## **Scientific Research Report**

# Somatic Symptoms as Idioms of Distress in East Asian Patients With Differing Temporomandibular Disorder Diagnostic Subtypes



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#### ABSTRACT

Objective: This cross-sectional study investigated the prevalence/severity of somatic symptoms, their relationship with psychological distress and oral behaviors in different temporomandibular disorder (TMD) diagnostic subtypes, and identified biopsychosocial factors associated with depression, anxiety, and jaw overuse behavior among East Asian patients. *Methods*: Anonymized data from consecutive new TMD patients at a tertiary oral medicine clinic were evaluated. TMD diagnoses were determined using the DC/TMD methodology, while somatic symptoms, depression, anxiety, and oral behaviors were assessed with the Patient Health Questionnaire (PHQ)-15, PHQ-9, Generalized Anxiety Disorder Scale-7, and Oral Behavior Checklist. Data were examined using the Chi-square/non-parametric tests and multivariate linear regression analysis ( $\alpha = 0.05$ ).

Results: Among the 699 patients, somatic symptoms were present in 36.8%, 54.0%, and 48.2% of individuals with intra-articular (IT), pain-related (PT), and combined (CT) TMDs respectively. Significant differences in somatic symptom burden/depression (PT, CT > IT) and anxiety (CT > IT) were observed. For all TMD subtypes, patients with somatic symptoms showed significantly greater depression, anxiety, and jaw overuse behavior compared to those without somatic symptoms. Somatic symptoms were moderately correlated with depression and anxiety ( $r_s = 0.51-0.65$ ).

*Conclusion:* Somatic symptom burden was linked to depression and anxiety, supporting the phenomenon of somatization across different TMD subtypes.

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## Introduction

Temporomandibular disorders (TMDs) encompass a spectrum of clinical problems involving the temporomandibular joints (TMJs), masticatory muscles, and supporting structures.<sup>1</sup> They rank as the second most common musculoskeletal conditions leading to pain and disability, following low back pain, impacting up to 16% of the general population.<sup>1-3</sup> Features of TMDs include facial and preauricular pain, TMJ sounds, as well as limitations in jaw movements and

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function.<sup>1</sup> TMDs are more prevalent among females, particularly those in the age range of 20 to 40 years.<sup>1,4</sup> Per the Diagnostic Criteria for TMDs (DC/TMD) and its stratified reporting framework, both TMDs and TMD patients can be classified into three categories: intra-articular (IT), pain-related (PT), and combined (CT) TMDs.<sup>5,6</sup> The complex etiology of TMDs corresponds with the "biopsychosocial model of illness", where biological, psychological, and social vulnerabilities interact with environmental and contextual stressors to produce TMD and comorbid symptoms.<sup>7,8</sup> Contributing factors include gender, age, sleep disorders, macro/micro-trauma, oral behaviors, catastrophizing, psychological distress, and somatic symptoms.<sup>9-11</sup> Among the various psychosocial variables, measures of somatic symptoms were most strongly associated with the development of TMDs.<sup>11</sup>

While somatic (physical) symptoms refer to perceived specific or generalized bodily sensations that may be medically unexplained, somatization concerns the expression of underlying psychological distress through somatic symptoms.<sup>12,13</sup> However, not all individuals with TMDs will experience somatic symptoms, and those with somatic symptoms might not have comorbid depression and anxiety.<sup>14,15</sup> Furthermore, the measures of somatization, such as the Patient Health Questionnaire-15 (PHQ-15) and the somatization subscale of the Symptom Checklist-90-R (SCL-90-R), primarily focus on the suffering or burden arising from perceived somatic symptoms, without explicitly assessing comorbid depression and anxiety.<sup>16,17</sup> More recently, non-clinical adults with TMD and/ or somatic symptoms were found to exhibit dissimilar psychological profiles except for anxiety.<sup>15</sup>

