Scientific Research Report

The Link Between Temporomandibular Disorders and Jaw Functional Limitations Among Chinese Adolescents

Yifan Wang [a,1], *Jingyi Xu* [a,1], *Chunmeng Ding* [a], *Tongyan Deng* [b], *Zhenguo Shen* [a], *WuanJing Huang* [a], *Yuhui Wan* [a,b*], *Tian Xing* [a*]

[a] *College & Hospital of Stomatology, Anhui Medical University, Key Lab. of Oral Diseases Research of Anhui Province, Hefei 230032, China*

[b] *Teaching Center for Preventive Medicine, School of Public Health, Anhui Medical University, Hefei 230032, China*

ARTICLE INFO

Article history:
Received 23 April 2024
Received in revised form
9 July 2024
Accepted 19 July 2024
Available online 13 August 2024

Key words:
Temporomandibular disorders
Adolescents
Jaw functional limitation
Sex

ABSTRACT

Background: Currently, there is still controversy surrounding the relationship between temporomandibular disorders (TMDs) symptoms and jaw functional limitations. We investigated the distribution of TMDs in senior high school students, including both the number and types of symptoms, and assessed their association with jaw functional limitations. Furthermore, we explored sex differences in these associations.

Methods: This study was conducted at a public high school in Hefei, Anhui Province, China, with data collected from September to October 2022. All subjects completed questionnaires assessing the anamnestic symptoms of TMDs and the Jaw Functional Limitation Scale (JFLS), and examinations were performed by trained dentists according to the Diagnostic Criteria for TMD. Data were analysed using the Kruskal–Wallis, Mann–Whitney U, and Chi-square tests.

Results: The mean age of the participants ($N = 2890$) was 17.2 ± 0.14 years and 38.9% were females (61.1% were males). Limitations in self-assessed jaw function were associated with the presence of TMDs ($P < .05$). Participants with more symptoms reported significantly high levels of functional limitations ($P < .05$). Compared to male adolescents, female adolescents more commonly experienced TMDs pain and tended to have more symptoms ($P < .05$). However, no sex differences were observed in most associations between TMDs and jaw functional limitations.

Conclusion: TMDs-positive symptoms are common in adolescents. Female adolescents were more affected by TMDs symptoms than male adolescents. Individuals with more TMDs symptoms have greater jaw functional limitations.

Introduction

Temporomandibular disorders (TMDs) are a group of orofacial diseases with similar clinical symptoms involving the musculature surrounding the face and temporomandibular joint (TMJ).[1] They are primarily characterized by pain in the preauricular area, TMJ, or muscles involved in mastication; range of motion limitations in the mandible; and TMJ noise during jaw function.[2] Owing to their high prevalence and negative impact on patients' daily lives, TMDs are becoming important diseases in dental care as well as a public health problem. A series of epidemiological studies have shown that the signs and symptoms of TMDs tend to peak at the age of 16 to 19 years, with 68% having signs and 41% experiencing

Abbreviations: DC/TMD, Diagnostic Criteria for Temporomandibular Disorders; IQR, interquartile range; JFLS, Jaw functional limitation; PS, temporomandibular disorders pain and sounds; SD, standard deviation; TD, temporomandibular disorders dysfunction; TP, temporomandibular disorders pain; TS, temporomandibular joint sounds; TMDs, temporomandibular disorders; TMJ, temporomandibular joint

* *Corresponding authors*. Yuhui Wan, Tian Xing, College & Hospital of Stomatology, Anhui Medical University, Key Lab. of Oral Diseases Research of Anhui Province, Meishan Road, Hefei 230032, China.

E-mail addresses: wyhayd@163.com (Y. Wan), xingtian8110@163.com (T. Xing).

[1] Yifan Wang and Jingyi Xu have contributed equally to this work.

https://doi.org/10.1016/j.identj.2024.07.1206

symptoms.[3,4] Moreover, in China, few epidemiological studies are available on TMDs among adolescents.

Differences in participant age, cultural background, ethnic diversity, and gender, sample size, examination scheme, symptoms/signs observed, and the diagnostic systems used across different studies, make direct comparison of results challenging.[4-6] Furthermore, previous research employed various guidelines and examination protocols, further complicating comparisons. Therefore, the internationally recommended Diagnostic Criteria for TMDs (DC/TMD) may help in standardizing assessments and improving comparability of findings.[7,8] An amended version of the DC/TMD was introduced in 2014 to define a structured protocol for examiners. The DC/TMD also consists of a two-axis model in which Axis I provides a physical assessment using the diagnostic criteria.[9] According to the DC/TMD symptom questionnaire and clinical examination, common TMDs symptoms can be divided into intra-articular and painful problems. Intra-articular symptoms include closed and open TMJ locking and TMJ sounds, whereas pain-related symptoms include TMDs (TMJ/masticatory muscle) pain and headache triggered by TMDs. DC/TMD Axis II assesses the psychological status and pain-related disabilities of patients with TMJ using a valid and reliable questionnaire.[1,9]

The TMJ is a complex anatomical structure in the human body and supports several orofacial functions, including breathing, swallowing, mastication, emotional communication, and facial expression.[10] TMDs usually lead to orofacial dysfunction, such as limitations in mandibular movements.[11] Limitations in jaw function refer to restrictions reportedly involved in the stomatognathic system but are not necessarily associated with clinically detected symptoms and signs, including opening, protrusion, and lateral movements. However, without inquiring patients about the problems that they experience, assessing whether these problems affect their routine daily activities, such as chewing, swallowing, speech, and smiling, is challenging.[12] Research on adults has shown that patients with TMDs are inclined to report greater limitations in mandibular function and that limitations in mandibular function are more affected by TMDs in the pain group than that by intraarticular capsular conditions.[13] However, some studies have reported that linking the diagnoses of different types of TMDs to limited mandibular function is challenging.[14] Therefore, the relationship between the number and types of TMDs symptoms and mandibular function requires further investigation. Moreover, research on the relationship between mandibular function and TMDs type or number in adolescents is limited and is mainly conducted in non-Asian populations.[13,15] Therefore, conducting urgent and purposeful studies on this topic is necessary in China.

