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Sleep

# Temporomandibular disorders symptoms in Asian adolescents and their association with sleep quality and psychological distress

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**Objectives:** The aim of this study was to investigate the prevalence of temporomandibular disorders (TMD) symptoms and their association with sleep quality and psychological distress in Chinese adolescents.

**Methods:** Five hundred seventy-eight adolescents were enrolled in the study and completed a self-reported TMD symptom questionnaire and socio-demographics survey. Sleep quality and psychological distress were assessed. Descriptive statistics and logistic regression analysis were performed with TMD symptoms as the outcome variable.

**Results:** The prevalence of adolescents with at least one TMD symptom was 61.4%. One-third of subjects experienced disturbed sleep, depression, and stress; 65.2% experienced anxiety. Subjects with TMD symptoms had greater psychological distress and disturbed sleep than those who were symptom-free. Logistic regression analysis showed that sleep disturbance and daytime dysfunction and anxiety were significantly related to TMD symptoms.

**Discussion:** The prevalence of TMD symptoms in Asian adolescents is high. Disturbed sleep and psychological distress are correlated with TMD; thus, a further longitudinal research of the causality is warranted.

**Keywords:** Depression, Anxiety, Stress, Sleep disturbance, Cross-sectional study, Risk factor

## Introduction

Temporomandibular disorder (TMD) is a collective term comprising a number of clinical problems involving the masticatory musculature, the temporomandibular joints (TMJs), and/or the associated structures. They are a major cause of non-dental orofacial pain. Epidemiological studies of non-patient Caucasian populations show that approximately 50% have signs and 30% have symptoms of TMD.<sup>1,2</sup> Similar prevalence was also observed with Asian populations.<sup>3,4</sup> As TMD signs and symptoms are more predominant among adults between 20 and 40 years old,<sup>5</sup> the majority of researches have been directed toward TMD in adults. Studies on TMD in children and adolescents are rarer and have reported increased TMD prevalence with

advancing age.<sup>6-9</sup> Temporomandibular disorder signs and symptoms tend to peak at age 16–19, with up to 68% having signs and 41% experiencing symptoms of TMD.<sup>6-17</sup> In addition to differences in diagnostic criteria and research methodology, ethnic diversities may also contribute to the variances in TMD prevalence.<sup>8,18</sup> Temporomandibular disorder prevalence in Asian children and adolescents has not been widely investigated.<sup>7,14,15</sup> Deng et al.<sup>15</sup> studied the occurrence of TMD in 3105 Chinese children and adolescents, aged 3–19 years. They divided subjects into four age groups and examined them using calibrated investigators. 18.4% of the adolescent group aged between 12 and 19 years (283/1539) had TMD signs, including joint sounds, pain, and/or abnormal jaw movements. Recent anecdotal observation and clinical data, however, suggest an increased prevalence of TMD in Chinese adolescents. Adolescents aged between 10 and 20 years comprised about 21% of all TMD patients seen at a tertiary dental hospital between 2012 and 2013.<sup>19</sup>

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As the signs and symptoms of TMD are often mild, self-limiting, and fluctuate over time, the percentage of TMD patients seeking care is very low and estimated to constitute only 1–2% of adolescent TMD sufferers.<sup>9,12</sup> The relatively large percentage of Chinese adolescents seeking TMD management is a worrying health trend. As available literature psychological factors and TMD in children and adolescents is about two decades old, this subject matter requires urgent and purposeful reexamination.

Psychological factors and disturbed sleep have been implicated as potential risk indicators for TMD and adverse TMD treatment outcome in adult patient populations.<sup>19–22</sup> Studies pertaining to the association between psychological factors and TMD in children and adolescents are limited and were conducted primarily on non-Asian populations.<sup>17,23–25</sup> Academic stress in adolescents is extremely high in Asia (especially in countries like China, Korea, and Singapore) due to parental desires, societal demands, and educational standards. It may result in inadequate sleep, daytime dysfunction, and psychological distress, which may contribute to incidence of TMD.<sup>17,26–29</sup>

The objective of this study was to examine the prevalence of TMD symptoms, sleep problems, and psychological distress in Asian adolescents. The associations between TMD symptoms and sleep quality as well as psychological distress in adolescents were also investigated.