Investigations into the inter-relationships among somatic symptoms, psychological distress, and oral behaviors within TMD subtypes are currently lacking. Although psychological distress has been linked to jaw overuse behaviors, the association between somatic symptoms and oral behaviors has not been elucidated.<sup>18,19</sup> The latter is plausible considering the greater somatosensory amplification (a hypervigilance-related tendency to experience bodily sensations as intense and disturbing) observed in individuals with TMDs.<sup>20,21</sup> Given the aforementioned, the objectives of this cross-sectional study were to (1) ascertain the prevalence and severity of somatic symptoms among various TMD diagnostic subtypes, (2) examine the relationships between somatic symptoms, psychological distress, and oral behaviors, and (3) identify the biopsychosocial factors, including somatic symptom burden, associated with depression, anxiety, and jaw overuse behavior among East Asian patients. The research hypotheses were: (a) significant differences in the occurrence and severity of somatic symptoms exist among the three TMD subtypes (b) somatic symptom burden, psychological distress, and jaw overuse behavior are moderate-to-strongly correlated in TMD patients, and (c) somatic symptom burden is linked to the presence of depression, anxiety, and jaw overuse behavior.

## Materials and methods

## Study sample

This retrospective cross-sectional study received approval from the Institutional Review Board of Seoul National

University Dental Hospital (ERI22001) and was exempted from the need for informed consent. Anonymized data extracted from a large-scale collaborative study of the phenotyping of East Asian TMD patients, were gathered from consecutive new patients seeking TMD care at a tertiary oral medicine clinic in South Korea as part of routine care between January 2020 and December 2021. A minimum of 390 patients was deemed necessary to attain a statistical power of 95% with an alpha error of 0.05. This calculation, determined using G\*Power software (version 3.1.9.3) and an Analysis of Variance (ANOVA) model, was based on the smallest effect size of 0.2 when comparing different psychosocial and behavioral variables across three TMD groups.<sup>13,22,23</sup> Inclusion criteria mandated participants to be 19 years or older, fluent in Korean, and experiencing facial/ preauricular pain, jaw joint sounds, and/or jaw locking. Exclusion criteria included previous orofacial trauma, non-TMD pain, debilitating physical or psychological disorders, cognitive impairments, and incomplete questionnaire submissions. At the initial visit, demographic information was obtained and the Korean language versions of the following measures were administered: DC/TMD Symptom Questionnaire (SQ), Patient Health Questionnaire-15 (PHQ-15), Patient Health Questionnaire-9 (PHQ-9), Generalized Anxiety Disorder Scale-7 (GAD-7), and Oral Behavior Checklist (OBC).<sup>24-27</sup>

#### TMD diagnosis and subtypes

The five primary TMD symptoms specified by the DC/TMD, namely TMD/orofacial pain, headache, TMJ noises, closed, and open locking, were appraised with the 14-item SQ over 30 days. Additionally, the duration of TMD symptoms/conditions was documented based on the DC/TMD SQ with questions relating to "how many months ago did your symptom/condition first begin?". Following the completion of the SQ and other measures, patients underwent a protocolized physical examination performed by oral medicine specialists with formal training and calibration in the DC/TMD methodology. Locations of pain, jaw opening pattern, jaw movements and pain, TMJ noises and locking, as well as masticatory muscle/TMJ palpation pain, were scrutinized. All patients received cone-beam computed tomography (CBCT) for the detection of osseous changes in the TMJs. Magnetic resonance imaging (MRI) was specifically indicated for individuals experiencing protracted restricted mouth opening or suspected TMJ tumors. DC/TMD diagnoses were determined by considering patients' symptoms, clinical signs, and relevant diagnostic imaging, utilizing the diagnostic algorithms provided by the DC/TMD. Following this, patients were stratified into PT, IT, and CT groups for statistical evaluations.<sup>5,6</sup>

#### Study measures

## PHQ-15

The 15-item PHQ-15 was employed to assess the burden of somatic symptoms over 30 days. Items examined encompassed the fifteen most prevalent pain-related, cardiopulmonary, gastrointestinal, neurological, and genitourinary symptoms associated with somatoform disorders or extreme somatization.<sup>17,24,28</sup> Items were evaluated using a three-point Likert scale where "not bothered at all", "bothered a little", and "bothered a lot" were assigned 0, 1, and 2 points

respectively. Total PHQ-15 scores were calculated, with scores of 5, 10, and 15 representing cut-points for low, medium, and high somatic symptom burden.