Existing epidemiological surveys of TMDs among adolescents reveal that many uncertainties remain regarding the relationship between sex and TMDs.[15] Scholars have reported that the degree of mandibular functional limitation differs between sexes. A recent study reported that compared to males, females with TMDs exhibited more limited mandibular function, more severe pain, and smaller mouth opening.[11] However, few studies have focused on the sex differences in the association between TMDs and jaw functional limitations, and whether there are sex differences in this association has not been determined.

Preventing or alleviating TMDs pain and diminishing its effect on the quality of life in adolescents is crucial.[16] Identifying the clinical symptoms and physical signs of TMDs and the associated factors in adolescents is conducive to promoting earlier TMDs detection in this age group. The primary objective of this study is to preliminarily assess the relationship between the number and types of TMDs symptoms in high school students and several aspects of mandibular functional limitation. Second, we aim to evaluate the distribution of the number and types of TMDs symptoms, as well as gender differences. Finally, we investigate whether the relationship between the number and types of TMDs symptoms and mandibular functional limitation varies by gender.

Materials and methods

Sample and procedures

This cross-sectional epidemiological study was conducted at a public high school in Hefei, Anhui Province, China. The school is one of the largest high school in Anhui Province, covering three grades, which comprises a total of 5998 students. The sample size was calculated using PASS 11.0. According to previous studies, the detection rate of TMDs in adolescents was 30% for males and 44.7% for females.[17] At the same time, it has been shown that jaw functional limitation is not affected by sex, with a prevalence of about 30%.[18] The required sample size was estimated at 95% confidence level with a margin of error of ±5%. When a 10% nonresponse was applied for the minimum sample size needed for the required sample size was determined as 379 for males and 443 for females. To increase the reliability of the results and account for potential missing data, a total of 2890 high school students were recruited for this study, including 1766 males and 1124 females. This also ensures the feasibility of stratifying the data during analysis, preventing certain groups from having insufficient sample sizes. Our sample comes from three grade levels of this high school. We selected all students from the odd-numbered classes as our study subjects. The investigation site of this study is in the gymnasium of this school. This study strictly adhered to the requirements of the Declaration of Helsinki. It was approved by the Ethics Committee of the Affiliated Stomatological Hospital of Anhui Medical University (T2022017), and informed consent was obtained from the students and their parents/guardians. The exclusion criteria for this study included several conditions: severe oral diseases, including but not limited to acute periodontitis, oral tumours; recent maxillofacial surgeries, such as tooth extraction, jaw surgery, etc.; recent treatment for TMDs or other facial pain disorders; severe systemic diseases, such as uncontrolled diabetes, cardiovascular diseases, etc.; cognitive or communication impairments. In our study, we used both Axis I and Axis II of the DC/TMD system. Axis I allowed us to clinically diagnose and classify the TMDs present among the high school students. Axis II enabled us to assess the jaw functional limitations associated with TMDs symptoms, providing a comprehensive understanding of the disease's impact on the participants' lives.[19]

Measures

According to the DC/TMD, all students who participated in the screening completed symptom questionnaires, the Jaw Functional Limitation Scale-8 (JFLS-8), and agreed to undergo clinical examinations. Before the main study, a pre-test was conducted in September 2022 with 60 high school students aged 16 to 18 years (mean age 17.32 ± 0.21 years). We assessed the comprehensibility and applicability of the questionnaires. The internal consistency of the questionnaires was assessed using Cronbach's alpha coefficient, and the internal consistency reliabilities of the DC/TMD and the JFLS-8 were scored as 0.76 and 0.82.

TMDs symptom questionnaire

The DC/TMD symptom questionnaire has been validated in populations from different cultural backgrounds, demonstrating its effectiveness as a cross-cultural diagnostic tool.[20,21] In this study, we used the Chinese version of the TMD symptom questionnaire translated by Professor Fu Kaiyuan.[22-24] The DC/TMD symptom questionnaire comprises 14 issues about the features of TMDs symptoms (specifically, facial pain [Q1-4], headaches triggered by TMDs [Q5-7], TMJ sounds [Q8], and TMJ closed and open locking [Q9-14]).[20] Positive answers to the main questionnaire items on TMDs pain/headache and TMJ sounds, and closed/open locking were used to determine TMDs pain (TP), TMJ sounds (TS), and TMDs dysfunction (TD). A patient may have multiple diagnostic results depending on diagnostic criteria. To ensure that participants accurately understood and correctly answered the questions, our study employed face-to-face interviews conducted by our researchers. Based on their answers to symptom questions, participants were divided into four groups (TP, TS, TD, and PS [TP plus TS]). All patients with TMDs functional limitations were categorized into the TD group and were further divided into three groups according to the number of positive answers to the TMDs symptom questions (0S, 1S, and 2S and above). Groups 0S and NT served as control groups.

