in addition to jaw functional limitation.[4] A large cross-sectional study (n = 137,718) using the 3Q/TMD tool revealed significant gender and age variations in temporomandibular disorder (TMD) symptoms. Symptoms increased during adolescence, peaked in middle age, and declined later in life.[18] The highlighted information is valuable for understanding the burden of TMD conditions, setting care priorities, and creating real-world practice guidelines that account for age-related experiential changes, including physical, cognitive, and socio-environmental alterations.[19,20]

The global adoption and translation of the DC/TMD have enabled the evaluation of physical and psychosocial/behavioral data across various countries. Despite this, relatively few clinical and research groups have reported DC/TMD Axis I and II findings stratified by age.[14,21] The DC/TMD serves as the international standard for TMD assessment, primarily focuses on a dual-axis framework categorizing TMD into IT and PT but does not provide stratified approaches for different age populations. Existing diagnostic guidelines (eg, DC/TMD) lack age-specific recommendations, limiting personalized therapeutic strategies. The absence of age-tailored guidelines may lead to suboptimal outcomes, particularly in understudied groups such as adolescents and the elderly.[14] This study aims to address this gap by comparing age-related variations in adult TMD patients, utilizing both Axis I and II of the DC/TMD, while also evaluating the impacts on OHRQoL using a TMD-specific measure. Despite its global adoption and translation, studies reporting age-stratified Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) Axis I and II findings remain scarce.

Therefore, the present study aimed to address this gap by comparing age-related variations in clinical (Axis I) and psychosocial/behavioral (Axis II) characteristics among adult patients seeking professional care for TMDs in a specialized dental hospital and by evaluating the impact of these factors on OHRQoL using a TMD-specific measure. The research hypotheses were as follows: (a) Young adults have a higher prevalence of IT conditions and exhibit significantly greater psychological distress, increased oral behaviors, and jaw functional limitation, as well as poorer OHRQoL compared to mature patients; (b) The strength of correlations between psychological/behavioral variables and OHRQoL varies across age groups; and (c) TMD pain and psychological distress are the main factors related to low OHRQoL. These findings may inform the development of age-specific treatment strategies, such as prioritizing biomechanical interventions for younger TMD patients with joint hypermobility, while focusing on degenerative management and comorbidity screening for older adults with osteoarthritic changes.

Methods

Study Design and Sample

This exploratory observational study, which was part of a larger investigation on biopsychosocial phenotype profiling of TMD patients, received ethics approval from the Institutional Review Board at the West China Hospital of Stomatology,

Sichuan University (ID: WCHSIRB-D-2022-212) and conducted in accordance with the Declaration of Helsinki. The first paper in this research series, which examined the correlations between general and health anxiety, other DC/TMD Axis II measures, and OHRQoL, was recently published.[22] To attain a power of 95% with a significance level of 0.05, the required minimum sample size was 390 participants for three comparison groups. This calculation was performed using G*Power software Version 3.1.9.3, employing an analysis of variance (ANOVA) model, and was based on a small effect size of 0.20 for psychological distress and OHRQoL among age groups.[13,23] Participants were recruited between January 2022 and May 2024 from a consecutive series of first-time adult patients seeking professional help at the West China Hospital of Stomatology. The inclusion criteria required individuals to be 18 years or older, proficient in Chinese, presenting with TMD symptoms, and having complete DC/TMD Axis I and II data.

Inclusion criteria were: (a) age ≥ 18 years; (b) proficiency in Chinese; (c) availability of complete DC/TMD Axis I and Axis II assessments. Exclusion criteria were: (a) history of TMJ trauma or surgery; (b) presence of other orofacial pain conditions (eg, odontogenic or neuropathic pain); (c) current or regular use of systemic analgesics or centrally acting neuroactive medications, or recent use of strong pain medication at the time of assessment; and (d) severe psychiatric disorders, debilitating systemic conditions, or cognitive impairment that could interfere with reliable completion of the questionnaires. Eligible individuals were provided with information about the study, after which informed consent was obtained. Subsequently, participants completed an extensive survey that included socio-demographic details and the Chinese versions of several DC/TMD assessment tools, including the DC/TMD Symptom Questionnaire (SQ), the Patient Health Questionnaire-9 (PHQ-9), the General Anxiety Disorder-7 (GAD-7), the Oral Behaviors Checklist-21 (OBC-21), the Jaw Functional Limitation Scale-8 (JFLS-8), along with the Oral Health Impact Profile for TMDs (OHIP-TMD).[4,24–29]

Age Stratification and TMD Diagnoses

The participants were stratified into three age groups: young adults (18 to 44 years), mature adults (45 to 64 years), and older adults (≥65 years), following previous studies that adhered to the World Health Organization's age group classification system.[12,13] After completing the assessment tools, participants received a physical examination performed by three trained specialists who were experienced and skilled in DC/TMD procedures. The examination involved evaluating pain locations, palpation pain, TMJ sounds, jaw deviations, and the range of jaw movements. Imaging was used selectively, based on clinical indications rather than obtained systematically for all patients. When structural abnormalities were suspected – such as advanced TMJ degenerative joint disease, persistent disc displacement without reduction, or neoplastic lesions – cone-beam computed tomography (CBCT) and/or magnetic resonance imaging (MRI) were requested to confirm the diagnosis. The indications for CBCT and MRI were standardized across clinicians. To ensure consistency, all clinicians participated in centralized training on the imaging interpretation protocol. Cases with ambiguous indications underwent collaborative review by a multidisciplinary panel. TMD diagnoses were made following the DC/TMD diagnostic algorithms and were classified into three categories: IT alone, PT alone, and combined (CT). To minimize assessment bias, inter-examiner calibration was rigorously implemented prior to the clinical evaluations. All clinicians participated in clinical training using standardized DC/TMD protocols, achieving a high inter-rater reliability ($\kappa > 0.80$) for key parameters such as pain palpation and joint noise assessment.

Study Measures

Depression and Anxiety

The 9-item PHQ-9 and 7-item GAD-7 were used to assess symptoms of depression and anxiety, respectively.[24,25] The effectiveness and strong psychometric properties of both measures are well established.[30] A 4-point Likert scale, ranging from "not at all" (0 points) to "nearly every day" (3 points), was employed to rate the items. Total scores were calculated, with higher scores reflecting greater symptom severity. Depression was categorized into four levels: mild (≥5 points), moderate (≥10 points), moderately severe (≥15 points), and severe (≥20 points). Anxiety was categorized into three levels: mild (≥5 points), moderate (≥10 points), and severe (≥15 points).

Oral Behaviors and Jaw Function

The 21-item OBC-21 was used to assess sleeping-state and waking-state oral activities.[26] A 5-point Likert scale, ranging from "none of the time" (0 points) to "4–7 nights per week" or "all of the time" (4 points) was employed to rate the items. Total scores, indicative of "jaw overuse behavior", were calculated and categorized into three levels: normal (0 to 16 points), low (17 to 24 points), and high (25 to 84 points).[31] The OBC was further divided into three subscales: sleeping-state (SA), waking-state non-functional (WN), and waking-state functional (WF) oral activities.[32] SA subscale scores were determined by adding the scores for "teeth clenching or grinding during sleep" (item 1) and "sleeping in a position that exerts pressure on the jaw" (item 2). This sum was then multiplied by three to normalize the scores, ensuring consistency with the number of items in the WN and WF subscales. WN subscale scores were calculated by adding the scores for "teeth grinding" (item 3), "teeth clenching" (item 4), "pressing, touching, or holding teeth together when not eating" (item 5), "holding or tensing muscles without clenching or bringing teeth together" (item 6), "pushing the jaw forward or to the side" (item 7), and "holding the jaw in a tense or rigid position" (item 11). Similarly, WF subscale scores, which relate to normal jaw functioning, were calculated by adding the scores for "biting or holding objects between the teeth" (item 12), "chewing gum" (item 13), "eating between meals" (item 17), "sustained talking" (item 18), "singing" (item 19), and "yawning" (item 20). Higher scores on the SA, WN, and WF subscales reflect a greater frequency of various sleeping and waking-state oral activities. The 8-item JFLS-8 was used to assess jaw functional status.[27] A numerical scale, ranging from "no limitation" (0 points) to "extreme limitation" (10 points) was employed to evaluate the items. Total JFLS-8 scores were calculated, with higher scores indicating increased levels of "jaw function disability" or "jaw malfunction".[33]

OHRQoL

The 22-item OHIP-TMD was used to assess OHRQoL across seven domains: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap.[28,29] It has been translated and cross-culturally adapted to Chinese and validated for use with Chinese TMD patients.[34] A 5-point Likert scale, ranging from "never" (0 points) to "very often" (4 points), was employed to rate the items. Total and domain-specific scores were calculated by adding the scores for all 22 items and the relevant items within each domain. Higher OHIP scores reflect poorer or impaired OHRQoL.

Statistical Analyses

Categorical data were expressed as frequencies and percentages, and assessed using the Chi-square test with Benjamini-Hochberg adjustment. Continuous data were reported as means with standard deviations (SDs) and medians with interquartile ranges (IQRs). The Shapiro–Wilk test was used to evaluate data normality, which revealed a deviation from normal distribution. Thus, non-parametric tests, specifically the Kruskal–Wallis test, post-hoc Dunn test, and Spearman's rank-order correlation with Benjamini-Hochberg adjustment, were employed. Correlation coefficients (r_s) among variables were categorized into four levels: weak (≥0.1), moderate (≥0.4), strong (≥0.7), or very strong (≥0.9).[35] OHRQoL was divided into high and low categories using a split-median technique. The socio-demographic, psychosocial, and behavioral factors associated with low OHRQoL were identified through univariate and multivariate logistic regression analyses. A stepwise variable selection method was applied, with a significance level of $p < 0.10$, to exclude non-significant factors. The results were presented as odds ratios (ORs) with corresponding 95% confidence intervals (95% CI). R statistical software (version 4.2.2, R Foundation for Statistical Computing, Vienna, Austria) was used for statistical analysis, with a significance level of $p < 0.05$.

Results

Of the 859 individuals who met the inclusion criteria, 37 were excluded because of prior TMJ trauma or surgery, and 24 were omitted due to recent use of analgesics. The final sample included 798 participants, aged 18 to 75 years, with 79.6% being women and 83.5% having completed secondary education or higher. Among them, 36.1% were diagnosed with IT, 21.9% with PT, and 42.0% with CT. Additionally, young adults (YA) comprised 88.0% of the study population, while matured adults accounted for 12.0%, with 11.0% being middle-aged (MA) and 1.0% being old adults (OA).

Tables 1 and 2 summarize the socio-demographic, psychosocial, and behavioral variables, as well as the OHRQoL scores, across the three age groups. Education level differed significantly between age groups ($p < 0.001$), with young adults being more highly educated than middle-aged and old adults. The prevalence of intra-articular TMDs was higher in YA than in MA (37.6% vs

Table 1 Socio-Demographic and Mean/Median Psychosocial and Behavioral Variable Scores Across the Three Age Groups

Variables	All Patients	Young Adults [YA]	Mature Adults [MA]	Old Adults [OA]	P-value Post-Hoc
Total, n (%)	798 (100)	702 (87.97)	88 (11.03)	8 (1.00)	
Sex					0.819*
Male, n (%)	163 (20.43)	145 (20.66)	16 (18.18)	2 (25.00)	
Female, n (%)	635 (79.57)	557 (79.34)	72 (81.82)	6 (75.00)	
Age					**<0.001**
Mean (SD)	29.81 (10.67)	26.52 (5.83)	52.56 (5.02)	67.88 (3.48)	OA,MA>YA
Median (IQR)	26.00(22.00, 33.00)	26.00(22.00, 30.00)	52.00(49.00, 57.00)	66.50(65.75, 68.75)	
Education					**<0.001***
Primary, n (%)	132 (16.54)	71 (10.11)	55 (62.50)	6 (75.00)	YA>MA,OA
Secondary, n (%)	567 (71.05)	535 (76.21)	30 (34.09)	2 (25.00)	
Higher, n (%)	99 (12.41)	96 (13.68)	3 (3.41)	0 (0.00)	
TMD diagnostic subtypes					**0.039***
Intra-articular [IT], n (%)	288 (36.09)	264 (37.61)	21 (23.86)	3 (37.50)	YA>MA
Pain-realted [PT], n (%)	175 (21.93)	151 (21.51)	22 (25.00)	2 (25.00)	0.746*
Combined [CT], n (%)	335 (41.98)	287 (40.88)	45 (51.14)	3 (37.50)	0.195*
P-value	**<0.001***	**<0.001***	**0.002***	>0.999	
Post-hoc	CT,IT>PT	CT,IT>PT	CT>PT,IT	–	
Depression (PHQ-9)					0.340
Mean (SD)	4.80 (4.57)	4.87 (4.64)	4.44 (4.10)	2.75 (3.45)	
Median (IQR)	4.00(1.00, 7.00)	4.00(1.00, 7.00)	3.50(1.00, 6.00)	2.00(0.00, 3.50)	
Anxiety (GAD-7)					0.256
Mean (SD)	4.54 (4.56)	4.43 (4.47)	5.50 (5.28)	3.62 (2.97)	
Median (IQR)	3.00(1.00, 7.00)	3.00(1.00, 7.00)	4.00(1.00, 7.00)	4.50(0.75, 5.25)	
Jaw overuse behavior (OBC-21)					**<0.001**
Mean (SD)	24.57 (9.08)	25.58 (8.65)	17.45 (8.55)	14.25 (10.74)	YA>MA,OA
Median (IQR)	25.00(18.00, 31.00)	25.00(20.00, 31.00)	17.00(11.00, 23.25)	10.00(9.00, 14.25)	
Sleeping-state OA (SA)					**<0.001**
Mean (SD)	12.78 (6.41)	13.20 (6.19)	9.78 (7.26)	9.38 (6.70)	YA>MA
Median (IQR)	12.00(9.00, 18.00)	12.00(9.00, 18.00)	12.00(3.00, 15.00)	9.00(5.25, 13.50)	
Waking-state non-functional OA (WN)					**<0.001**
Mean (SD)	6.30 (4.06)	6.66 (3.98)	3.73 (3.52)	3.00 (5.01)	YA>MA,OA
Median (IQR)	6.00(3.00, 9.00)	7.00(4.00, 9.00)	3.00(0.75, 5.25)	1.50(0.00, 3.00)	
Waking-state functional OA (WF)					**<0.001**
Mean (SD)	7.57 (3.04)	7.87 (2.95)	5.44 (2.78)	4.25 (2.49)	YA>MA,OA
Median (IQR)	7.00(6.00, 10.00)	8.00(6.00, 10.00)	5.00(3.00, 8.00)	4.00(2.00, 5.25)	
Jaw functional limitation (JFLS-8)					**0.001**
Mean (SD)	14.60 (11.46)	14.02 (11.02)	18.62 (13.82)	21.25 (11.12)	MA>YA
Median (IQR)	13.00(6.00, 21.00)	13.00(5.25, 20.00)	17.50(8.00, 26.00)	21.00(15.50, 26.75)	

Notes: Results of Chi-square test* and Kruskal–Wallis/post-hoc Dunn's test with Benjamini-Hochberg adjustment. For expected cell sizes <5, the p-values were computed by Monte Carlo simulation. Bold indicates p <0.05.

Abbreviations: SD, standard deviation; IQR, Interquartile range; PHQ-9, Patient Health Questionnaire-9; GAD-7, General Anxiety Disorder-7; OBC-21, Oral Behaviors Checklist-21; SA, Sleeping-state oral activity; WA, Waking-state non-functional oral activity; JFLS-8, jaw functional limitation scale-8, IT, Intra-articular; PT, Pain-realted; CT, Combined; YA, Young adults; MA, mature patients; OA, Old adults.

23.9%; p = 0.039), and the distribution of TMD diagnostic subtypes differed within age groups, with combined and intra-articular TMDs being more frequent than pain-related TMDs in YA and in the total sample (all $p < 0.05$). Jaw overuse behavior scores were highest in YA (mean 25.58, SD 8.65) compared with MA (mean 17.45, SD 8.55) and OA (mean 14.25, SD 10.74; $p < 0.001$; post-hoc YA > MA, OA), whereas jaw functional limitation scores were higher in MA (mean 18.62, SD 13.82) than YA (mean 14.02, SD 11.02; p = 0.001; post-hoc MA > YA). Regarding OHRQoL, MA reported greater impairment than YA, with higher total OHIP-TMD scores (mean 36.64, SD 16.13 vs 31.37, SD 16.68; p = 0.008) and higher scores in the domains of functional limitation (p = 0.011), physical pain (p = 0.005), psychological disability (p = 0.008), and social disability (p = 0.007; all post-hoc MA > YA).

Table 3 presents the results of the correlation analyses among the psychosocial, behavioural, and clinical variables for the three age groups. Across YA and MA, depression and anxiety were strongly and positively correlated (YA: *rs* = 0.74,

Table 2 Mean/Median Total and Domain OHIP-TMD Scores Across the Three Age Groups

Variables	All Patients	Young Adults [YA]	Mature Patients [MA]	Old Adults [OA]	P-value *Post-Hoc*
OHRQoL (total OHIP)					
Mean (SD)	31.93 (16.73)	31.37 (16.68)	36.64 (16.13)	29.88 (21.03)	**0.008**
Median (IQR)	32.00(20.00, 43.00)	31.00(19.25, 42.00)	38.00(26.00, 46.00)	29.00(17.75, 41.50)	MA>YA
Functional limitation					
Mean (SD)	3.68 (2.10)	3.60 (2.09)	4.38 (2.02)	3.50 (2.62)	**0.011**
Median (IQR)	4.00(2.00, 5.00)	4.00(2.00, 5.00)	4.00(3.00, 6.00)	4.00(1.50, 5.25)	MA>YA
Physical pain					
Mean (SD)	6.53 (3.98)	6.38 (3.92)	7.83 (4.13)	5.25 (5.20)	**0.005**
Median (IQR)	6.00(4.00, 9.00)	6.00(3.00, 9.00)	8.00(5.00, 10.25)	4.00(1.50, 8.00)	MA>YA
Psychological discomfort					
Mean (SD)	8.05 (4.15)	7.98 (4.14)	8.65 (4.18)	7.75 (4.92)	0.271
Median (IQR)	8.00(5.00, 11.00)	8.00(5.00, 11.00)	8.00(7.00, 12.00)	8.50(4.00, 11.25)	
Physical disability					
Mean (SD)	3.06 (1.94)	3.05 (1.95)	3.18 (1.77)	3.12 (2.85)	0.587
Median (IQR)	3.00(2.00, 4.00)	3.00(2.00, 4.00)	3.00(2.00, 4.00)	3.50(0.00, 5.25)	
Psychological disability					
Mean (SD)	6.71 (4.64)	6.55 (4.65)	7.93 (4.35)	7.25 (5.63)	**0.008**
Median (IQR)	7.00(3.00, 10.00)	6.00(3.00, 9.00)	8.50(5.75, 11.00)	7.00(4.50, 10.00)	MA>YA
Social disability					
Mean (SD)	1.63 (1.66)	1.58 (1.65)	2.09 (1.63)	1.25 (1.58)	**0.007**
Median (IQR)	1.00(0.00, 3.00)	1.00(0.00, 2.75)	2.00(0.75, 3.00)	0.50(0.00, 2.25)	MA>YA
Handicap					
Mean (SD)	2.27 (1.94)	2.24 (1.94)	2.58 (1.94)	1.75 (1.28)	0.173
Median (IQR)	2.00(0.00, 4.00)	2.00(0.00, 3.00)	3.00(1.00, 4.00)	2.00(0.75, 3.00)	

Notes: Results of Kruskal–Wallis/post-hoc Dunn's test with Benjamini-Hochberg adjustment. Bold indicates p <0.05.
Abbreviations: OHIP-TMD, Oral Health Impact Profile for TMDs (OHRQoL); OHRQoL, oral health-related quality of life; YA, Young adults; MA, mature patients; OA, Old adults; SD, standard deviation; IQR, Interquartile range.

Table 3 Correlations Among the Various Variables for the Three Age Groups

Age Group	Variables	PHQ-9	GAD-7	OBC-21	JFLS-8	OHIP-TMD
Young adults (YA)	PHQ-9	–	**0.74*** **	0.27***	0.31***	**0.52*** **
	GAD-7	**0.74*** **	–	0.26***	0.34***	**0.62*** **
	OBC-21	0.27***	0.26***	–	0.22***	0.32***
	JFLS-8	0.31***	0.34***	0.22***	–	**0.58*** **
	OHIP-TMD	**0.52*** **	**0.62*** **	0.32***	**0.58*** **	–
Middle-aged adults (MA)	PHQ-9	–	**0.75*** **	**0.45*** **	0.31**	**0.50*** **
	GAD-7	**0.75*** **	–	**0.43*** **	0.38***	**0.61*** **
	OBC-21	**0.45*** **	**0.43*** **	–	0.18	0.34**
	JFLS-8	0.31**	0.38***	0.18	–	**0.55*** **
	OHIP-TMD	**0.50*** **	**0.61*** **	0.34**	**0.55*** **	–
Old adults (OA)	PHQ-9	–	**0.67**	0.07	0.34	0.11
	GAD-7	**0.67**	–	−0.08	0.05	−0.04
	OBC-21	0.07	−0.08	–	−0.23	**0.69**
	JFLS-8	0.34	0.05	−0.23	–	0.33
	OHIP-TMD	0.11	−0.04	**0.69**	0.33	–

Notes: Results of Spearman correlation with Benjamini-Hochberg Adjustment. *indicates p <0.05, ** indicates p <0.01, *** indicates p <0.001, and bold indicates correlation coefficient ≥0.4.
Abbreviations: YA, Young adults; MA, Middle-aged adults; OA, Old adults; PHQ-9, Patient Health Questionnaire-9 (depression); GAD-7, General Anxiety Disorder-7 (anxiety); OBC-21, Oral Behaviors Checklist-21 (jaw overuse behavior); JFLS-8, Jaw Functional Limitation-8 (jaw function); OHIP-TMD, Oral HealthImpact Profile for TMDs (OHRQoL).

Table 4 Factors Associated with Low OHRQoL

Variables	Univariate		Multivariate	
	Odds Ratio (95% CI)	P-value*	Odds Ratio (95% CI)	P-value^
Sex				
Male	Reference			
Female	2.15 (1.51, 3.09)	**<0.001**	1.49 (0.95, 2.38)	0.087
Age	1.02 (1.00, 1.03)	**0.017**	1.02 (1.00, 1.04)	**0.036**
Education				
Primary	Reference			
Secondary	0.59 (0.40, 0.87)	**0.008**	0.69 (0.39, 1.22)	0.207
Higher	0.45 (0.26, 0.76)	**0.003**	0.51 (0.24, 1.05)	0.067
TMDs subtypes				
Intra-articular	Reference			
Pain-related	3.47 (2.35, 5.16)	**<0.001**	2.30 (1.40, 3.80)	**0.001**
Combined	3.93 (2.82, 5.52)	**<0.001**	2.10 (1.37, 3.23)	**0.001**
Depression	1.26 (1.21, 1.32)	**<0.001**	1.01 (0.95, 1.08)	0.654
Anxiety	1.40 (1.33, 1.48)	**<0.001**	1.32 (1.23, 1.42)	**<0.001**
Jaw overuse behavior	1.05 (1.04, 1.07)	**<0.001**	1.05 (1.02, 1.07)	**<0.001**
Jaw functional limitation	1.11 (1.09, 1.13)	**<0.001**	1.08 (1.06, 1.10)	**<0.001**

Notes: Results of *univariate and ^multivariate logistic regression analyses. Bold indicates p <0.05.
Abbreviations: OHRQoL, oral health-related quality of life; TMDs, Temporomandibular disorders.

MA: *rs* = 0.75; both p < 0.001), with a similarly large, but non-significant, correlation in OA *(rs* = 0.67; p > 0.05). In YA, higher levels of depression and anxiety were moderately associated with poorer OHRQoL and greater jaw functional limitation *(rs* = 0.52–0.62; all p < 0.001). In MA, OHRQoL also showed moderate positive correlations with depression, anxiety, and jaw functional limitation *(rs* = 0.50–0.61; all p < 0.001), and jaw overuse behavior was moderately and positively correlated with both depression and anxiety *(rs* = 0.45 and 0.43, respectively; both p < 0.001). In OA, a large positive correlation was observed between OHRQoL and jaw overuse behavior *(rs* = 0.69), but this association did not reach statistical significance (p > 0.05), likely reflecting the small sample size in this age group.

Table 4 shows the results of univariate and multivariate logistic regression analyses. While univariate modeling indicated significant associations with all examined variables, the multivariate analysis revealed that only certain factors increased the odds of low OHRQoL. These factors were age (OR = 1.02; 95% CI = 1.00–1.04), PT (OR = 2.30; 95% CI = 1.40–3.80), CT (OR = 2.10; 95% CI = 1.37–3.23), depression (OR = 1.01; 95% CI = 0.95–1.08), anxiety (OR = 1.32; 95% CI = 1.23–1.42), jaw overuse behavior (OR = 1.05; 95% CI = 1.02–1.07), and jaw functional limitation (OR = 1.08; 95% CI = 1.06–1.10).

Discussion

This study compared TMD profiles across age groups and found that middle-aged and older adults generally experienced greater jaw dysfunction and poorer OHRQoLthan younger adults. TMD-related pain and anxiety emerged as key factors linked to lower OHRQoL across all ages. Consistent with reports in other East Asian populations, the sample was predominantly female and showed a high prevalence of arthralgia—patterns often attributed to biological, psychological, and sociocultural influences.[13,14,36]

Young adults comprised 88.0% of the adult TMD patients seen during the study period, while mature patients accounted for only 12.0%. This distribution was consistent with an earlier study, which reported a similar pattern of young and mature adults seeking TMD care in another Chinese dental hospital.[13] Although the proportion of old adults in the present study was slightly lower (1% versus 4%), the rates from both studies fell within the reported range of up to 5%.[37] At face value, this pattern may suggest that TMD symptoms are less common at older ages, possibly reflecting spontaneous remission or adaptation of pain and dysfunction over time. However, an alternative and not mutually exclusive explanation is that TMD may be more disabling among those who continue to have symptoms into middle and

older age. In line with this, the older age groups in our sample showed substantial jaw functional limitation and impaired OHRQoL, suggesting that patients who present at a later age may represent a subgroup with more persistent or clinically impactful disease.

Regarding TMD diagnostic categories, significant differences were found only for IT, with young adults showing a higher prevalence compared to middle-aged patients. Findings corroborate earlier research that documented high frequencies of TMJ disorders, particularly disc displacements and degenerative joint disease, in young people.[13,14,38,39] The notably lower prevalence of PT alone in the YA group has also been described, indicating that young TMD patients are more susceptible to IT, both with and without accompanying pain.[13,14] In contrast, the MA group demonstrated a considerably higher prevalence of CT, characterized by the coexistence of PT and IT conditions. The latter could be partially attributed to chronic pain resulting from "altered neural manifestations".[40] The low number of old adults seeking treatment, despite the progression of TMJ degeneration with age, has been linked to the prioritization of more severe symptoms caused by other medical conditions.[37] Taken together, our cross-sectional data cannot disentangle whether the lower representation of middle-aged and older adults reflects true remission or selective persistence of more severe cases. Longitudinal, population-based cohorts with repeated DC/TMD assessments are needed to clarify age-related trajectories of TMD and to identify prognostic factors for persistence versus recovery.

Psychosocial and Behavioral Factors

TMDs have been associated with psychological distress, and young and mature TMD patients may experience depression and anxiety differently.[41–43] Age can influence life circumstances, such as job opportunities, physical health, and the availability of social support, which may affect how depression and anxiety present.[43] However, similar to findings from a previous Chinese study, there were no significant differences in depression and anxiety among the three age groups.[13] This could be explained in part by the generally normal to mild levels of depression and anxiety observed, which appears to contradict earlier Research Diagnostic Criteria for TMDs (RDC/TMD) studies indicating a high occurrence of moderate-to-severe psychosocial distress.[42] The disparity may stem from the RDC/TMD Axis II instruments, specifically the Symptom Checklist-90-Revised (SCL-90-R), tending to classify patients with more severe symptoms compared to the DC/TMD Axis II measures.[44]

While the YA group displayed significantly higher jaw overuse behavior and oral activities during both sleep and wakefulness compared to mature patients, the MA group exhibited significantly greater jaw function disability. Specifically, young adult patients had high levels of jaw overuse behavior, with greater frequencies of oral activities during sleep. Findings align with a recent study showing that, although oral behaviors are often reported by TMD patients, they do not predict TMDs, unlike factors such as age, sex, and jaw functional limitation.[45] The greater jaw functional limitation in the MA group could be due to their higher prevalence of painful TMDs relative to the YA group (76.1% versus 62.4%).

OHRQoL

OHRQoL was assessed using a TMD-specific measure rather than a generic instrument, such as the OHIP-14, which has been applied in many prior TMD studies.[6,7] Condition-specific measures are tailored to capture the symptoms and impacts associated with defined oral diseases or disorders, offering improved sensitivity, specificity, and responsiveness compared to generic instruments. They also reduce "no impact" or "floor effects", as the items are more likely to be prevalent and relevant.[13,46] Middle-aged patients experienced significantly lower OHRQoL compared to their younger counterparts, particularly in the domains of functional limitation, physical pain, psychological disability, and social disability. Findings confirmed that the physical and psychosocial domains were more affected in TMD patients, particularly those who are middle-aged.[47] The exact reasons are not fully understood, though hormonal changes, lifestyle factors, cumulative damage, and reduced regenerative capacity of the masticatory system may contribute.[37]

Correlation and Regression Analyses

Correlations among psychosocial/behavioral variables and OHRQoL varied somewhat across age groups, suggesting differences in how these factors interact depending on age. The moderate to strong correlations between depression and

anxiety, regardless of age group, were anticipated due to the well-established comorbidity between these two emotional states. Possible links include stressful life events, common negative effects, impaired cognitive functions, and shared genetic or biological vulnerabilities.[48] OHRQoL was moderately associated with depression, anxiety, and jaw functional limitations in both the YA and MA groups. Moderate relationships between OHRQoL and psychological distress were also identified in a separate study on Chinese TMD patients using a different psychometric tool.[13] Psychological distress can amplify pain perception, leading to greater limitations in jaw function and social impairments. Conversely, chronic TMD pain and dysfunction can elevate levels of depression and anxiety, establishing a bidirectional relationship.[49] Jaw overuse behavior was moderately correlated to depression and anxiety in the MA group but not the YA group, suggesting that the role of psychological factors in sleeping-state and waking-state oral activities may be age-dependent. This could explain the weaker, albeit significant, associations observed in other Chinese studies.[50] The relationships observed in the OA group were discounted due to a lack of statistical significance resulting from the small sample size.

After adjusting for potential confounders in the multivariate analysis, painful TMDs, specifically PT and CT, were found to increase the odds of low OHRQoL by more than twofold. Anxiety was associated with a 32% increase in the likelihood of low OHRQoL, whereas age, depression, jaw overuse behavior, and jaw functional limitations were linked to smaller increases in odds, ranging from 1% to 8%. Consequently, TMD pain and anxiety emerged as the primary factors associated with low OHRQoL and should be prioritized in TMD management. A comprehensive treatment plan should include targeted pain management for TMDs, address related oral behaviors and jaw functional disabilities, and incorporate interventions to reduce psychological distress, all aimed at improving overall well-being and daily functioning. Future studies should prioritize multi-center collaborations and prospective designs to recruit larger OA patient cohorts, thereby addressing the current limitation of statistical underpowering in age-stratified analyses.

In summary, building on prior observations of age differences in TMD, our study refines the understanding of age-specific disease expression by demonstrating that young adults (88.0% of our cohort) exhibit lower pain-predominant TMD rates (62.4% vs 76.1% in middle-aged adults) despite higher jaw overuse behaviors, while middle-aged patients show significantly greater functional limitations driving OHRQoL decline. Crucially, we provide empirical evidence that psychological factors interact with age: jaw overuse correlates with anxiety only in middle-aged patients (moderate correlation), and anxiety exerts a substantially stronger impact on OHRQoL (OR=1.32) than depression or behavioral factors (OR=1.01–1.08). This contextualizes existing biopsychosocial models by identifying age as a potential effect modifier for clinical decision-making—suggesting behavioral interventions may be prioritized for youth, while integrated pain-functional-psychological approaches benefit middle-aged patients. As noted in our limitations, these findings require validation in diverse populations but offer actionable refinements to age-tailored TMD management within current clinical frameworks.

Study Strengths and Limitations

This study adds several novel contributions to the existing TMD literature. First, by applying the DC/TMD to a large, help-seeking clinical population and stratifying analyses by age, we provide a detailed picture of Axis I and Axis II profiles across the adult lifespan, which has rarely been reported. Second, we demonstrate that jaw overuse behavior and psychological distress are differentially distributed across age groups and are consistently associated with TMD-specific OHRQoL, thereby highlighting age-specific psychosocial targets for intervention. Third, the identification of a predominantly IT phenotype in young adults and more complex CT profiles with greater functional limitation in mature adults provides translatable insights for designing age-tailored treatment strategies in specialized TMD clinics.

The study has many limitations. Firstly, the present study encountered a challenge in enrolling a sufficiently large cohort of older adult patients. This limitation restricts the generalizability of our findings and may have reduced the statistical power for analyses pertaining to this population. To address this and to further elucidate the characteristics of TMJ degeneration in the aging population, subsequent phases of our research will place enhanced emphasis on the continued recruitment of older adult patients with TMD, specifically targeting those with confirmed or suspected TMJ OA. Expanding this sample size in future studies is crucial for obtaining more robust and definitive conclusions regarding this patient population. Secondly, the cross-sectional design limits the ability to infer causality, r restricting the understanding of the direction of the relationships between psychosocial/behavioral variables and OHRQoL. Thirdly, we excluded a small subgroup of patients who were using regular

systemic analgesics or centrally acting neuroactive medications. This decision was made to reduce pharmacological confounding on pain and psychosocial measurements, but it may have selectively removed individuals with more severe or chronic pain and greater comorbidity. Fourthly, the study was limited to Chinese TMD patients, and the research must be replicated in other racial groups and clinical settings before definitive conclusions can be established. Fifthly, the disproportionate representation of women and young adults, while consistent with current literature, hinders the generalizability of the findings to male and older TMD patients. Although enrolling more dental hospitals could potentially help address this issue, sample imbalances may persist. Sixthly, despite being validated, the DC/TMD Axis II and OHRQoL measures relied on self-reporting, which can be subject to inaccuracies due to recall, social desirability, and other information biases. Lastly, we did not assess menopausal status or hormone replacement therapy, and our age bands were not specifically tailored to reproductive stages. Consequently, we could not formally evaluate hormone-related influences on TMDs and mood, and our results should not be over-interpreted in terms of hormonal mechanisms.

Conclusion

Young adults constituted the majority of help-seeking TMD patients, whereas middle-aged and older adults presented with more complex diagnostic profiles and greater jaw functional limitation. Psychosocial and behavioral factors, particularly jaw overuse and psychological distress, were strongly associated with TMD burden and OHRQoL across age groups. These findings underscore the close interaction between mental health and TMD-related disability. Clinically, they support age-tailored management strategies that combine biomechanical care with integrated psychological interventions.

Abbreviations

CT, Combined TMDs; DC/TMD, Diagnostic Criterial for TMDs; GAD-7, General Anxiety Disorder-7; IT, Intra-articular TMDs; JFLS-8, Jaw Functional Limitation Scale-8; OBC, Oral Behaviors Checklist; OHIP-TMD, Oral Health Impact Profile for TMDs; OHRQoL, Oral Health-related Quality of Life; PHQ-9, Patient Health Questionnaire-9; PT, Pain-related TMDs; SA, Sleeping-state oral activities; TMDs, Temporomandibular Disorders; WF, Waking-state functional oral activities; WN, Waking-state non-functional oral activities.

Data Sharing Statement

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participant

This research received ethics approval from the Institutional Review Board at the West China Hospital of Stomatology, Sichuan University (grant number: WCHSIRB-D-2022-212). Written informed consent has been obtained from all participants.

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