## Materials and Methods

### Subject population

The current study was approved by the Biomedical Institutional Review Board of Peking University School of Stomatology (PKUSSIRB-2012002). A local middle school in Peking, China was appointed for the research. The study was conducted between March and April 2014 at the beginning of the school semester. Three classes from each grade level were randomly selected, resulting in a maximum of 620 students from the six grades. Written informed consents were obtained from all participants or their guardians if they were younger than 18 years old. Participants were between 12 and 18 years of age, consistent with Armstrong's age stratification for adolescents,<sup>30</sup> with no exclusion criteria. They were asked to complete a self-reported TMD symptom questionnaire, sleep quality, and psychometric scales, in addition to a socio-demographic survey. Data from 578 subjects were obtained after the removal of non-responders and unfinished forms, and subjected to statistical analysis. 64.2% of the subjects were females and 35.8%

males, with a mean age of  $15.56 \pm 1.70$  years. The subjects were divided into two groups according to the Chinese middle school system: junior high stage (12–15 years,  $n = 281$ ) and senior high stage (16–18 years,  $n = 297$ ). The academic stresses of the two groups were expected to differ due to school grade levels and college entrance examinations. Subjects were also divided into those with and without TMD symptoms to determine the association of TMD symptoms with psychological distress and sleep quality.

### TMD symptom questionnaire

The self-reported TMD symptom form was derived from the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) Symptom Questionnaire. The questionnaire consisted of five segments, each targeting explicit TMD symptoms of orofacial pain, headache, jaw joint noise(s), closed locking, and open locking of the jaw.<sup>31</sup> Subjects selected YES or NO to indicate whether or not he/she had experienced the specified symptom(s) in the last 30 days. The Chinese version of the TMD symptom questionnaire employed was developed according to the guidelines specified by the International RDC/TMD Consortium and constituted phase I (translation and cultural adaptation) and early phase II (translation validation and documentation) of the Chinese DC/TMD instrument development process. The latter is currently at the final stages of phase I, and the pre-final instrument is undergoing independent review prior to international posting and deployment.

### Sleep quality and psychometric scales

Chinese versions of the Pittsburgh Sleep Quality Index (CPSQI) and the Depression, Anxiety, and Stress Scales-21 (DASS-21) were used to evaluate sleep quality and psychological distress. The CPSQI has good internal consistency, reliability, and construct validity,<sup>32</sup> and comprises seven components, including subjective sleep quality (A), sleep latency (B), sleep duration (C), sleep efficiency (D), sleep disturbance (E), use of sleeping medication (F), and daytime dysfunction (G). The PSQI has been widely used for studying adolescent populations (including Chinese adolescents) and is well validated.<sup>33–39</sup> Bei et al. reported a positive correlation between subjective sleep status of adolescent students assessed using the PSQI and objective sleep status assessed using wrist-worn actigraphy (Actiwatch-64; Mini Mitter, Bend, OR, USA). The latter is well tolerated and has been validated in adolescent populations.<sup>34,40</sup> A total score (t-CPSQI) of  $> 5$  yielded a sensitivity and specificity of 98 and 55%, while a t-CPSQI of  $> 6$  yielded a sensitivity and specificity of 90 and

67% in community dwelling adults with primary insomnia.<sup>32</sup> A total score (t-CPSQI) of 6 was designated as the cutoff point for poor sleep quality in this study due to its better sensitivity and specificity. Temporomandibular disorder patients, in contrast, had t-CPSQI scores greater than 9 and were deemed to have moderate to severe disturbed sleep.<sup>41</sup>

DASS-21 is the abridged version of DASS-42. It consists of 21 self-report items reflecting the negative emotional symptoms of depression, anxiety, and stress. Although DASS-21 omits the overlapping items between anxiety and stress subscales of DASS-42, it has been found to have adequate reliability. The Chinese version of DASS-21 has been validated and was reported to have high internal consistency and composite reliability as well as good construct and criterion-related validity.<sup>42</sup> Each item is rated on a four-point Likert scale of severity or frequency experienced over the past week. Psychological distress (depression, anxiety, and stress) are classified into normal, mild, moderate, severe, and extremely severe, according to computed scores from the developer's algorithm.<sup>42,43</sup>

In this study, patients were considered positive for disturbed sleep, depression, anxiety, and stress if t-CPSQI was  $\geq 7$ , depression scale score was  $\geq 10$ , anxiety scale score was  $\geq 8$ , and stress scale score was  $\geq 15$ , respectively.