### PHQ-9 and GAD-7

Depression (feelings of extreme sadness and despair) and anxiety (feelings of tension and worry) were assessed with the 9-item PHQ-9 and 7-item GAD-7 over 2 weeks.<sup>25,26,28</sup> Items were evaluated using a four-point Likert scale, ranging from "not at all" with 0 points to "nearly every day" with 3 points. Total PHQ-9 scores were computed, with scores of 5, 10, 15, and 20 representing cut-points for mild, moderate, moderately severe, and severe depression. Total GAD-7 scores were also calculated, with scores of 5, 10, and 15 representing cutpoints for mild, moderate, and severe anxiety.

## OBC

Oral behaviors were assessed with the 21-item OBC, which examined the frequency of sleeping-state and waking-state oral activities. Items were evaluated using a five-point Likert scale, ranging from "none of the time" with 0 points to "4 to 7 nights per week" or "all of the time" with 4 points. Total OBC scores were computed, with scores of 0 to 15, 17 to 24, and 25 to 84 points representing normal, low, and high "jaw overuse behavior".<sup>27,29</sup> Additionally, sleeping-state and waking-state subscale scores were calculated by summing the two and nineteen items for oral activities during sleep and wakefulness respectively.

#### Statistical analysis

Statistical analyses were conducted using the SPSS statistical software version 25.0 (IBM Corporation, Armonk, New York, USA) with the significance level set at 0.05. For qualitative data, frequency distributions with corresponding proportions were presented and assessed using the Chi-square test. Quantitative data were presented as means with standard deviations (SDs) as well as medians with interquartile ranges (IQRs). Given the non-normal distribution indicated by the Shapiro-Wilk test, quantitative data were assessed using the Kruskal-Wallis test, followed by the post-hoc Mann-Whitney U test with Bonferroni correction. To explore the connections between somatic symptom burden, depression, anxiety, and jaw overuse behavior, Spearman's rank-order correlation was performed, with correlation coefficients ( $r_s$ ) of 0.1, 0.4, 0.7, and 0.9 representing weak, moderate, strong, and very strong relationships, accordingly.<sup>30</sup> Multivariate linear regression analysis was conducted to establish the biopsychosocial factors associated with depression, anxiety, and jaw overuse behavior while accounting for potential influences of age, sex, TMD duration, and subtypes. The coefficient ( $\beta$ ), standard error (SE), and t-statistics (t) were reported for the various variables, alongside the P values.  $\beta$  represents the anticipated change in the dependent variable with a one-unit shift in the corresponding independent variable, assuming all other variables are constant. SE estimates the precision of the regression coefficient measurement, and t is the ratio of the coefficient to its SE. A smaller SE increases confidence in the estimate, whereas a larger t-statistic value indicates a greater likelihood that the regressor variable indeed has a significant effect. Positive and negative t-statistic values suggest that as the regressor variable increases, the response variable also increases or decreases correspondingly.

## Results

A total of 1005 anonymized patient records were reviewed. Of these, 306 were excluded due to non-eligibility, missing and/or incomplete questionnaires. The final study sample (n = 699) comprised 70.2% females and had a mean age of 37.4  $\pm$  15.7 years. The proportions of patients diagnosed with IT, PT, and CT were 15.2%, 12.4%, and 72.4% respectively. Notable variations in sex distribution (males: PT > CT), age (PT > CT, IT), and TMD duration (CT > IT, PT) were observed. Somatic symptoms were found in 36.8%, 54.0%, and 48.2% of IT, PT, and CT patients respectively, with the majority of patients experiencing low (31.2%) or medium (11.2%) somatic symptom burden. Significant differences in somatic symptom burden (PT, CT > IT), depression (PT, CT > IT), and anxiety (CT > IT) scores were discerned among the three TMD subtypes (Table 1).

Table 2 reflects the mean/median depression, anxiety, and oral behavior scores for patients without (IN, PN, and CN) and with (IS, PS, and CS) somatic symptoms. For the three TMD subtypes, significant differences in sex distribution (females: PS > PN; CS > CN), TMD duration (IS > IN; CS > CN), depression (IS > IN; PS > PN; CS > CN), anxiety (IS > IN; PS > PN; CS > CN), and jaw overuse behavior (IS > IN; PS > PN; CS > CN) scores were noted between patients without and with somatic symptoms.