TMDs clinical examination

After the symptom questionnaire survey, all participants underwent clinical evaluation for signs of TMDs in accordance with the DC/TMD examination form to confirm the presence of TMDs symptoms. The examinations were performed by five examiners from the School of Stomatology, Anhui Medical University, who were trained and calibrated in the DC/TMD protocol before the formal commencement of the study, and the Kappa coefficient ranged from 0.69 to 0.88. The examination included the location of the pain/headache, maximum assisted opening, opening and closing movements, lateral and forward movements, TMJ snapping or rubbing sounds during opening and closing and lateral and forward movements, joint locking, and muscle or TMJ pain on palpation. All examination findings were bilateral jaws, and the clinical examination results were grouped in the same manner as the symptom questionnaire results as follows: TP, TS, TD, and PS (TP plus TS). In the statistical analysis, mouth opening was defined as the overbite plus the interincisal distance. The TP group was defined as any pain with palpation of the muscles/lateral pole of the TMJ and/or around the lateral pole or a familiar headache caused by palpation of the temporalis muscle. The TS group was defined as any click and/or crepitus during joint movement, and all patients with mouth opening <40 mm were categorized into the TD group.[21]

Jaw functional limitation

The Jaw Functional Limitation Scale-8 (JFLS-8) is a self-administered questionnaire and proven organ-specific instrument for evaluating the functional status of the masticatory system.[25] It has been used in several TMDs studies with moderate sample sizes. The DC/TMD recommends the use of the JFLS-8 to measure jaw functional limitations during various activities. The scale includes eight items covering three areas: mastication, vertical jaw mobility, and verbal and emotional expression. At present, a cutoff point has not been provided, but the higher the JFLS-8 score, the more severe the jaw functional limitation. The score of each item ranges from 0 to 10, with '0' and '10' corresponding to no and extreme limitations, respectively. The JFLS-8 has demonstrated acceptable reliability and validity.[26]

Statistical analysis

Statistical analyses were conducted using Windows (IBM SPSS version 23.0), and the significance level was set at 0.05. The chi-square test was used to determine gender differences in the distribution of TMDs. All variables were subjected to descriptive statistics and presented as mean ± standard deviation and median and interquartile range. All data were checked for normality using the Kolmogorov–Smirnov test. Because the JFLS data did not conform to a normal distribution ($P < .05$), the Kruskal–Wallis and Mann–Whitney *U* tests were applied.

Results

A total of 2998 students' information was collected for this study. Of these, 108 students were unable to participate in the final data collection because they did not meet the eligibility criteria or had incomplete data. In the end, we collected valid data from 2890 adolescents. The final sample had a mean age of 17.2 ± 0.14 years. Among the participants, 38.9% were females and 61.1% were males, and the results of both the questionnaire survey and clinical examination revealed the occurrence rates of TMDs-positive symptoms. According to the questionnaire survey, 34.5% of the participants reported TMDs-positive symptoms, while clinical examination indicated a TMDs-positive rate of 38.5%.

Distribution of the number of symptoms of TMDs based on the questionnaire and its association with jaw functional limitations

As shown in Table 1, the frequency ranking based on the number of TMDs symptoms was as follows: 0S (65.50%), 1S (27.40%), and 2S and more (7.10%). In our study, TMDs were more commonly observed in females than in males ($P < .05$), with the gender difference being more pronounced among individuals with two or more TMDs symptoms ($P < .001$). Table 2 shows the mean, median, and statistical comparison

Table 1 – Distribution of study sample by number of TMDs questionnaire survey symptoms.

	0S		1S		≥2S	
	n	%	*n*	%	*n*	%
Male (1766)	1185	67.1% (64.9%, 69.3%)	487	27.6% (25.5%, 29.7%)	94	5.3% (4.3%, 6.4%)
Female (1124)	708	63.0% (60.1%, 65.8%)	305	27.1% (24.5%, 29.7%)	111	9.9% (8.1%, 11.6%)
Total (2890)	1893	63.5% (63.8%, 67.3%)	792	27.4% (25.7%, 29.0%)	205	7.1% (6.1%, 8.0%)
P†		**.023***		.795		**<.001****

Bold values represent statistically significant results (P <0.05).

* Statistical significance at $P < .05$.
** Significant at $P < .001$.
† Comparing the differences in male and female. Results of chi-square test ($P < .05$).

results of the JLFS-8 score based on the number of TMDs symptoms. All limitations, except for communication (2S and above > 1S, 0S, $P < .001$), were significantly higher in more symptomatic cases than in less symptomatic cases (2S and above > 1S > 0S, $P < .001$). Except in the 1S group, the global JFLS-8 score of females was higher than that of males ($P < .05$). No significant differences were noted between males and females in the overall and other aspects of the JFLS-8 scores in different groups ($P > .05$).

Distribution of TMDs symptom types based on questionnaires and their association with jaw functional limitations

Table 3 shows the distribution of the TMDs symptom types. The order by symptom type was as follows: NT, 65.40%; TS, 16.10%; TP, 12.70%; PS, 4.50%; and TD, 1.30%. In our study, female adolescents more frequently reported TP symptoms compared to male adolescents ($P < .001$), while they reported TS symptoms less frequently ($P < .01$). Table 4 shows the mean, median, and statistical comparison results of the JLFS-8 scores based on the type of TMDs symptoms. Except for communication, the appearance of all types of TMDs symptoms was related to significantly larger functional limitations compared to the control group ($P < .05$). Except for the TP group, females had more communication limitations than males ($P < .05$), and no significant differences were noted between males and females in the global or other aspects of JFLS scores in the different groups ($P > .05$).

Distribution of symptoms of TMDs based on clinical examination and their association with jaw functional limitations

According to Table 6, the frequencies of the TMDs clinical examination symptoms were as follows: NT, 61.5%; TS, 27.7%; PS, 4.7%; TP, 3.5%; and TD, 2.6%. The clinical examination results demonstrate that compared to male adolescents, female adolescents more frequently exhibit TP and TD

Table 2 – Mean/median JLFS scores based on number of TMDs questionnaire survey symptoms.