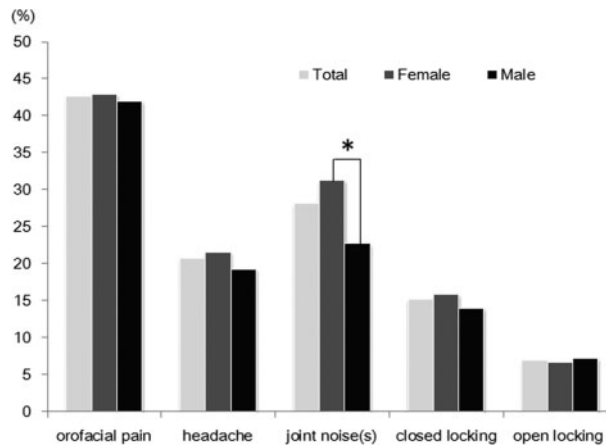
**Statistical analysis**

Independent-samples *t*-test and Chi-square tests were used to compare average scores and the prevalence of disturbed sleep and psychological distress between subjects. Step-wise logistic regression analysis was used to determine disturbed sleep/psychological distress as possible risk indicators for TMD. Variables including sex, age, junior and senior high stages, school grade level, sleep quality, depression, anxiety, and stress were independently analyzed at a significance level of  $p < 0.05$ . All data analysis was conducted using SPSS software version 20.0.

**Results**

**Self-reported TMD symptoms**

A high prevalence of TMD symptoms was observed in Chinese adolescents. At least one symptom was reported by 61.4% of subjects, and 32.4% had two or more symptoms. The most common reported TMD symptom was orofacial pain, followed by jaw joint noise(s) and headache (Figure 1). No gender difference was observed for the various TMD symptoms, with the exception of jaw joint noise(s) where a significantly higher percentage of females were

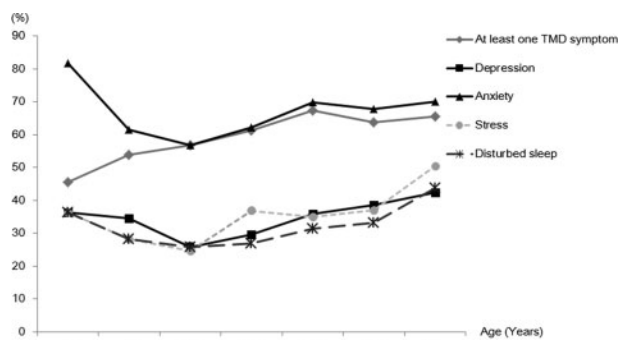


**Figure 1** Prevalence of temporomandibular disorder (TMD) symptoms in the total sample and among female/male subjects. No significant gender difference was observed, except for jaw joint noise(s) \* $p < 0.05$ .

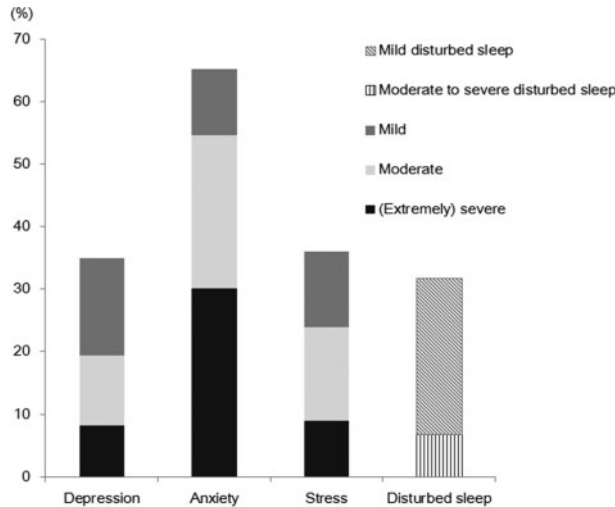
observed (Figure 1). The prevalence of at least one TMD symptom tended to increase with advancing age from 45.5% at age 12 to 65.5% at age 18 (Figure 2).

**Psychological distress and sleep disturbance**

A high proportion of Chinese adolescents also reported symptoms of psychological distress and sleep disturbance. Approximately one-third of subjects reported indicators for depression, stress, and disturbed sleep, while 65.2% suffered from anxiety (Figure 3). Of particular concern is the high fraction of adolescents who scored moderate to (extremely) severe for the DASS-21. Moderate to (extremely) severe depression, anxiety, and stress symptoms were experienced by 19.3, 54.7, and 23.8%, respectively. Excluding anxiety (54.6% for male and 71.2% for female,  $p < 0.05$ ), no significant gender difference was noted in the prevalence of psychological distress. Depression, stress, and



**Figure 2** Prevalence of at least one self-reported temporomandibular disorder (TMD) symptom, psychological distress, and disturbed sleep at each age group. Linear-by-linear association with age group: TMD symptom ( $p < 0.05$ ), depression ( $p = 0.05$ ), anxiety ( $p = 0.12$ ), stress ( $p < 0.01$ ), disturbed sleep ( $p < 0.05$ ).



**Figure 3** Prevalence of psychological distress and disturbed sleep. Percentage of subjects with mild, moderate, and (extremely) severe psychological distress and mild to moderate/severe disturbed sleep variable are also indicated.

disturbed sleep, in addition to TMD symptoms also tended to increase with age (Figure 2).

#### Comparison between junior and senior high school subjects

The prevalence of at least one self-reported TMD symptom (65.3%), depression (39.1%), anxiety (69.0%), stress (40.4%), and disturbed sleep (35.7%) in the senior high stage (16–18 years) was all significantly greater than in the junior high stage (12–15 years) ( $p < 0.05$ ). Prevalence for the junior high group was as follows: at least one self-reported TMD symptom (57.3%), depression (30.2%), anxiety (61.2%), stress (31.0%), and disturbed sleep (27.4%).

#### Comparison between subjects with and without TMD symptoms

Results of independent samples *t*-test showed that subjects with TMD symptoms had significantly higher scores for psychological distress and disturbed sleep than those without TMD symptoms ( $p < 0.05$ ). The prevalence of psychological distress and disturbed sleep in the group with TMD symptoms was also significantly higher (Table 1). Most sleep components also scored higher in the group with TMD symptoms, with the exception of sleep efficiency (*D*) and use of sleep medication (*F*) (Table 1).

#### Comorbidity of disturbed sleep and psychological distress

Disturbed sleep and psychological distress may occur in the same subject either simultaneously or sequentially.<sup>19,20</sup> In the present study, the occurrence of comorbid disturbed sleep and at least one negative emotional state of depression, anxiety, or stress was 27.9%.

Prevalence was significantly higher in subjects with TMD symptoms (34.10%) when compared to subjects who were symptom-free (17.90%) ( $p < 0.01$ ).

#### Psychological distress and disturbed sleep as possible TMD risk indicators

Stepwise logistic regression analysis demonstrated that disturbed sleep and anxiety were possible risk indicators for TMD symptoms in Chinese adolescents with odds ratios (OR), 1.74 and 2.16, respectively. As for specific sleep problems, two components of the CPSQI (*E* and *G*) were found to be possible risk indicators for TMD symptoms. Odds ratios were 1.58 and 1.43 for sleep disturbance (*E*) and daytime dysfunction (*G*), respectively. *P* values were significant even after controlling for other variables ( $p < 0.01$ ) (Table 2).

#### Discussion

Approximately 30% of the general population has symptoms of TMD.<sup>1–4</sup> In the present study, the prevalence of TMD symptoms in Asian adolescents was found to be considerably higher, with 61.4% of subjects reporting one or more TMD symptom/s. Temporomandibular disorders symptom prevalence in non-Asian adolescents of similar age was only 20–41%.<sup>10,12,44</sup> The present study focused only on the symptoms of TMD as specified in the DC/TMD. Subjective TMD symptoms are associated with objective and observable signs of TMD.<sup>45</sup> The frequency of TMD signs is, however, usually greater than symptoms, as subjects often do not notice or recognize the symptoms of TMD.<sup>9</sup> The occurrence of TMD signs in non-Asian adolescents was reported to range from 10 to 67.6%.<sup>6,8,11,16,17,44</sup> Prevalence of TMD signs in Asian adolescents is anticipated to be even higher given the pervasiveness of TMD symptoms, and warrants further exploration. The prevalence of TMD in Asian adolescents was only 10–20% in the past century.<sup>7,14,15</sup> The current study indicates a substantial and perturbing increase in TMD prevalence in Asian adolescents and explains in part the high proportion of adolescents seeking care at the authors' TMD clinic.<sup>19</sup>

The etiology of TMD is multifactorial with trauma, anatomical, pathophysiologic (including genetics), and psychosocial factors acting alone or in combination. Studies have shown that TMD patients have higher levels of psychological and affective distress, and validated the important role that psychosocial factors play in predisposing, precipitating, and perpetuating TMD.<sup>19–22</sup> In the authors' previous study, the frequency of moderate to severe psychological distress and disturbed sleep

**Table 1 Comparison of average scores and prevalence of disturbed sleep and psychological distress for subjects with/without at least one self-reported temporomandibular disorder (TMD) symptom.**

		TMD symptom group n = 355	No of TMD symptom group n = 223		P
Disturbed sleep (t-CPSQI)	Average score				
	Mean + SD	5.91 + 2.59	4.65 + 2.91	t = 5.46	<0.01
	Prevalence (%)	38.3	21.1	χ <sup>2</sup> = 18.81	<0.01
PSQI-A	Mean + SD	1.02 + 0.70	0.79 + 0.73	t = 3.75	<0.01
PSQI-B	Mean + SD	0.82 + 0.84	0.66 + 0.80	t = 2.18	<0.05
PSQI-C	Mean + SD	1.02 + 0.79	0.86 + 0.81	t = 2.37	<0.05
PSQI-D	Mean + SD	0.15 + 0.46	0.13 + 0.46	t = 0.68	0.5
PSQI-E	Mean + SD	0.94 + 0.46	0.73 + 0.56	t = 4.76	<0.01
PSQI-F	Mean + SD	0.05 + 0.32	0.05 + 0.26	t = 0.01	0.99
PSQI-G	Mean + SD	1.92 + 0.89	1.43 + 1.01	t = 6.16	<0.01
Depression	Average score				
	Mean + SD	8.81 + 8.20	6.38 + 7.21	t = 3.63	<0.01
	Prevalence (%)	38.3	29.1	χ <sup>2</sup> = 5.07	<0.05
Anxiety	Average Score				
	Mean + SD	13.28 + 8.85	8.76 + 7.56	t = 6.32	<0.01
	Prevalence (%)	74.4	50.7	χ <sup>2</sup> = 33.90	<0.01
Stress	Average Score				
	Mean + SD	14.16 + 8.90	10.19 + 8.95	t = 5.21	<0.01
	Prevalence (%)	42.5	25.1	χ <sup>2</sup> = 18.09	<0.01

**Table 2 Variables and risk indicators for self-reported temporomandibular disorder (TMD) symptoms.**

	TMD symptom group n = 355	No TMD symptom group n = 223	OR (95% CI)
Sex (%)			
Male	34.10	38.60	0.98 (0.67–1.44)
Female	65.90	61.40	
Age (years)	15.68 ± 1.66	15.37 ± 1.75	0.87 (0.61–1.24)
School stage (%)			
Junior high	45.40	53.80	0.80 (0.27–2.39)
Senior high	54.60	46.20	
School grade level (%)			
Junior high 1	13.00	20.20	0.59 (0.33–1.06)
Junior high 2	9.60	12.10	0.81 (0.42–1.56)
Junior high 3	17.70	18.40	0.82 (0.47–1.43)
Senior high 1	17.20	12.60	1.29 (0.71–2.37)
Senior high 2	17.50	17.50	0.89 (0.50–1.57)
Senior high 3	25.10	19.30	1.00
Disturbed sleep (%)	38.30	21.10	1.74 (1.16–2.62)**
PSQI-E (sleep disturbance)	Mean + SD		
	0.94 + 0.46	0.73 + 0.56	1.58 (1.09–2.30)**
PSQI-G (daytime dysfunction)	Mean + SD		
	1.92 + 0.89	1.43 + 1.01	1.43 (1.17–1.75)**
Depression (%)	38.30	29.10	0.73 (0.47–1.14)
Anxiety (%)	74.40	50.70	2.16 (1.46–3.19)**
Stress (%)	42.50	25.10	1.45 (0.97–2.18)

OR: odds ratio; CI: confidence interval; \*\*P < 0.01.

in TMD patients that was mainly constituted by adults was 17.6% for depression, 36.5% for anxiety, 17.5% for stress, and 7.1% for disturbed sleep.<sup>19</sup> The percentage of subjects who scored moderate to severe for depression (19.3), anxiety (54.7), and stress (23.8) was higher in the present adolescent cohort (Figure 3). The findings suggest that Chinese school adolescents may be suffering from higher levels of psychological distress than adults. The latter may be attributed in part to academic stress, which has been described as mental distress with respect to some anticipated frustration associated

with academic failure or even unawareness to the possibility of such failure.<sup>46</sup> Recognized academic stressors include fear of falling behind, finding motivation, time pressures, as well as concerns about academic ability, grades, and time management. Prevalence of depression (34.9%) and anxiety (65.2%) in the Chinese adolescents was higher than those of non-Asian adolescents. Bonjardim et al., using the Hospital Anxiety and Depression Scale (HADS), reported the presence of depression and anxiety in 26.7 and 16.6% of Brazilian adolescents, respectively.<sup>24</sup>

Psychological distress was significantly more common in subjects with TMD symptoms than those without symptoms (Table 1). In the present study, 61.4% of adolescents had one or more TMD symptoms, of which depression, anxiety, and stress was present in 38.3, 74.4, and 42.5%, respectively. Diniz et al. studied the relation of psychological factors to TMD in high school students 6 months and 1 week before college entrance examinations.<sup>17</sup> At the beginning of the semester (i.e. 6 months before college entrance examinations), 36.4% of subjects suffered from TMD, of which 65% presented with anxiety and 70% presented stress. One week before college entrance examinations, the percentage of subjects with TMD increased to 50.9, and almost all subjects with TMD had anxiety and stress. Their findings were consistent with the elevated prevalence of TMD symptoms in the senior high stage in the present study. Students preparing to take major examinations are therefore a potential risk for developing TMD. Stepwise logistic regression analysis further demonstrated that psychological factors other than age were possible risk indicators, with the OR 1.74 and 2.16 for disturbed sleep and anxiety, respectively (Table 2). Sleep problems that often coexist with psychological distress have also been proven to be a risk indicator of TMD.<sup>19-21</sup>

No significant gender difference was found in the prevalence of the various TMD symptoms with the exception of jaw joint noise(s). Observations corroborated those of previous studies,<sup>9,13,15,16</sup> and may be explained by the fact that hormonal (estrogen) effect alone does not play a significant role in the initiation of TMD symptoms,<sup>47</sup> especially in patients who are not of child-bearing age. Most of the aforementioned studies, which largely ended at age 12, did not take pubertal effects into consideration. Gender differences in post-pubertal females were not adequately investigated, and further studies on hormonal relationship to TMD in adolescents are warranted. The lack of gender difference in TMD symptoms may also be contributed by the overall absence of gender difference in psychological distress among Chinese adolescents.

Although the prevalence of TMD symptoms tends to increase with advancing age, stepwise logistic regression analysis indicated that disturbed sleep and anxiety, rather than age or school grade level *per se*, increase the risk of TMD symptoms. Academic pressure from parents and society is great in Asia. College entrance examinations in Asia, which are highly competitive, can result in psychological distress over school/future successes

as well as fewer hours of sleep and daytime dysfunction.<sup>17,26-29</sup> Greater academic pressures lead to higher levels of psychological distress, which in turn results in increased TMD symptoms.<sup>17</sup> The aforementioned explains the higher prevalence of psychological distress, disturbed sleep, and TMD symptoms in senior high students when compared to junior high students. It also helps expound on the positive relationships between age and TMD symptoms in children and adolescents, especially if psychosocial factors were not considered.

## Conclusions

In conclusion, the prevalence of self-reported TMD symptoms, psychological distress, and disturbed sleep is found to be high, and tends to increase with advancing age in Chinese adolescents. Adolescents with self-reported TMD symptoms are found to have more severe psychological distress and disturbed sleep than those who are symptom-free. Comorbidity of disturbed sleep and at least one negative emotional state is more pronounced in adolescents with TMD symptoms than those without symptoms. Stepwise logistic regression analysis indicates that disturbed sleep and anxiety are comorbid conditions, and are possible risk indicators for TMD symptoms.

Although the present study has yielded some significant findings, the case-control and cross-sectional design employed is not without flaws. It remains vulnerable to biases, and definitive conclusions on causality between psychological distress/sleep quality and TMD symptoms cannot be made. Psychological distress and sleep disturbance were thus considered possible risk indicators rather than risk factors. While the sample size was comparatively larger than other studies on TMD in adolescents, it involved only a single school and province in China. A nation-wide survey is necessary for a more complete understanding of TMD and psychological distress in Chinese adolescents. The study, however, served as an operationalized pilot study for the latter, and there are plans to extend it to other schools and provinces in China. Future studies could also include the assessment of objective TMD signs, as some self-reported symptoms like orofacial pain and headache may not be exclusive to TMD.

## Disclaimer Statements

**Contributors** All the contributors have participated in conceiving and designing the study, obtaining ethics approval, collecting the data, analyzing the data, interpreting the data, writing the article in whole or in part, and revising the article.

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**Conflicts of interest** The authors declare that they have no conflict of interests.

**Ethics approval** The study was approved by the Biomedical Institutional Review Board of Peking University School of Stomatology (PKUSSIRB-2012002).

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