Table 3 displays the correlations between the various variables for the three TMD subtypes. For both the IT and CT groups, somatic symptom burden was moderately correlated with depression and anxiety ( $r_s = 0.51-0.65$ ). In the PT group, somatic symptom burden demonstrated moderate correlations with depression, anxiety, as well as jaw overuse behavior (total OBC) and waking-state oral activities ( $r_s = 0.41-0.65$ ). For all three TMD subtypes, depression and anxiety showed moderate to strong correlations ( $r_s = 0.67-0.75$ ). Additionally, both depression and anxiety were moderately associated with waking-state oral activities ( $r_s = 0.44-0.45$ ). Jaw overuse behavior was moderately and very strongly related to the sleeping-state ( $r_s = 0.65-0.68$ ) and waking-state ( $r_s = 0.93-0.96$ ) oral activities, while the association between the two oral activities was moderate ( $r_s = 0.40-0.47$ ).

Table 4 presents the biopsychosocial factors significantly associated with depression, anxiety, and jaw overuse behavior. The factors for depression encompassed sex (t = -3.07), somatic symptom burden (t = 11.11), anxiety (t = 21.13), and jaw overuse behavior (t = 3.63), while those for anxiety included somatic symptom burden (t = 2.44), depression (t = 21.13), and jaw overuse behavior (t = 2.43). Additionally, age (t = -8.74), TMD duration (t = 3.06), somatic symptom burden (t = 2.87), depression (t = 3.63), and anxiety (t = 2.43) were linked to jaw overuse behavior.

## Discussion

This study investigated the prevalence and severity of somatic symptoms in different TMD diagnostic subtypes, explored the relationships between somatic symptoms,

Variable	All patients	Intra-articular TMDs [IT]	Pain-related TMDs [PT]	Combined TMDs [CT]	P value Post-hoc
Total					
n (%)	699 (100%)	106 (15.2)	87 (12.4)	506 (72.4)	
Sex	. ,				.013*
Females, n (%)	491 (70.2)	68 (64.2)	52 (59.8)	371 (73.3)	CT>PT
Males, n (%)	208 (29.8)	38 (35.8)	35 (40.2)	135 (26.7)	PT>CT
Age	. ,		. ,		
Mean (SD)	37.36 (15.66)	34.85 (15.31)	41.53 (16.14)	37.18 (15.54)	.006*
Median (IQR)	32.00 (24.00)	29.00 (17.25)	39.00 (28.00)	32.00 (24.00)	PT>CT,IT
TMD duration (months)	· · · ·			· · · ·	
Mean (SD)	35.99 (65.92)	25.29 (52.80)	23.28 (47.10)	40.41 (70.55)	<.001*
Median (IQR)	9.00 (35.00)	2.00 (24.00)	4.00 (23.00)	12.00 (46.00)	CT>IT,PT
Somatic symptoms / symp-	· · · ·			· · · ·	
tom burden (PHQ-15)					
Present					.040*
No, n (%)	369 (52.8)	67 (63.2)	40 (46.0)	262 (51.8)	IT>PT
Yes, n (%)	330 (47.2)	39 (36.8)	47 (54.0)	244 (48.2)	PT>IT
Severity	. ,				
No/minimal	369 (52.8)	67 (63.2)	40 (46.0)	262 (51.8)	.096
Low, n (%)	218 (31.2)	29 (27.4)	32 (36.8)	157 (31.0)	
Medium, n (%)	79 (11.3)	8 (7.5)	13 (14.9)	58 (11.5)	
High, n (%)	33 (4.7)	2 (1.9)	2 (2.3)	29 (5.7)	
Mean (SD)	5.27 (4.59)	3.93 (3.87)	5.50 (3.97)	5.51 (4.78)	.001*
Median (IQR)	4.00 (6.00)	3.00 (5.00)	5.00 (6.00)	4.00 (6.00)	PT,CT>IT
Depression (PHQ-9)	. ,				
Mean (SD)	4.69 (5.13)	3.39 (4.03)	5.39 (5.19)	4.84 (5.28)	.009*
Median (IQR)	3.00 (5.00)	2.00 (5.00)	4.00 (8.00)	3.00 (5.00)	PT,CT>IT
Anxiety (GAD-7)					
Mean (SD)	4.01 (4.59)	2.97 (3.77)	4.05 (4.08)	4.22 (4.80)	.038*
Median (IQR)	2.00 (6.00)	2.00 (5.00)	3.00 (7.00)	3.00 (5.00)	CT>IT
Oral behaviors					
Jaw overuse behavior (total					
OBC)					
Mean (SD)	15.61 (9.33)	14.19 (7.64)	15.94 (8.97)	15.85 (9.69)	.419
Median (IQR)	14.00 (12.00)	14.00 (9.25)	13.00 (11.00)	15.00 (11.00)	
Sleeping-state	. ,				
Mean (SD)	3.54 (2.48)	3.23 (2.36)	3.76 (2.51)	3.57 (2.50)	.337
Median (IQR)	4.00 (3.00)	3.00 (4.00)	4.00 (3.00)	4.00 (3.00)	
Waking-state	. ,	· ·			
Mean (SD)	12.07 (7.95)	10.96 (6.32)	12.18 (7.68)	12.28 (8.29)	.539
Median (IQR)	11.00 (9.00)	10.00 (8.00)	10.00 (9.00)	11.00 (9.00)	

Table 1 - Demographic characteristics of the TMD patients.

SD, standard deviation; IQR, Interquartile range.

Results of \*Kruskal-Wallis/Mann-Whitney U tests and  $^{Chi}$ -square test/Z tests. Bold indicates P < .05.

psychological distress, and oral behaviors, and identified the biopsychosocial factors associated with depression, anxiety, and jaw overuse behavior. All three hypotheses were confirmed, with observed variations in the occurrence and severity of somatic symptoms among the three TMD subtypes, moderate correlations between somatic symptoms, psychological distress, and oral behaviors, and the significant association of somatic symptom burden with depression, anxiety, and jaw overuse behavior. Psychosocial and behavioral (axis II) measures from the evidence-based DC/TMD were applied, enabling cross-study comparisons and facilitating future meta-analyses.<sup>6</sup>

### Comparison among TMD subtypes

The mean age and sex distribution of Korean TMD patients were consistent with that reported in other racial groups and

populations.<sup>2</sup> A combination of intra-articular and painrelated conditions was diagnosed in the majority of patients (72.4%). The PT group had a higher proportion of males than the CT group and was older than both the CT and IT groups, corroborating the existence of generational-gender diversities in TMD subtypes.<sup>31</sup> The extended TMD duration in the CT group, in comparison to the IT and PT groups, may be partly clarified by the time required to develop both jaw pain and dysfunction. Somatic symptoms were present in about half (47.2%) of all TMD patients, and the ranking of prevalence was: PT (54.0%) > CT (48.2%) > IT (36.8%). The observed prevalence of somatic symptoms aligns with the documented range of 29 to 77% in patients with TMDs.<sup>14,32</sup> Patients with painful TMDs, specifically PT and CT, experienced significantly higher levels of somatic symptom burden and depression compared to those with non-painful IT. Furthermore, the CT group exhibited significantly greater anxiety than the

			-						
Variable	IN	IS	P value	PN	PS	P value	CN	CS	<b>P value</b> Post-hoc
Total									
n (%)	67 (9.6)	39 (5.6)		40 (5.7)	47 (6.7)		262 (37.5)	244 (34.9)	
Sex						.002*			<.001*
Females, n (%)	40 (59.7)	28 (71.8)	.211	17 (42.5)	35 (74.5)	PS>PN	168 (64.1)	203 (83.2)	CS>CN
Males, n (%)	27 (40.3)	11 (28.2)		23 (57.5)	12 (25.5)	PN>PS	94 (35.9)	41 (16.8)	CN>CS
Age									
Mean (SD)	33.73 (14.77)	36.77 (16.21)	.325	41.80 (17.22)	41.30 (15.35)	.922	38.34 (16.52)	35.93 (14.36)	.312
Median (IQR)	29.00 (15.00)	30.00 (19.00)		39.00 (33.25)	36.00 (28.00)		32.00 (27.00)	32.00 (17.75)	
TMD duration (months)									
Mean (SD)	16.88 (34.53)	39.75 (72.76)	.013*	15.38 (27.85)	30.00 (58.22)	.212	35.93 (72.20)	45.22 (68.55)	.001*
Median (IQR)	1.00 (15.00)	5.00 (35.75)	IS>IN	2.50 (12.00)	6.00 (35.00)		8.00 (35.00)	17.00 (57.00)	CS>CN
Depression (PHQ-9)									
Mean (SD)	2.21 (2.69)	5.42 (5.07)	<.001*	2.50 (2.85)	7.85 (5.47)	<.001*	2.25 (2.57)	7.62 (6.00)	<.001*
Median (IQR)	1.00 (3.00)	3.00 (6.00)	IS>IN	2.00 (4.00)	7.00 (8.00)	PS>PN	1.00 (3.00)	6.00 (7.00)	CS>CN
Anxiety (GAD-7)									
Mean (SD)	1.70 (2.83)	5.15 (4.20)	<.001*	1.88 (2.94)	5.90 (4.03)	<.001*	2.30 (3.04)	6.29 (5.45)	<.001*
Median (IQR)	1.00 (2.00)	5.00 (3.00)	IS>IN	0.00 (3.00)	6.00 (7.00)	PS>PN	1.00 (2.00)	5.00 (8.00)	CS>CN
Oral behaviors									
Jaw overuse behavior (total OBC)									
Mean (SD)	12.28 (6.77)	17.46 (8.03)	.001*	12.76 (5.89)	18.65 (10.23)	.011*	13.74 (8.23)	18.11 (10.60)	<.001*
Median (IQR)	12.00 (9.00)	15.00 (6.00)	IS>IN	11.50 (9.625)	15.00 (16.00)	PS>PN	13.00 (11.25)	17.00 (13.00)	CS>CN
Sleeping-state									
Mean (SD)	2.70 (2.35)	4.13 (2.13)	.002*	3.90 (2.46)	3.64 (2.57)	.729	3.17 (2.44)	3.99 (2.50)	<.001*
Median (IQR)	2.00 (4.00)	4.00 (3.00)	IS>IN	4.00 (2.50)	4.00 (3.00)		3.00 (5.00)	4.00 (4.00)	CS>CN
Waking-state									
Mean (SD)	9.58 (5.58)	13.33 (6.88)	.003*	8.86 (4.42)	15.01 (8.71)	<.001*	10.57 (6.97)	14.12 (9.18)	<.001*
Median (IQR)	9.00 (9.00)	12.00 (6.00)	IS>IN	8.00 (6.50)	13.00 (14.00)	PS>PN	10.00 (9.25)	13.00 (10.00)	CS>CN

Table 2 - Depression, anxiety, and oral behavior scores for patients without and with somatic symptoms.

SD, standard deviation; IQR, inter-quartile range; IN, Intra-articular TMDs with no somatic symptoms; IS, intra-articular TMDs with somatic symptoms; PN, pain-related TMDs with no somatic symptoms; PS, pain-related TMDs with somatic symptoms; CN, combined TMDs with no somatic symptoms.

Results of \*Mann-Whitney U tests and ^Chi-square test tests.

Bold indicates P < .05.

# Table 3 – Correlations between TMD duration, somatic symptoms burden, depression, anxiety, and oral activity scores for subtypes of TMD patients.

Subtypes	Variables	TD	SOM	DEP	ANX	JOB	SA
Intra-articular TMDs	TD	-	-	-	-	-	-
	SOM	0.30**	-	-	-	-	-
	DEP	0.22*	0.60***	-	-	-	-
	ANX	0.25*	0.65***	0.71***	-	-	-
	JOB	0.33***	0.33***	0.37***	0.26**	-	-
	SA	0.23*	0.22*	0.02	0.22*	0.65***	-
	WA	0.34***	0.34***	0.39***	0.25**	0.95***	0.40***
Pain-related TMDs	TD						
	SOM	0.20	-	-	-	-	-
	DEP	0.10	0.65***	-	-	-	-
	ANX	0.14	0.61***	0.75***	-	-	-
	JOB	0.37***	0.41***	0.39***	0.39***	-	-
	SA	0.23*	0.09	0.14	0.12	0.67***	-
	WA	0.39***	0.47***	0.45***	0.44***	0.93***	0.40***
Combined TMDs	TD	-					
	SOM	0.16***	-				
	DEP	0.19***	0.64***	-			
	ANX	0.11*	0.51***	0.67***	-		
	JOB	0.18***	0.30***	0.38***	0.39***	-	
	SA	0.16***	0.18***	0.26***	0.26***	0.68***	-
	WA	0.16***	0.31***	0.37***	0.39***	0.96***	0.47***

TD, TMD duration; SOM, somatic symptom burden (PHQ-15 scores); DEP, depression (PHQ-9 scores); ANX, anxiety (GAD-7 scores); JOB, jaw overuse behavior (total OBC scores); SA, sleeping-state oral activity scores; WA, waking-state oral activity scores. Results of Spearman's correlation. \*Indicates P < .05, \*\* indicates P < .01, \*\*\* indicates P < .001, and bold specifies correlation coefficient >0.4.

Outcomes	Variables	Coefficient (β)	Standard Error	t-statistic	P value
Depression	Sex (Female = 1)	-0.07	0.26	-3.07	.002
	Age	-0.03	0.01	-1.28	.202
	TMD duration	0.01	<0.01	0.25	.800
	Intra-articular TMDs	-0.01	0.32	-0.37	.708
	Pain-related TMDs	0.04	0.35	1.73	.084
	Combined TMDs	-	-	-	-
	Somatic symptom burden	0.31	0.03	11.11	<.001
	Anxiety	0.57	0.03	21.13	<.001
	Jaw overuse behavior	0.09	0.01	3.63	<.001
Anxiety	Sex (Female = $1$ )	0.04	0.25	1.66	.097
	Age	0.02	0.01	0.79	.432
	TMD duration	-0.03	<0.01	-1.03	.304
	Intra-articular TMDs	-0.01	0.32	-0.47	.637
	Pain-related TMDs	-0.04	0.34	-1.50	.135
	Combined TMDs	-	-	-	-
	Somatic symptom burden	0.08	0.03	2.44	.015
	Depression	0.69	0.03	21.13	<.001
	Jaw overuse behavior	0.07	0.01	2.43	.016
Jaw overuse	Sex (Female $= 1$ )	0.04	0.69	1.21	.225
behavior	Age	-0.29	0.02	-8.74	<.001
	TMD duration	0.10	0.01	3.06	.002
	Intra-articular TMDs	-0.02	0.86	-0.60	.551
	Pain-related TMDs	0.04	0.94	1.11	.269
	Combined TMDs	_	-	-	-
	Somatic symptom burden	0.13	0.09	2.87	.004
	Depression	0.20	0.10	3.63	<.001
	Anxiety	0.12	0.10	2.43	.016

Table 4 - Factors associated with depression, anxiety, and oral behaviors.

For TMD subtypes, presence of condition = 1. Results of multivariate linear regression analysis. Bold indicates P < .05.

IT group. While prior studies have shown that patients with painful TMDs were more depressed and anxious than those with non-painful TMDs, the specific variances in somatic symptom burden among different TMD subtypes remain understudied.<sup>33</sup>

#### Influence of somatic symptoms

Significant differences in psychological distress, and jaw oral behaviors were observed between individuals with and without somatic symptoms across the three TMD subtypes. Patients with somatic symptoms demonstrated notably higher levels of depression, anxiety, jaw overuse behaviors, and waking-state oral activities than those without somatic symptoms. The latter could be attributed to increased sensitivity to somatosensory stimuli, especially during wakefulness, in people experiencing TMDs.<sup>20,21</sup> Depression and anxiety levels of patients with somatic symptoms were generally in the mild to moderate range, while jaw overuse behaviors varied from low to high. As somatic symptoms appeared to be associated with increased psychological distress and oral behaviors, discrete inter-relationships were explored within this context.

#### Correlations and associated factors

For all TMD subtypes, somatic symptom burden showed a moderate correlation with depression and anxiety. Findings corroborated those of earlier TMD research in non-clinical samples, as well as the 4 to 6 times higher occurrence of depression and anxiety in people reporting somatic symptoms than the general population.<sup>13,34</sup> Somatic symptoms may thus serve as "idioms of distress", thereby substantiating the phenomenon of somatization in TMD patients.<sup>12,13</sup> Additionally, dysregulation in autonomic, metabolic, immuneinflammatory, and hypothalamic-pituitary-adrenal axis function has been proposed to explain the connection between somatization and psychological distress.<sup>35</sup> Somatization is more prevalent among East Asians, including Koreans, Japanese, and Chinese, compared to Westerners. The variance has been attributed to societal disapproval and stigma associated with mental illness.<sup>36,37</sup> Moreover, East Asians perceived using somatic words as more effective for expressing distress and eliciting sympathy than using emotional words.<sup>36</sup> Beyond depression and anxiety, somatic symptoms have also been connected to suicidal ideation in Korean youths.<sup>38</sup> Depression and anxiety, which often co-exist, were moderate to strongly correlated irrespective of TMD subtypes.<sup>39</sup> Possible explanations include stressful life circumstances, adverse effects of both emotional states, dysfunctional cognitive processes, and shared genetic or biological vulnerabilities.<sup>40</sup>

Considering the moderate inter-relations of both depression and anxiety with waking-state oral activities, the observed moderate correlation between somatic symptom burden and oral behaviors in the PT group could be ascribed to the greater proportion of individuals with somatic symptoms and underlying psychological distress. Furthermore, somatization might reduce pain perception thresholds, resulting in the misinterpretation of ordinary bodily sensations as painful or abnormal in patients with PT.<sup>41,42</sup> Jaw overuse behavior was more strongly correlated with oral activities during wakefulness than during sleep, reflecting the state of consciousness and heightened vigilance.

The strongest regressor variable (absolute t-statistic value) for depression, anxiety, and jaw overuse behaviors were anxiety, depression, and age accordingly. Findings can be clarified by the moderate to strong correlations between depression and anxiety, in addition to the decline in oral parafunction with increasing age.<sup>43</sup> While somatic symptom burden was significantly associated with psychological distress and jaw overuse behavior, the t-statistic values for these relations were lower than those for depression and anxiety. Hence, anxiety was more likely to be linked to depression, whereas depression had a higher likelihood of being related to both anxiety and jaw overuse behavior compared to somatic symptom burden. Depression and anxiety may thus play pivotal roles in TMD patients who present with varied somatic complaints, especially among those of East Asian descent. This further supports the validity of somatization in individuals with TMDs and underscores the need for a comprehensive management approach that includes biopsychosocial assessments and tailored interventions addressing physical, mental, and social aspects of health and well-being.44,45

#### Study strengths and limitations

This study is among the first to investigate the relationships between somatic symptoms, psychological distress, and oral behaviors across various TMD subtypes in East Asian patients, utilizing the DC/TMD methodology. Findings are clinically relevant given the propensity of East Asians to "somatize" psychological distress. The study was constrained by certain limitations. First, the study involved only Korean TMD patients and further research is warranted in other East Asian TMD populations before findings can be generalized. Second, a cross-sectional design was employed, which does not permit the determination of causality between somatic symptoms and psychological distress, as well as oral behaviors. Causal inferences can only be ascertained through the use of longitudinal and experimental study designs, such as cohort studies and randomized controlled trials. Third, the measures for somatic symptoms, psychological distress, and oral behaviors, though validated and integral to the DC/TMD axis II protocol, were self-reported and disposed to various information biases, including recall and social desirability partialities.<sup>46</sup> While several variables associated with somatic symptom burden were explored, additional insights could potentially be gained by stratifying the study population based on factors such as pain chronicity.

## Conclusion

Somatic symptoms were reported by approximately half of the East Asian TMD patients examined. Although more widespread among those with painful TMDs (PT -54.0%; CT -48.2%), patients with non-painful TMDs also exhibited somatic symptoms (IT -36.8%). Significant differences in somatic symptom burden (PT, CT > IT), depression (PT, CT > IT), and anxiety (CT > IT) were observed among the three TMD diagnostic subtypes. For all TMD subtypes, patients with somatic symptoms showed significantly greater depression, anxiety, and jaw overuse behavior compared to those without somatic symptoms. Given their significant and positive correlations with depression and anxiety ( $r_s = 0.51-0.65$ ), somatic symptoms could serve as "idioms of distress", providing support for the phenomenon of somatization in TMD patients. Multivariate regression analysis revealed that somatic symptom burden was significantly associated with psychological distress and oral behaviors. Nevertheless, anxiety was more strongly linked to depression, while depression exhibited a stronger association with anxiety and jaw overuse behavior compared to somatic symptoms. Collectively, the findings suggest that TMD patients comprise a diverse group, demonstrating variations in psychological distress that may be expressed through somatic symptoms. This highlights the importance of a comprehensive TMD management approach that includes biopsychosocial assessments and tailored interventions.

## **Conflict of interest**

None disclosed.

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## Ethics approval and patient consent

The retrospective study was approved by the Institutional Review Board of Seoul National University Dental Hospital with a waiver of the requirement for informed consent (ID: ERI22001).

### Data availability

The data for this study are not publicly available but can be obtained from the corresponding author upon reasonable request.

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