			0S	1S	≥2S	P†
Mastication limitation	Total	Mean ± SD	0.37 ± 1.45	0.75 ± 2.14	2.02 ± 3.47	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-3.00)	2S>1S > 0S
	Female	Mean ± SD	0.42 ± 1.45	0.85 ± 2.13	1.72 ± 3.00	**<.001*****
	Male	Mean ± SD	0.34 ± 1.45	0.69 ± 2.14	2.37 ± 3.93	**<.001*****
		P‡	.049*	.104	.531	
Mobility limitation	Total	Mean ± SD	0.24 ± 1.18	0.55 ± 1.78	1.43 ± 2.82	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-2.00)	2S > 1S > 0S
	Female	Mean ± SD	0.20 ± 0.92	0.64 ± 1.94	1.33 ± 3.04	**<.001*****
	Male	Mean ± SD	0.27 ± 1.31	0.50 ± 1.67	1.54 ± 2.54	**<.001*****
		P‡	.680	.318	.194	
Communication limitation	Total	Mean ± SD	0.05 ± 0.46	0.07 ± 0.51	0.26 ± 1.35	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	2S > 1S, 0S
	Female	Mean ± SD	0.04 ± 0.40	0.08 ± 0.52	0.32 ± 1.72	**.010***
	Male	Mean ± SD	0.05 ± 0.49	0.07 ± 0.51	0.19 ± 0.72	**.003****
		P‡	.084	.354	.432	
Global limitation	Total	Mean ± SD	0.66 ± 2.50	1.37 ± 3.48	3.71 ± 6.49	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-1.00)	0.00 (0.00-5.00)	2S > 1S > 0S
	Female	Mean ± SD	0.65 ± 2.14	1.56 ± 3.53	3.37 ± 6.89	**<.001*****
	Male	Mean ± SD	0.66 ± 2.70	1.26 ± 3.44	4.11 ± 6.00	**<.001*****
		P‡	.245	.045*	.161	

Bold values represent statistically significant results (P <0.05).

* Statistical significance at $P < .05$.
** Significant at $P < .01$.
*** Significant at $P < .001$.
† Comparing the intergroup differences in 0S, 1S and ≥2S. Results of Kruskal–Wallis/Mann–Whitney U test ($P < .05$).
‡ Comparing the differences in Male and Female. Results of Kruskal–Wallis/Mann–Whitney U test ($P < .05$).

Table 3 – Distribution of study sample by type of TMDs questionnaire survey symptoms.

	NT		TP		TS		TD		PS	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Male (1766)	1183	67.0% (64.8%, 69.2%)	177	10.0% (8.6%, 11.4%)	315	17.8% (16.1%, 19.6%)	21	1.2% (0.7%, 1.7%)	70	4.0% (3.4%, 5.3%)
Female (1124)	706	62.8% (60.0%, 65.6%)	191	17.0% (14.8%, 19.2%)	149	13.3% (11.3%, 15.2%)	18	1.6% (0.9%, 2.3%)	60	5.3% (4.5%, 7.3%)
Total (2890)	1889	65.4% (63.7%, 67.1%)	368	12.7% (11.5%, 13.9%)	464	16.1% (14.7%, 17.4%)	39	1.3% (0.9%, 1.8%)	130	4.5% (4.1%, 5.7%)
P†		**.021***		**<.001*****		**.001****		.349		.082

Bold values represent statistically significant results (P <0.05).

* Statistical significance at $P < .05$.
** Significant at $P < .01$.
*** Significant at $P < .001$.
† Comparing the differences in Male and Female. Results of chi-square test ($P < .05$).

symptoms ($P < .05$). However, gender differences in TS and PS symptoms are not significant. Further details of each examination are presented in Supplementary Table 1.

Table 6 shows the mean/median JLFS-8 scores and statistical analysis results based on the type of TMDs symptoms observed on clinical examination. The appearance of all types of TMDs symptoms correlated with significantly greater functional limitations in terms of mastication, vertical jaw mobility, and global limitation compared to that in the control group ($P < .05$). The PS group demonstrated significantly greater functional limitations than the TS group. In NT group, the global mandibular function and mastication limitation scores of females were higher than those of males ($P < .05$). In the TS group, functional limitations in mastication were more common in females than in males ($P < .05$). In addition, no significant sex differences were noted in global and other aspects of JFLS-8 scores among the other TMDs type groups ($P > .05$). Supplementary Table 2 also shows that participants with TMD symptoms had higher JFLS-8 scores ($P < .05$). The JLFS-8 scores, except for the mastication limitation of the TMJ sounds, did not differ significantly between the male and female adolescents.

Discussion

This school-based survey including 2890 senior high school students, investigated the distribution of TMDs symptoms, the number and types of TMDs symptoms, and their associations with jaw functional limitations in adolescents. These results demonstrate that self-assessed jaw functional limitations are associated with TMDs. Compared to male adolescents, female

Table 4 – Mean/median JLFS scores based on type of TMDs questionnaire survey symptoms.

			NT	TP	TS	TD	PS	P†
Mastication limitation	Total	Mean ± SD	0.37 ± 1.45	0.80 ± 2.06	0.73 ± 2.27	3.38 ± 4.81	1.86 ± 2.95	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	1.00 (0.00-6.00)	0.00 (0.00-3.00)	TD, PS > TP, TS > NT
	Female	Mean ± SD	0.41 ± 1.45	0.80 ± 1.85	0.93 ± 2.37	3.11 ± 4.95	1.73 ± 2.68	**<.001*****
	Male	Mean ± SD	0.34 ± 1.45	0.80 ± 2.28	0.64 ± 2.23	3.61 ± 4.80	1.97 ± 3.18	**<.001*****
		P‡	.059	.471	**.025***	.458	.914	
Mobility limitation	Total	Mean ± SD	0.24 ± 1.18	0.51 ± 1.80	0.58 ± 1.75	2.36 ± 4.15	1.39 ± 2.50	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-3.00)	0.00 (0.00-2.00)	TD, PS > TP, TS > NT
	Female	Mean ± SD	0.20 ± 0.93	0.59 ± 1.79	0.68 ± 2.06	2.72 ± 5.35	1.32 ± 2.53	**<.001*****
	Male	Mean ± SD	0.27 ± 1.31	0.43 ± 1.80	0.54 ± 1.59	2.05 ± 2.84	1.46 ± 2.49	**<.001*****
		P‡	.684	.097	.767	.697	.632	
Communication limitation	Total	Mean ± SD	0.05 ± 0.46	0.07 ± 0.52	0.08 ± 0.55	0.69 ± 2.68	0.14 ± 0.68	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	TD > NT, TP, TS
	Female	Mean ± SD	0.04 ± 0.40	0.13 ± 0.72	0.05 ± 0.34	1.00 ± 3.77	0.15 ± 0.82	**.009****
	Male	Mean ± SD	0.05 ± 0.49	0.01 ± 0.11	0.10 ± 0.63	0.43 ± 1.16	0.13 ± 0.54	**<.001*****
		P‡	.085	**.042***	.765	.575	.555	
Global limitation	Total	Mean ± SD	0.66 ± 2.51	1.39 ± 3.23	1.40 ± 3.74	6.44 ± 10.52	3.39 ± 4.99	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-1.00)	0.00 (0.00-1.00)	2.00 (0.00-8.00)	1.00 (0.00-5.00)	TD, PS > TP, TS > NT
	Female	Mean ± SD	0.65 ± 2.14	1.52 ± 3.24	1.66 ± 3.96	6.83 ± 13.03	3.20 ± 5.06	**<.001*****
	Male	Mean ± SD	0.66 ± 2.70	1.24 ± 3.24	1.27 ± 3.64	6.10 ± 8.09	3.56 ± 4.97	**<.001*****
		P‡	.273	.106	.083	.559	.561	

Bold values represent statistically significant results (P <0.05).

* Statistical significance at $P < .05$.
** Significant at $P < .01$.
*** Significant at $P < .001$.
† Comparing the intergroup differences in NT, TP, TS, TD and PS. Results of Kruskal–Wallis/Mann–Whitney U test ($P < .05$).
‡ Comparing the differences in Male and Female. Results of Kruskal–Wallis/Mann–Whitney U test ($P < .05$).

adolescents experienced TMDs pain more commonly and tended to have more TMDs symptoms. However, no sex differences were noted in most associations between TMDs and jaw functional limitations.

Association between the number and types of TMDs and jaw functional limitations

TMDs have several clinical manifestations. This can cause functional restrictions in the masticatory system, most commonly unilateral chewing, asymmetric movements, and masticatory muscle fatigue.[27] Many patients with TMJ disorders modify their diet. Avoidant eating behaviour is strongly linked to TMDs progression, and patients may withhold certain foods because of their texture or consistency. For example, patients tend to reduce their dietary fibre intake because foods with more dietary fibre require more grinding than other foods.[28] This, in turn, affects the nutritional status. Oral and general health statuses positively correlate with jaw limitation scores.[18]

Although the standardized value of the JFLS-8 score has not yet been determined, the results of clinical examination of pain with muscle palpation, headache with temporalis muscle palpation, familiar pain with muscle palpation, pain with TMJ palpation, and familiar pain with TMJ palpation of TMDs in the present study showed higher mean global scores (≥3.478). A histopathological relationship and clinical overlap were noted between masticatory muscle pain, TMJ pain, and some types of headache because they involve similar pain pathways and occur in similar areas of the anatomy. Muscle pain, joint pain, and headache are associated with the jaw.[29,30]

Our results showed that students with TMDs symptoms had higher self-reported functional limitations than those without symptoms ($P < .001$). These findings are consistent with those of a study on dental students that reported significantly more limitations in individuals with TMDs.[9,31] Subjects with more symptoms had a higher degree of reported functional limitations, and those with more than two symptoms had markedly higher levels than those with only one or no symptoms. In a study involving >900 individuals, patients with TMDs and more symptoms generally tended to report substantially higher levels of anxiety, depression, and stress.[32] In addition, a previous study showed that anxiety and depression scores increased with greater mandibular functional limitations.[33,34] Limitations in mandibular function may play an intermediary role in the relationship between TMDs symptoms and psychological factors. The presence of any type of TMDs symptom is associated with greater functional limitations. As participants with TD had significantly greater functional limitations than other groups, TMDs types should be distinguished by evaluating the relationships between TMDs and functional limitation variables in future studies. Participants classified into the TD symptom type group have limitations in mouth opening and closing, which leads to TD symptoms that may have a significant impact on daily life, nutrition, and socialization of these adolescents. The results of this study confirm that TMDs mainly causes limitations in mobility and mastication, rather than communication. Similar results have been reported previously. Some scholars reported that communication scores did not differ significantly between TMDs groups.[35]

Sex differences in relationship between TMDs and jaw functional limitations

The proportion of female adolescents with two or more TMDs symptoms was significantly higher than that of male adolescents ($P < .05$), indicating that TMDs were more severe in this population. As the grouping of TMDs adopted self-reported data, the higher symptom-reporting rate among girls is probably because female adolescents report physical signs more often than their male counterparts.[36] A retrospective observational study on the correlation between sex and the number of TMDs diagnoses through magnetic resonance imaging also revealed that women were more susceptible to developing a higher number of accompanying symptoms than men.[37] As shown in Table 3, significant sex-based differences were observed in the total rates of TMDs, TS, and TP. The overall symptom-reporting rate for female adolescents with TMDs is higher, with a 70% higher likelihood of experiencing TMDs pain symptoms compared to male adolescents, which is consistent with the findings of most studies on this topic.[38,39] Sex differences may exist in fundamental pain mechanisms and related psychosocial factors. Compared with men, women with TMDs experience more severe pain, which is probably related to the fact that women with TMDs are more sensitive.[40] Techniques for coping with stress also differ between sexes. Compared to males, females experience higher levels of stress, depression, and pain.[41] The only exception is that boys self-report a higher frequency of TMJ sounds than girls, consistent with the results of a cross-sectional survey of German adolescents.[21] However, as shown in Table 5, there is no difference in the frequency of TMJ sounds between male and

Table 5 – Distribution of study sample by type of TMDs clinical examination symptoms.

	NT		TP		TS		TD		PS	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Male (1766)	1092	61.8% (59.6%, 64.1%)	50	2.8% (2.1%, 3.6%)	516	29.2% (27.1%, 31.3%)	27	1.5% (1.0%, 2.1%)	81	4.6% (3.6%, 5/6%)
Female (1124)	686	61.0% (58.2%, 63.9%)	50	4.4% (3.2%,5.7%)	285	25.4% (22.8%, 27.9%)	49	4.4% (3.2%, 5.6%)	54	4.8% (3.6%, 6.1%)
Total (2890)	1778	61.5% (59.8%, 63.3%)	100	3.5% (2.8%, 4.1%)	801	27.7% (26.1%, 29.4%)	76	2.6% (2.0%, 3.2%)	135	4.7% (3.9%, 5.4%)
P[†]		.665		.024*		.108		**<.001****		.787

Bold values represent statistically significant results ($P < 0.05$).

* Statistical significance at $P < .05$

** Significant at $P < .001$.

† Comparing the differences in Male and Female. Results of chi-square test ($P < .05$).

Table 6 – Mean/median JLFS scores based on type of TMDs clinical examination symptoms.

			NT	TP	TS	TD	PS	P†
Mastication limitation	Total	Mean ± SD	0.39 ± 1.54	1.14 ± 2.41	0.38 ± 1.34	0.97 ± 2.29	1.71 ± 3.49	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-1.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-2.00)	TS, TP, PS, TD > NT PS > TS
	Female	Mean ± SD	0.47 ± 1.58	1.14 ± 2.50	0.49 ± 1.49	1.06 ± 2.55	1.81 ± 3.50	**<.001*****
	Male	Mean ± SD	0.34 ± 1.51	1.14 ± 2.34	0.32 ± 1.24	0.81 ± 1.75	1.64 ± 3.50	**<.001*****
		P‡	.005**	.711	.023*	.958	.593	
Mobility limitation	Total	Mean ± SD	0.23 ± 1.07	0.83 ± 2.00	0.43 ± 1.49	0.74 ± 2.44	1.37 ± 3.16	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-1.00)	TS, TP, PS, TD > NT PS > TS
	Female	Mean ± SD	0.24 ± 1.01	0.86 ± 2.24	0.41 ± 1.53	0.90 ± 2.88	1.83 ± 3.72	**<.001*****
	Male	Mean ± SD	0.22 ± 1.10	0.80 ± 1.74	0.44 ± 1.47	0.44 ± 1.31	1.06 ± 2.70	**<.001*****
		P‡	.246	.699	.694	.831	.214	
Communication limitation	Total	Mean ± SD	0.05 ± 0.47	0.19 ± 1.15	0.03 ± 0.30	0.11 ± 0.56	0.24 ± 1.53	.381
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	0.00 (0.00-0.00)	
	Female	Mean ± SD	0.05 ± 0.37	0.32 ± 1.60	0.02 ± 0.24	0.04 ± 0.29	0.39 ± 2.27	.66
	Male	Mean ± SD	0.05 ± 0,53	0.06 ± 0.31	0.04 ± 0.32	0.22 ± 0.85	0.14 ± 0.68	.102
		P‡	.469	.968	.161	.247	.768	
Global limitation	Total	Mean ± SD	0.67 ± 2.51	2.16 ± 4.24	0.84 ± 2.42	1.82 ± 4.70	3.32 ± 6.98	**<.001*****
		Median (IQR)	0.00 (0.00-0.00)	0.00 (0.00-3.00)	0.00 (0.00-0.00)	0.00 (0.00-1.00)	0.00 (0.00-4.00)	TS, TP,PS, TD > NT TP, PS > TS PS > TD
	Female	Mean ± SD	0.77 ± 2.34	2.32 ± 4.85	0.92 ± 2.75	2.00 ± 5.21	4.04 ± 8.42	**<.001*****
	Male	Mean ± SD	0.61 ± 2.60	2.00 ± 3.56	0.80 ± 2.22	1.48 ± 3.65	2.84 ± 5.82	**<.001*****
		P‡	.015*	.596	.384	.649	.158	

Bold values represent statistically significant results ($P < 0.05$).

* Statistical significance at $P < .05$.
** Significant at $P < .01$.
*** Significant at $P < .001$.
† Comparing the differences in NT, TS, TP, TD and PS. Results of Kruskal–Wallis/Mann–Whitney *U* test ($P < .05$).
‡ Comparing the differences in Male and Female. Results of Kruskal–Wallis/Mann–Whitney *U* test ($P < .05$).

female students in the clinical examination results of this study, possibly because girls were less likely to open their mouths to the maximum extent after hearing TMJ sounds; thus, the reported rate of TMJ sounds within 30 days was lower than that in boys. Senior high school is often described as a chaotic and vague period, which makes it difficult to compare males and females in general because of changes in adolescent development.

In a study of the Swedish general adult population, sex did not influence functional jaw limitations, with female participants reporting more limitations than male.[18] However, no studies have addressed the association between functional jaw limitations and sex in adolescents with TMDs. In our study, the JFLS scores in most comparisons did not show an association between sex and functional limitations. This finding is consistent with that of a study by List, which reported similar rates of limitations in activities of daily living for both sexes in children and adolescents with TMDs.[42] Regarding the mastication limitation of TS only, in both the symptom questionnaire and clinical examination, female adolescents showed increased limitations compared to male adolescents. This finding may also be associated with women with higher sensitivity, who pay more attention to the impact of TMJ sounds on themselves, which leads to mastication limitations.

Study strengths and limitations

The strengths of this study lie in the use of valid and reliable examination procedures to assess the participants, including both symptom questionnaires and clinical examinations, which were calibrated in line with recognized standards before study initiation. The findings of this study may contribute to the development of preventive care programs for adolescents with TMDs. In addition to these noteworthy findings, this study had some limitations. First, all participants were from a single senior high school; therefore, extended studies incorporating students from other senior high schools, with increased sample sizes, and studies that truly reflect the situation of TMDs among senior high school students are needed. Moreover, the results may be applicable only to the Chinese population. Before drawing unambiguous conclusions, further research in other racial and ethnic groups is required. Second, cross-sectional studies only collect data at one-time point, failing to capture the progression and changes of the disease. TMDs are a chronic condition, and its symptoms and severity may vary over time. Cross-sectional designs cannot capture this dynamic change, potentially leading to an incomplete understanding of the relationship between TMDs and jaw functional limitations. Furthermore, causality between the variables could not be

established. Future longitudinal studies are needed to confirm whether these factors are predictive factors for TMDs. Thirdly, some potential confounding factors were overlooked, affecting the accuracy of the study results. Fourthly, similar to all epidemiological health surveys, a memory bias is possible.

Implications and recommendations

The results of the study indicate that patients with TMDs exhibit significantly greater limitations in jaw function compared to non-TMD patients. This finding supports the hypothesis of a potential association between TMDs and restricted jaw function. It underscores the importance for clinicians to assess jaw function when diagnosing and treating TMDs, because jaw functional limitation may be one of the important clinical manifestations of TMDs. Early identification and intervention for jaw functional limitations can contribute to improving patients' quality of life. Given the limitations of cross-sectional design, future studies should employ multiple study designs (eg, case-control studies and cohort studies). Additionally, tracking changes over time in patients with TMDs can help to improve the reliability and validity of study results. Multi-perspective and multi-method studies can provide more comprehensive evidence and help us to gain a deeper understanding of the pathomechanisms of TMDs and its effects on jaw function. Future studies should consider collecting data on confounding factors such as socioeconomic status, family environment, and parental education level, so as to allow for adjustment using regression models, thereby more accurately assessing the association between TMDs and jaw functional limitation.

Conclusion

This study found that the most common TMD symptoms among high school students were TMJ sounds, followed by TMJ pain. Jaw functional limitations were affected by different numbers and types of TMDs symptoms. Individuals with more symptoms of TD generally showed more severe global, mastication, and mobility mandibular functional limitations, with almost no difference in the domain of communication. These elements are likely to have intricate associations and fluctuate with disease development. Thus, additional cohort studies are required to further explore these connections. These findings underscore the importance of giving adequate attention to initial TMDs symptoms. Early interventions could prevent the further development of TMDs and prevent it from developing into more severe cases. Moreover, female adolescents deserve special attention, as the results showed that this population may be more susceptible to developing a higher number of accompanying symptoms.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Availability of data and materials

The datasets analysed for the current study can be made available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki, and all methods were carried out in accordance with relevant guidelines and regulations. The study was approved by the Ethics Committee of Anhui Medical University (T2022017) and informed consent was obtained from the students and their parents or caregivers. We have suggested that students who reported symptoms related to TMDs seek further clinical assessment at specialized hospitals to confirm the diagnosis and evaluate the severity of symptoms.

Acknowledgments

The study was supported by the 'Fengyuan' cooperation project of Disciplinary Construction Project in School of Dentistry, Anhui Medical University (2021kqxkFY11) and Research Fund of Anhui Institute of Translational Medicine (2022zhyx-C85).

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.identj.2024.07.1206.

REFERENCES

1. Häggman-Henrikson B, M Visscher C, Wänman A, et al. Even mild catastrophic thinking is related to pain intensity in individuals with painful temporomandibular disorders. J Oral Rehabil 2021;48(11):1193–200. doi: 10.1111/joor.13251.
2. Ekici Ö, Dündar Ü, Gökay GD, et al. Evaluation of the efficiency of different treatment modalities in individuals with painful temporomandibular joint disc displacement with reduction: a randomised controlled clinical trial. Br J Oral Maxillofac Surg 2022;60(3):350–6. doi: 10.1016/j.bjoms.2021.08.001.
3. Lei J, Fu J, Yap AU, et al. Temporomandibular disorders symptoms in Asian adolescents and their association with sleep quality and psychological distress. Cranio 2016;34(4):242–9. doi: 10.1179/2151090315Y.0000000021.
4. Paulino MR, Moreira VG, Lemos GA, et al. Prevalence of signs and symptoms of temporomandibular disorders in college preparatory students: associations with emotional factors, parafunctional habits, and impact on quality of life. Prevalência de sinais e sintomas de disfunção temporomandibular em estudantes pré-vestibulandos: associação de fatores emocionais, hábitos parafuncionais e impacto na qualidade de vida. Cien Saude Colet 2018;23(1):173–86. doi: 10.1590/1413-81232018231.18952015.
5. de Melo Júnior PC, Aroucha JMCNL, Arnaud M, et al. Prevalence of TMD and level of chronic pain in a group of Brazilian adolescents. PLoS One 2019;14(2):e0205874. doi: 10.1371/journal.pone.0205874.

6. Homeida L, Felemban E, Kassar W, et al. Temporomandibular joints disorders (TMDs) prevalence and their relation to anxiety in dental students. F1000Res 2022;11:271. doi: 10.12688/f1000research.76178.2.
7. Christidis N, Lindström Ndanshau E, Sandberg A, et al. Prevalence and treatment strategies regarding temporomandibular disorders in children and adolescents—a systematic review. J Oral Rehabil 2019;46(3):291–301. doi: 10.1111/joor.12759.
8. Toscano P, Defabianis P. Clinical evaluation of temporomandibular disorders in children and adolescents: a review of the literature. Eur J Paediatr Dent 2009;10(4):188–92.
9. Lövgren A, Österlund C, Ilgunas A, et al. A high prevalence of TMD is related to somatic awareness and pain intensity among healthy dental students. Acta Odontol Scand 2018;76(6):387–93. doi: 10.1080/00016357.2018.1440322.
10. Ottria L, Candotto V, Guzzo F, et al. Temporomandibular joint and related structures: anatomical and Histological aspects. J Biol Regul Homeost Agents 2018;32(2 Suppl. 1):203–7.
11. Xu L, Cai B, Fan S, et al. Association of oral behaviors with anxiety, depression, and jaw function in patients with temporomandibular disorders in China: a cross-sectional study. Med Sci Monit 2021;27:e929985. doi: 10.12659/MSM.929985.
12. Song YL, Yap AU. Impact of pain-related temporomandibular disorders on jaw functional limitation, psychological distress and quality of life in postoperative class III East Asian patients. Clin Oral Investig 2020;24(2):953–61. doi: 10.1007/s00784-019-02994-x.
13. Fetai A, Dedic B, Lajnert V, et al. To what extent are the characteristics of painful temporomandibular disorders predictors of self-reported limitations in jaw function? Cranio 2023;41(4):290–7. doi: 10.1080/08869634.2020.1853309.
14. Ohrbach R, Fillingim RB, Mulkey F, et al. Clinical findings and pain symptoms as potential risk factors for chronic TMD: descriptive data and empirically identified domains from the OPPERA case-control study. J Pain 2011;12(11 Suppl):T27–45. doi: 10.1016/j.jpain.2011.09.001.
15. Kuć J, Szarejko KD, Gołębiewska M. Smiling, yawning, jaw functional limitations and oral behaviors with respect to general health status in patients with temporomandibular disorder-myofascial pain with referral. Front Neurol 2021;12:646293. doi: 10.3389/fneur.2021.646293.
16. Fernandes G, van Selms MK, Gonçalves DA, et al. Factors associated with temporomandibular disorders pain in adolescents. J Oral Rehabil 2015;42(2):113–9. doi: 10.1111/joor.12238.
17. Minervini G, Franco R, Marrapodi MM, et al. Prevalence of temporomandibular disorders in children and adolescents evaluated with diagnostic criteria for temporomandibular disorders: a systematic review with meta-analysis. J Oral Rehabil 2023;50(6):522–30. doi: 10.1111/joor.13446.
18. Oghli I, List T, John MT, et al. Prevalence and normative values for jaw functional limitations in the general population in Sweden. Oral Dis 2019;25(2):580–7. doi: 10.1111/odi.13004.
19. Yap AU, Kim S, Lee BM, et al. Correlates of jaw functional limitation, somatization and psychological distress among different temporomandibular disorder diagnostic subtypes. J Oral Rehabil 2024 Feb;51(2):287–95. doi: 10.1111/joor.13606.
20. Srivastava KC, Shrivastava D, Khan ZA, et al. Evaluation of temporomandibular disorders among dental students of Saudi Arabia using diagnostic criteria for temporomandibular disorders (DC/TMD): a cross-sectional study. BMC Oral Health 2021;21(1):211. doi: 10.1186/s12903-021-01578-0.
21. Rauch A, Schierz O, Körner A, et al. Prevalence of anamnestic symptoms and clinical signs of temporomandibular disorders in adolescents—results of the epidemiologic LIFE child study. J Oral Rehabil 2020;47(4):425–31. doi: 10.1111/joor.12926.
22. Yap AU, Cao Y, Zhang MJ, et al. Comparison of emotional disturbance, sleep, and life quality in adult patients with painful temporomandibular disorders of different origins. Clin Oral Investig 2021;25(6):4097–105. doi: 10.1007/s00784-020-03740-4.
23. Yap AU, Zhang XH, Cao Y, et al. Functional, physical and psychosocial impact of degenerative temporomandibular joint disease. J Oral Rehabil 2022;49(3):301–8. doi: 10.1111/joor.13288.
24. Cao Y, Yap AU, Lei J, et al. Subtypes of acute and chronic temporomandibular disorders: their relation to psychological and sleep impairments. Oral Dis 2021 Sep;27(6):1498–506. doi: 10.1111/odi.13692.
25. Schiffman E, Ohrbach R, Truelove E, et al. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network* and Orofacial Pain Special Interest Group†. J Oral Facial Pain Headache 2014;28(1):6–27. doi: 10.11607/jop.1151.
26. Xu L, He Y, Fan S, et al. Validation of a Chinese version of the jaw functional limitation scale in relation to the diagnostic subgroup of temporomandibular disorders. J Oral Rehabil 2020;47(1):1–8. doi: 10.1111/joor.12868.
27. Kurita H, Ohtsuka A, Kurashina K, et al. Chewing ability as a parameter for evaluating the disability of patients with temporomandibular disorders. J Oral Rehabil 2001;28(5):463–5. doi: 10.1046/j.1365-2842.2001.00688.x.
28. Haketa T, Kino K, Sugisaki M, et al. Difficulty of food intake in patients with temporomandibular disorders. Int J Prosthodont 2006;19(3):266–70.
29. Conti PC, Costa YM, Gonçalves DA, et al. Headaches and myofascial temporomandibular disorders: overlapping entities, separate managements? J Oral Rehabil 2016;43(9):702–15. doi: 10.1111/joor.12410.
30. Almudhi A, Zafar H. Self-reported musculoskeletal pain, headache, jaw pain and swallowing dysfunction in a sample of young Saudi adults who stutter. J Pak Med Assoc 2024;74(1):32–7. doi: 10.47391/JPMA.7264.
31. Dan R, Li J, Xie T, et al. Impact of different types of temporomandibular disorders on jaw functional limitation and psychological distress in orthodontic patients. J Oral Rehabil 2023;50(8):644–54. doi: 10.1111/joor.13463.
32. Yap AU, Cao Y, Zhang MJ, et al. Number and type of temporomandibular disorder symptoms: their associations with psychological distress and oral health-related quality of life. Oral Surg Oral Med Oral Pathol Oral Radiol 2021;132(3):288–96. doi: 10.1016/j.oooo.2021.04.059.
33. Nguyen MS, Reemann P, Loorits D, et al. Association of temporomandibular joint osseous changes with anxiety, depression, and limitation of mandibular function in elderly Vietnamese. East Asian Arch Psychiatry 2019;29(1):20–5.
34. Chen L, