Number and type of temporomandibular disorder symptoms: their associations with psychological distress and oral health-related quality of life

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Objective. In this case-control study, we investigated the presence of differing numbers and types of temporomandibular disorder (TMD) symptoms, their association with psychological distress, and their impact on oral health-related quality of life (OHRQoL).
Study Design. We recruited a total of 814 participants with TMD and 147 control subjects. The participants were instructed to complete the Diagnostic Criteria for Temporomandibular Disorders Symptom Questionnaire; the Depression, Anxiety and Stress Scale-21; and the Oral Health Impact Profile−Temporomandibular Disorders. The participants were subsequently categorized by their number and type of TMD symptoms. Data were analyzed with the Kruskal-Wallis/Mann-Whitney U test (α = .05).
Results. The mean age of the participants (N = 961) was 32.99 $\pm$ 13.14 years, and 79.2% were women. Participants with more and all types of TMD symptoms generally exhibited significantly higher levels of psychological distress and worse OHRQoL ($P <$ .001). Those with TMD pain plus temporomandibular joint (TMJ) sounds/dysfunction had significantly greater psychological distress, whereas those with painful symptoms and TMJ dysfunction experienced significantly more impairment in OHRQoL than individuals with only TMJ sounds.
Conclusions. Psychological states and OHRQoL are influenced by the number and type of TMD symptoms. Individuals with more and all types of pain-related TMD symptoms with/without intra-articular features had greater psychological distress and OHRQoL impairment. (Oral Surg Oral Med Oral Pathol Oral Radiol 2021;132:288−296)

Temporomandibular disorders (TMDs) are a cluster of medical and dental conditions involving the temporomandibular joints (TMJs), masticatory musculature, and contiguous hard and soft tissues. They are a public health concern affecting about 6%-15% of the population.[1,2] Symptoms of TMDs include headaches, facial and periauricular pain, TMJ noises with function, jaw opening/ movement difficulties and restrictions, and functional limitations. TMD symptoms are more prevalent in women and have a peak occurrence between 20 and 40 years of age.[1,2] The multifactorial etiology of TMDs was found to be consistent with a "biopsychosocial model of illness"[3] and had been associated with depression and other negative emotional states.[2,3] Moreover, TMDs also affect both the general and oral health-related quality of life (OHRQoL) of individuals.[4-6]

OHRQoL is a multidimensional construct reflecting an individual's oral health; physical, psychological, and social well-being; care expectations and satisfaction; and self-esteem.[7,8] OHRQoL measures are beneficial for determining/monitoring the impacts of oral conditions and intervention outcomes and for distinguishing problems encountered and prioritizing care.[9] Although prior literature had indicated that TMDs negatively impacted OHRQoL, these studies did not employ TMD-specific OHRQoL measures; rather, they used generic ones that have lower sensitivity, specificity, and responsiveness as well as higher "floor effects."[7,8] Furthermore, most studies did not differentiate TMD symptoms/conditions on the basis of the contemporary Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) standard.[10] On the basis of DC/TMD, common TMD symptoms and conditions can be categorized into pain-related and intra-articular problems. Pain-related symptoms include TMD (masticatory muscle/TMJ) pain and headaches attributable to

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Statement of Clinical Relevance

Patients with more and all types of pain-related temporomandibular disorder (TMD) symptoms often have higher levels of psychological distress and greater oral health-related quality of life impairments in the psychological domains. The mental state of these patients should be reviewed as part of comprehensive TMD management.

TMDs, whereas intra-articular symptoms encompass TMJ noises and closed and open locking as specified in the DC/TMD Symptom Questionnaire (SQ).

To date, only 1 study had explored the impact of the number and type of DC/TMD symptoms on emotional states and OHRQoL.[11] Tay et al.[11] found that individuals with TMD symptoms had better OHRQoL but higher levels of psychological disturbance than their TMD-free counterparts. Nonetheless, significant differences in Oral Health Impact Profile-14 (OHIP-14) and Depression, Anxiety and Stress Scale-21 (DASS-21) scores were noted among disparate numbers and types of symptoms for participants with TMDs.[11] Explanations offered for the incongruence with available literature included the involvement of military personnel who may have other comorbid oral diseases and the employment of a generic OHRQoL instrument. Therefore, a need for a similar study on patients with TMD with a condition-specific OHRQoL measure is warranted.

The objectives of this study were to investigate the presence of differing numbers and types of TMD symptoms and their associations with psychological distress and OHRQoL compared with TMD-free control subjects. A secondary purpose was to explore the potential of the principal symptoms of the DC/TMD-SQ for screening TMDs from the patient perspective. The null hypotheses were (1) the number/type of TMD symptoms was not related to the severity of depression, anxiety, and stress; (2) the number/type of TMD symptoms did not impact functional, physical, psychological, and social well-being differently; and (3) the 5 primary symptoms of the DC/TMD-SQ were not associated with participant-reported outcome measures.

METHODS
Study participants
This case-control study was approved by the Biomedical Institutional Review Board of Peking University School of Stomatology (PKUSSIRB-201732009). G*Power software version 3.1.9.3[12] was used to calculate the minimum sample size (n = 770) a priori on the basis of the Wilcoxon-Mann-Whitney model with an effect size of 0.50, alpha error of .05, power of 95%, and allocation ratio of 12.[11] Allowing for a 15% nonparticipation rate, an estimated sample size of 886 individuals was required. Participants in the "with TMD symptoms" (WT) group were recruited from among consecutive patients referred to the TMD and Orofacial Pain Center, Peking University Hospital of Stomatology, and those in the "no TMD symptoms" (NT) control group were enrolled from the Department of Prosthodontics. The inclusion criteria were individuals aged ≥18 years and the presence or absence of any DC/TMD symptoms in the last 30 days for the WT or NT group, respectively. Patients with prior orofacial trauma, uncontrolled

psychiatric disorders, autoimmune and metabolic diseases, and cognitive difficulties and illiteracy were excluded from the study. Contribution to the study was entirely voluntary, and informed consent was attained from all participants. At the intake visit, participants were instructed to complete a general/health questionnaire and the Chinese versions of the DC/TMD-SQ, DASS-21, and OHIP-TMD.[13-15]

Measures
TMD symptoms were ascertained with the DC/TMD-SQ, which is composed of 14 items concerning pain-related and TMJ intra-articular symptoms.[13] The DC/TMD-SQ provides the necessary history for deriving axis I (physical) TMD diagnoses together with physical examination, radiographic imaging, and the DC/TMD diagnostic algorithms. Positive responses to the principal questions on TMD pain/headaches and TMJ sounds/closing or opening locking (Table I) were used to indicate the presence of TMD pain (TP), TMJ sounds (TS), and TMJ dysfunction (TD). Clinical examinations were then conducted by a single TMD specialist, who was trained and calibrated in the DC/TMD protocol, to verify the presence of the TMD symptoms. The participants were subsequently classified by the number (1-5 symptoms [1-5S]) and type (TP, TS, TD, PS [TP plus TS], and PD [TP plus TD]) of TMD symptoms with the control subjects serving as the reference (0S and NT) group.

Psychological distress was evaluated with the DASS-21,[14,16] whose psychometric properties are well established.[17] It consists of 21 items with 7 questions

TABLE I. Principal items of Diagnostic Criteria for Temporomandibular Disorders Symptom Questionnaire

Item no.	Questions (in the last 30 days)	Classification
1	Have you ever had pain in your jaw, temple, in the ear, or in front of the ear on either side?	TMD pain (TP)
2	Have you had any headaches that include the temple areas of your head?	
3	Have you had any jaw joint noise (s) when you moved or used your jaw?	TMJ sounds (TS)
4	Have you ever had your jaw lock or catch, even for a moment, so that it would not open all the way?	TMJ dysfunction (TD)
5	When you opened your mouth wide, did your jaw lock or catch even for a moment such that you could not close it from the wide-open position?	

TMD, temporomandibular disorder; *TMJ*, temporomandibular joint.

offered for each of the 3 emotional states. A 4-point response scale, ranging from 0 = did not apply to me at all to 3 = applied to me very much/most of the time, is used to score the items. Total DASS and domain scores are computed by summing the points for all 21 items and the 7 emotion-specific questions, respectively. Higher total DASS/domain scores indicate greater overall psychological distress and more severe depressive, anxiety, and stress symptoms.[16]

OHRQoL was appraised with the OHIP-TMD, a validated 22-item TMD-specific adaptation of the OHIP.[15,18,19] The items encompass 7 domains, namely functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap, founded on Locker's conceptual framework for measuring oral health.[20] A 5-point response scale that varies from 0 = never to 4 = very often is used to score the items. Total OHIP and domain scores are calculated by summing the points for all 22 items and designated questions for the respective domains accordingly. Higher total OHIP and domain scores signify worse or poorer quality of life.

Statistical analyses

IBM SPSS Statistics for Windows software version 24.0 (IBM Corporation, Armonk, NY) was used for statistical analyses, with the significance level set at .05. Data distribution was explored with the Shapiro-Wilk test. Continuous variables were presented as means/medians and examined using the Kruskal-Wallis/Mann-Whitney U post hoc test because data were not normally distributed. Categorical variables were displayed as frequencies/proportions and analyzed with the chi-square test. Spearman's rho correlation was employed to relate the number of TMD symptoms, total DASS, and total OHIP scores. Correlation coefficients (r_s) were subsequently classified as weak (0.1-0.3), moderate (0.4-0.6), or strong (0.7-0.9).[21]

RESULTS

The study cohort was composed of 79.2% women and 20.8% men with a mean age of 32.99 ± 13.14 years. The WT and NT groups included 814 and 147 participants, respectively. Table II shows the distribution of the study sample by number of TMD symptoms. Ranking of frequency by number of TMD symptoms was 2S (38.9%), 3S (27.2%), 1S (26.7%), 4S (6.6%), and 5S (0.6%). Although the variance in age was statistically inconsequential, significant differences in disease duration (months) were observed among participants with TMD symptoms (3S, 2S > 1S). Table III displays the mean/median DASS-21/OHIP-TMD scores and the findings of statistical comparison by number of TMD symptoms. Participants with more symptoms usually exhibited significantly higher levels of general

TABLE II. Distribution of study sample by number of temporomandibular disorder symptoms (N = 961)

Demographics	No symptoms (0S)	1 symptom (1S)	2 symptoms (2S)	3 symptoms (3S)	4 symptoms (4S)	5 symptoms (5S)	P value post hoc
No. (%)	147	217 (26.7)	317 (38.9)	221 (27.2)	54 (6.6)	5 (0.6)	Not applicable
Age, y							.234
Mean ± SD	31.12 ± 9.90	32.47 ± 13.16	34.74 ± 14.25	32.14 ± 12.99	32.56 ± 13.46	41.00 ± 15.64	
Median (IQR)	29.00 (25.00-34.00)	29.00 (23.00-37.00)	30.00 (24.00-44.50)	28.00 (23.00-37.50)	28.00 (22.75-39.25)	41.00 (25.50-56.50)	
Male, no. (%)	51 (5.3)	49 (5.1)	66 (6.9)	29 (3.0)	5 (0.5)	0 (0)	<.001*
Female, no. (%)	96 (10.0)	168 (17.5)	251 (26.1)	192 (20.0)	49 (5.1)	5 (0.5)	
Duration, mo,	Not applicable	15.31 ± 32.15	14.30 ± 28.11	10.53 ± 20.62	7.62 ± 17.17	19.20 ± 20.90	<.001†
Mean ± SD							3S, 2S > 1S
Median (IQR)		1.00 (0.00-12.00)	3.00 (1.00-12.00)	3.00 (1.00-12.00)	3.00 (1.00-6.00)	6.00 (3.00-42.00)	

No. (%) indicates the distribution of the study sample by number of TMD symptoms for the WT group.

IQR, interquartile range; *TMD*, temporomandibular disorder; *SD*, standard deviation *WT*, with TMD symptoms.

*χ² test with Bonferroni correction (*P* < .05).

†Kruskal-Wallis/Mann-Whitney *U* test with Bonferroni correction (*P* < .05).

psychological distress (total DASS), depression, anxiety, and stress (4S $\geq$ 3S, 2S, 1S > 0S). Likewise, those with more TMD symptoms also reported significantly greater total OHIP (5S, 4S, 3S, 2S > 1S > 0S) and OHIP domain (5S, 4S, 3S, 2S $\geq$ 1S > 0S) scores. Some variance in statistical differences among those with 4S, 3S, and 2S was noted for the different domains.

Table IV shows the distribution by type of TMD symptoms. Ranking of prevalence by symptom type was as follows: PD (42.4%), TS (19.8%), PS (17.7%), TD (13.5%), and TP (6.6%). Participants with pain-related TMD symptoms (TP, PD, and PS) were mostly older than those with TD. Significant differences in disease duration were noted among participants with different types of TMD symptoms (TD, PD, PS > TS). Table V reflects the mean/median scores and results of statistical analyses by type of TMD symptoms. The presence of all types of TMD symptoms was associated with significantly greater general psychological distress as well as more anxiety and stress symptoms than the control subjects. Significant differences in depression were only present for those with pain-related symptoms (TP, PS, PD > NT). Additionally, individuals with combined symptoms (PS and PD) reported significantly higher total DASS and stress scores than those with only TS. The presence of all symptom types was also related to significantly worse OHRQoL. Participants with pain-related symptoms and TD often presented higher total OHIP and OHIP domain scores than their counterparts with only TS. For participants with nonpainful TMD symptoms (TS and TD), the psychological discomfort and disability domains were most impaired (highest scores). Besides these two domains, the physical pain domain was also markedly impacted for those with painful symptoms (TP, PS, and PD).

Table VI indicates the results of correlation analyses. Correlations between total DASS, depression, anxiety, and stress were strong (r_s = 0.75-0.95). Associations between total OHIP and the psychological variables were moderately strong (r_s = 0.51-0.57) as were those between total OHIP and the number of TMD symptoms (r_s = 0.59). However, correlations between the number of TMD symptoms and the psychological variables were weak (r_s = 0.20-0.26).

DISCUSSION
General overview
This study examined the presence of differing number/ type of TMD symptoms and their relationships to psychological distress and OHRQoL. Furthermore, it explored the potential of the 5 principal DC/TMD-SQ symptoms for screening TMDs from the patient perspective. Because the number/type of TMD symptoms affected psychological variables/OHRQoL and the

various OHIP domains were impacted dissimilarly, the first two null hypotheses were rejected. The third null hypothesis was also discarded because the 5 symptoms were linked to the OHIP-TMD. Past OHRQoL studies involved relatively smaller TMD samples and were not established on the DC/TMD-SQ symptoms and TMD-specific measures.[4-6] Moreover, TMJ dysfunction, specifically closed and open locking of the TMJs, was generally not appraised. The definitive diagnosis of TMJ disc displacement without reduction with or without limited opening entails magnetic resonance imaging.[10] However, this was only performed for selected participants to limit unnecessary diagnostic imaging and cost. TMJ closed and open locking was categorized together (TD) as with masticatory muscle/TMJ pain and headaches (TP) due to possible common causes as well as overlapping symptoms and for simplification of statistical analyses. Although the TS group encompasses participants with only TMJ sounds, the history or presence of concurrent TMJ sounds is expected for the TD group.

Number of TMD symptoms
The majority of the WT group experienced 1-3 symptoms, and only 7.2% had 4 or 5 symptoms. Even so, participants with more symptoms typically reported significantly higher levels of general psychological distress, depression, anxiety, and stress. However, the correlations between the number of TMD symptoms and all psychological variables were weak (r_s = 0.20-0.26), unlike its association with OHRQoL, which was moderately strong (r_s = 0.59). The latter was consistent with the generally higher total OHIP and domain scores reported by participants with more TMD symptoms. Findings corroborated those of Tay et al. based on the DASS-21 and OHIP-14.[11] They pointed out that even though evidence for the number of symptoms needed to determine the presence of TMDs is lacking, a threshold number of symptoms predictive of TMDs onset may well exist.[22] Regardless of the number of the TMD symptoms, the WT group usually exhibited more impairments in the physical pain, psychological discomfort, and psychological disability domains. This was in agreement with the inferences made by Bitiniene et al., who postulated that lower OHRQoL associated with TMDs is caused by "psychological and physical ailments."[6] Psychological variables may play a more substantial role, given their moderately strong correlations (r_s = 0.51-0.57) with OHRQoL in this study and links observed in others.[23,24]

Type of TMD symptoms
TMD pain combined with TMJ dysfunction (PD) was the most frequent type of symptom (42.4%) observed in the WT group. This was followed by TMJ sounds

TABLE III. Mean/median Depression, Anxiety and Stress Scale-21 and Oral Health Impact Profile−Temporomandibular Disorders scores based on number of temporomandibular disorder symptoms

Variables	No symptom (0S)	1 symptom (1S)	2 symptoms (2S)	3 symptoms (3S)	4 symptoms (4S)	5 symptoms (5S)	P value post hoc
DASS-21							
Total DASS,	11.97 ± 13.83	22.07 ± 21.32	26.99 ± 26.08	28.27 ± 26.53	39.19 ± 28.20	44.00 ± 45.23	< .001*
Mean ± SD	6.00 (0.00-20.00)	16.00 (6.00-32.00)	18.00 (8.00-38.00)	20.00 (8.00-42.00)	33.00 (16.00-57.00)	24.00 (15.00-83.00)	4S > 3S
Median (IQR)							2S, 1S > 0S
Depression,	3.14 ± 4.72	5.86 ± 7.56	7.06 ± 9.37	7.47 ± 9.52	10.70 ± 10.21	13.20 ± 16.25	< .001*
Mean ± SD	0.00 (0.00-4.00)	2.00 (0.00-10.00)	4.00 (0.00-10.00)	4.00 (0.00-10.00)	8.00 (4.00-16.00)	6.00 (4.00-26.00)	4S > 3S
Median (IQR)							2S, 1S > 0S
Anxiety,	3.82 ± 4.60	7.45 ± 6.85	9.22 ± 8.51	9.25 ± 8.34	12.59 ± 9.33	14.00 ± 14.56	< .001*
Mean ± SD	2.00 (0.00-6.00)	6.00 (2.00-10.00)	6.00 (2.00-14.00)	8.00 (4.00-14.00)	10.00 (6.00-16.00)	8.00 (4.00-27.00)	4S, 3S, 2S, 1S > 0S
Median (IQR)							4S > 2S, 1S
Stress,	5.01 ± 6.16	8.77 ± 9.03	10.71 ± 10.30	11.56 ± 10.47	15.89 ± 10.99	16.80 ± 14.94	< .001*
Mean ± SD	2.00 (0.00-8.00)	6.00 (2.00-16.00)	8.00 (2.00-16.00)	8.00 (4.00-18.00)	14.00 (8.00-24.00)	12.00 (6.00-30.00)	4S, 3S, 2S, 1S > 0S
Median (IQR)							4S > 2S, 1S
OHIP-TMD							
Total OHIP,	5.42 ± 10.73	26.60 ± 18.44	38.23 ± 18.09	42.54 ± 17.42	53.65 ± 18.37	58.80 ± 14.74	< .001*
Mean ± SD	0.00 (0.00-5.00)	24.00 (11.00-38.50)	37.00 (24.50-50.00)	42.00 (30.50-55.50)	53.50 (38.00-70.25)	64.00 (46.00-69.00)	5S, 4S, 3S, 2S > 1S > 0S
Median (IQR)							4S > 2S
Functional limitation,	0.49 ± 1.09	2.97 ± 2.31	4.72 ± 2.16	5.76 ± 1.92	6.02 ± 1.82	6.00 ± 0.71	< .001*
Mean ± SD	0.00 (0.00-0.00)	3.00 (1.00-4.00)	5.00 (3.00-6.00)	6.00 (4.00-7.00)	5.00 (6.00-8.00)	6.00 (5.50-6.50)	5S, 4S, 3S, 2S, 1S > 0S
Median (IQR)							4S, 3S > 2S > 1S
Physical pain,	1.11 ± 2.38	4.71 ± 4.15	7.35 ± 4.26	8.62 ± 4.13	10.91 ± 5.03	14.40 ± 3.05	< .001*
Mean ± SD	0.00 (0.00-1.00)	4.00 (1.00-7.00)	7.00 (4.00-10.00)	8.00 (6.00-12.00)	10.50 (8.00-15.00)	13.00 (12.00-17.00)	5S, 4S, 3S, 2S > 1S > 0S
Median (IQR)							4S,3S > 2S
Psychological discomfort,	1.64 ± 2.99	7.15 ± 4.61	9.15 ± 4.28	9.94 ± 4.15	11.80 ± 3.94	12.80 ± 4.60	< .001*
Mean ± SD	0.00 (0.00-2.00)	7.00 (3.00-11.00)	9.00 (6.00-12.00)	11.00 (7.00-13.00)	12.5 (9.00-16.00)	16.00 (8.00-16.00)	5S, 4S, 3S, 2S, 1S > 0S
Median (IQR)							4S, 3S, 2S > 1S
							4S > 2S
Physical disability,	0.50 ± 1.10	2.39 ± 2.01	3.77 ± 2.01	4.14 ± 2.09	5.17 ± 1.79	4.60 ± 1.14	< .001*
Mean ± SD	0.00 (0.00-0.00)	2.00 (0.50-4.00)	4.00 (2.00-5.00)	4.00 (3.00-6.00)	5.00 (4.00-7.00)	5.00 (3.50-5.50)	5S, 4S, 3S, 2S.1S > 0S
Median (IQR)							4S, 3S, 2S > 1S
							4S > 2S
Psychological disability,	1.08 ± 2.73	5.89 ± 5.10	7.88 ± 5.27	8.24 ± 4.93	11.89 ± 5.11	12.40 ± 4.56	< .001*
Mean ± SD	0.00 (0.00-0.00)	5.00 (1.00-9.00)	8.00 (4.00-12.00)	8.00 (4.50-12.00)	12.00 (8.75-16.00)	15.00 (8.00-15.50)	5S, 4S, 3S, 2S, 1S > 0S
Median (IQR)							4S >3 S, 2S > 1S
Social disability,	0.25 ± 0.91	1.34 ± 1.79	2.10 ± 2.16	2.14 ± 2.13	3.24 ± 2.34	3.80 ± 1.79	< .001*
Mean ± SD	0.00 (0.00-0.00)	1.00 (0.00-2.00)	2.00 (0.00-3.00)	2.00 (0.00-4.00)	3.00 (1.00-5.00)	4.00 (2.50-5.00)	5S, 4S, 3S, 2S, 1S > 0S
Median (IQR)							4S > 3S.2S > 1S
Handicap,	0.35 ± 1.05	2.16 ± 2.24	3.25 ± 2.40	3.70 ± 2.35	4.63 ± 2.32	4.80 ± 2.39	< .001*
Mean ± SD	0.00 (0.00-5.00)	2.00 (0.00-4.00)	3.00 (1.50-5.00)	3.00 (2.00-5.00)	4.50 (2.75-6.25)	5.00 (2.50-7.00)	5S, 4S, 3S, 2S, 1S > 0S
Median (IQR)							4S, 3S, 2S > 1S
							4S > 2S

IQR, interquartile range; *SD*, standard deviation.

*Results of Kruskal-Wallis/Mann-Whitney *U* test with Bonferroni correction (*P* < .05).

TABLE IV. Distribution of the study sample by type of temporomandibular disorder symptoms (N = 961)

Demographics	NT	TP	TS	TD	PS	PD	P value post hoc
No. (%)	147	54	161	110	144	345	Not applicable
	–	(6.6)	(19.8)	(13.5)	(17.7)	(42.4)	
Age, y,							<.001*
Mean ± SD	31.12 ± 9.90	40.76 ± 15.86	30.20 ± 11.29	28.27 ± 9.56	35.55 ± 14.51	34.30 ± 14.12	TP > PD, PS > TD
Median (IQR)	29.00 (25.00-34.00)	36.5 (27.00-52.75)	28.00 (23.00-34.00)	25.50 (21.00-31.00)	30.00 (25.00-44.75)	29.0 (24.00-41.50)	TP > NT, TS
Male, no. (%)	51 (5.3)	14 (1.5)	36 (3.7)	16 (1.7)	37 (3.9)	46 (4.8)	<.001†
Female, no. (%)	96 (10.0)	40 (4.2)	125 (13.0)	94 (9.8)	107 (11.1)	299 (31.1)	
Duration,							<.001*
Mean ± SD	Not applicable	7.47 ± 17.85	17.92 ± 35.40	20.99 ± 37.65	13.03 ± 23.70	9.32 ± 18.59	TD, PD, PS > TS
Median (IQR)		2.00 (0.93-6.00)	0.00 (0.00-24.00)	3.50 (0.12-24.00)	2.50 (0.63-12.00)	3.00 (1.00-9.25)	

No. (%) indicates the distribution of the study sample by type of TMD symptoms for the with TMD symptoms group.
IQR, interquartile range; *NT*, no TMD symptoms; *PD*, TMD pain plus TMJ dysfunction; *PS*, TMD pain plus TMJ sounds; *SD*, standard deviation; *TD*, TMJ dysfunction; *TMD*, temporomandibular disorder; *TMJ*, temporomandibular joint; *TP*, TMD pain; *TS*, TMJ sounds.
*Results of Kruskal-Wallis/Mann-Whitney *U* test with Bonferroni correction (P < .05).
†Results of χ^2 test with Bonferroni correction (P < .05).

without (19.8%) and with pain (17.7%). Vainionpää et al. evaluated the prevalence of self-reported TMD symptoms on the basis of DC/TMD-SQ and found facial pain (54.0%) and TMJ sounds (43.0%) to be most common.[25] However, their study involved only a small sample of Finnish prisoners. Findings were in agreement with the higher prevalence of muscle disorders (45.3%) and disc displacements (41.1%) reported in prior studies based on the RDC/TMD.[26]

The presence of any type of TMD symptoms was associated with significantly higher total DASS, anxiety, and stress but not depressive symptoms. Significant differences in depression were only noted for pain-related symptoms (TP, PS, and PD) compared with the control subjects. The comorbidity between pain and depression is well known and has been attributed to shared biological pathways and neurotransmitters.[27] Although moderate to severe pain diminishes function and is related to more depressive symptoms and worse depression outcomes, including quality of life, depression in persons with pain is associated with more pain complaints as well as greater pain impairments.[28] Although previous studies had indicated moderate to severe levels of depression in up to 60.1% of patients with TMD, painful and nonpainful TMD symptoms/conditions were seldom differentiated. Because participants with combined pain symptoms (PS and PD) also had significantly greater psychological distress and stress than those with only TMJ sounds, it is sensible that TMD types be distinguished for future research when assessing the relationships between TMDs and psychosocial variables.

The presence of all symptom types was also associated with significantly poorer OHRQoL. Moreover, participants with painful symptoms and TMJ dysfunction had significantly higher total OHIP and OHIP domain scores than those with only TMJ sounds. OHRQoL associated with TMJ dysfunction has not been widely reported in the literature. The prevalence of TMJ dysfunction without and with pain was in reality quite high (55.9%). Despite the functional deficits anticipated, the contribution of functional limitation domain scores to overall OHRQoL was relatively low for TMJ dysfunction as with the other TMD symptoms. The reason for this phenomenon remains "complex and poorly understood" and may be linked to the severity and duration of TMD symptoms as well as somatization and psychological distress.[29] For participants with nonpainful TMD symptoms, the domains most impacted were psychological discomfort and disability. Likewise, Bayat et al. determined psychological impairments to be one of the more important predictors of OHRQoL.[23] As for individuals with painful TMD symptoms, the physical pain domain was also noticeably affected in addition to the two psychological

TABLE V. Mean/median Depression, Anxiety and Stress Scale-21 score and Oral Health Impact Profile−Temporomandibular Disorders scores based on type of temporomandibular disorder symptoms

Variables	NT	TP	TS	TD	PS	PD	P value post hoc
DASS-21							
Total DASS,	11.97 ± 13.83	27.76 ± 26.53	20.47 ± 19.67	24.87 ± 21.69	31.19 ± 29.05	28.72 ± 27.03	< .001*
Mean ± SD	6.00 (0.00-20.00)	20.00 (4.00-44.00)	14.00 (6.00-30.00)	18.00 (8.00-36.50)	22.00 (10.00-45.50)	20.00 (10.00-41.00)	PS, PD, TP, TD, TS > NT
Median (IQR)							PS, PD > TS
Depression,	3.14 ± 4.72	8.17 ± 8.78	5.29 ± 7.20	5.71 ± 7.24	8.33 ± 10.73	7.78 ± 9.66	< .001*
Mean ± SD	0.00 (0.00-4.00)	6.00 (0.00-14.00)	2.00 (0.00-8.00)	3.00 (0.00-8.00)	4.00 (0.00-12.00)	4.00 (0.00-11.00)	TP, PS, PD > NT
Median (IQR)							
Anxiety,	3.82 ± 4.60	8.44 ± 8.31	7.01 ± 6.23	9.11 ± 7.54	10.44 ± 9.55	9.40 ± 8.53	< .001*
Mean ± SD	2.00 (0.00-6.00)	6.00 (2.00-12.00)	6.00 (2.00-10.00)	8.00 (4.00-14.00)	6.00 (2.00-16.00)	8.00 (4.00-14.00)	PS, PD, TD, TP, TS > NT
Median (IQR)							
Stress,	5.01 ± 6.16	11.15 ± 11.48	8.18 ± 8.50	10.05 ± 9.10	12.42 ± 11.00	11.54 ± 10.59	< .001*
Mean ± SD	0.00 (0.00-8.00)	9.00 (1.50-16.50)	6.00 (2.00-14.00)	7.00 (2.00-16.00)	10.00 (4.00-19.50)	8.00 (4.00-18.00)	PS, PD, TP, TD, TS > NT
Median (IQR)							PS, PD > TS
OHIP-TMD							
Total OHIP,	5.42 ± 10.73	40.72 ± 20.21	22.05 ± 16.02	31.85 ± 15.95	37.93 ± 17.88	45.71 ± 17.74	< .001*
Mean ± SD	0.00 (0.00-5.00)	41.00 (27.25-56.75)	19.00 (8.50-31.50)	32.50 (18.75-41.00)	37.00 (22.25-51.50)	37.00 (22.25-51.50)	PD, TP, PS, TD > TS > NT
Median (IQR)							PD > PS, TD
Functional limitation,	0.49 ± 1.09	4.56 ± 2.24	2.32 ± 1.99	4.30 ± 2.01	4.17 ± 1.91	6.02 ± 1.86	< .001*
Mean ± SD	0.00 (0.00-0.00)	4.00 (3.00-6.00)	2.00 (1.00-4.00)	4.00 (3.00-6.00)	4.00 (3.00-5.00)	6.00 (5.00-8.00)	PD, PS, TP, TD > TS > NT
Median (IQR)							PD > TP, TD
Physical pain,	1.11 ± 2.38	8.76 ± 4.34	3.54 ± 3.45	4.51 ± 3.15	8.11 ± 3.95	9.31 ± 4.31	< .001*
Mean ± SD	0.00 (0.00-1.00)	9.00 (6.00-12.00)	3.00 (1.00-6.00)	4.00 (2.00-6.25)	8.00 (5.00-11.00)	9.00 (6.00-12.00)	TP, PD, PS, TD, TS > NT
Median (IQR)							TP > TD, TS
							PD,PS > TS
Psychological discomfort,	1.64 ± 2.99	9.35 ± 4.86	6.44 ± 4.38	8.85 ± 4.14	8.80 ± 4.41	10.33 ± 4.13	< .001*
Mean ± SD	0.00 (0.00-2.00)	10.00 (5.00-13.00)	7.00 (2.00-9.00)	9.00 (6.00-12.00)	9.00 (5.00-12.00)	11.00 (8.00-13.00)	PD, TP, TD, PS > TS > NT
Median (IQR)							PD > PS
Physical disability,	0.50 ± 1.10	3.70 ± 2.06	1.94 ± 1.81	3.28 ± 1.92	3.49 ± 1.80	4.50 ± 2.06	< .001*
Mean ± SD	0.00 (0.00-0.00)	4.00 (2.00-5.00)	2.00 (0.00-3.00)	3.00 (2.00-5.00)	4.00 (2.00-5.00)	4.00 (3.00-6.00)	PD, TP, PS, TD > TS > NT;
Median (IQR)							PD > PS, TD
Psychological disability,	1.08 ± 2.73	8.30 ± 5.68	5.09 ± 4.72	6.77 ± 4.76	7.73 ± 5.12	9.20 ± 5.28	< .001*
Mean ± SD	0.00 (0.00-0.00)	7.00 (3.00-13.25)	4.00 (1.00-9.00)	7.00 (2.75-10.00)	8.00 (3.00-11.00)	9.00 (5.00-13.00)	PD, PS, TP, TD, TS > NT;
Median (IQR)							PD, PS, TD > TS;
							PD > TD
Social disability,	0.25 ± 0.91	2.39 ± 2.31	1.04 ± 1.56	1.52 ± 1.84	2.22 ± 2.23	2.44 ± 2.20	< .001*
Mean ± SD	0.00 (0.00-0.00)	2.00 (0.00-4.00)	0.00 (0.00-2.00)	1.00 (0.00-2.25)	2.00 (0.00-4.00)	2.00 (0.00-4.00)	PD, PS, TP, TD, TS > NT;
Median (IQR)							PD, PS, TD > TS;
							PD > TD
Handicap,	0.35 ± 1.05	3.67 ± 2.63	1.67 ± 1.91	2.62 ± 2.14	3.42 ± 2.43	3.90 ± 2.37	< .001*
Mean ± SD	0.00 (0.00-0.00)	4.00 (1.00-6.00)	1.00 (0.00-2.00)	2.00 (1.00-4.00)	3.00 (2.00-5.00)	4.00 (2.00-6.00)	PD, TP, PS, TD > TS > NT;
Median (IQR)							PD > TD

DASS, Depression, Anxiety and Stress Scale-21; *IQR*, interquartile range; *NT*, no TMD symptoms; *OHIP-TMD*, Oral Health Impact Profile−Temporomandibular Disorders; *PD*, TMD pain plus TMJ dysfunction; *PS*, TMD pain plus TMJ sounds; *SD*, standard deviation; *TD*, TMJ dysfunction; *TMD*, temporomandibular disorder; *TMJ*, temporomandibular joint; *TP*, TMD pain; *TS*, TMJ sounds.
*Results of Kruskal-Wallis/Mann-Whitney *U* test with Bonferroni correction (P < .05).

TABLE VI. Correlations between total Depression, Anxiety and Stress Scale-21 score, total Oral Health Impact Profile scores, and number of temporomandibular disorder symptoms

	Depression	Anxiety	Stress	Total DASS	Total OHIP
Anxiety	0.75*	—	—	—	—
Stress	0.81*	0.81*	—	—	—
Total DASS	0.92*	0.91*	0.95*	—	—
Total OHIP	0.52*	0.51*	0.57*	0.57*	—
No. of TMD symptoms	0.20*	0.26*	0.26*	0.26*	0.59*

Results of Spearman's correlation.
DASS-21, Depression, Anxiety and Stress Scale-21; *OHIP*, Oral Health Impact Profile; *TMD*, temporomandibular disorder.
*Significant at $P < .01$.

domains. Findings corroborated the results of past studies[6] and highlighted the potential of the principal symptoms of the DC/TMD-SQ for screening TMDs from a patient outcome perspective.

Correlations between variables
Correlations between the three emotional states of depression, anxiety, and stress were strong ($r_s = 0.75$-0.81). Although the relationship between anxiety (body's response to stress) and stress is apparent, the connection between depression and anxiety-stress is more complex and includes faulty cognitive processes as well as shared genetic and biological predispositions.[30] The associations between total OHIP and all psychological variables were moderately strong ($r_s = 0.51$-0.57), unlike those between the number of TMD symptoms and psychological variables, which were weak ($r_s = 0.20$-0.26). Because the OHRQoL measure employed was TMD-specific, findings specify that negative affectivity accompanying TMDs might play a substantial role in OHRQoL. Although the DC/TMD incorporates a 6-item screener (TMD Pain Screener),[10] it only identifies TMD pain symptoms and their aggravating activities. Intra-articular TMJ symptoms, including TMJ sounds and dysfunction, are not considered. Given the moderately strong correlation ($r_s = 0.59$) between the number of TMD symptoms and the OHIP-TMD, the 5 primary symptoms of the DC/TMD-SQ showed reasonably good construct validity for screening the presence and impact of TMDs. Future work could involve the development of a new SQ-based screener incorporating the frequency, duration, intensity of pain, and intra-articular symptoms as well as the interference they produce.

Study limitations
This case-control study had some limitations. First, the numbers of participants in the WT and NT groups were unequal, and the participants also were not age and sex matched. However, a large control group was difficult to achieve because study participation was strictly voluntary, and control participants had little to benefit from their contributions. Second, as with all health

surveys, recall, social desirability, and other biases may occur. Third, other oral conditions that might affect OHRQoL, including periodontal disease and caries, were not considered. Last, findings may possibly apply only to Chinese populations. Further research in other racial/ethnic groups is required before definitive conclusions can be made.

CONCLUSIONS
Within the limitation of this case-control study, psychological states and OHRQoL were found to be affected by differing number and type of TMD symptoms. Individuals having more and pain-related TMD symptoms with/without intra-articular features generally had higher levels of psychological distress and greater OHRQoL impairments especially in the psychological domains. Therefore, patients presenting with multiple and painful TMD symptoms should ideally be screened for psychological disturbance and referred for psychosocial interventions where appropriate. The latter may not only improve TMD management outcomes but also patient's quality of life. The 5 principal symptoms of the DC/TMD-SQ holds promise as a screener for the presence and impact of TMDs.

DECLARATION OF COMPETING INTEREST
None.

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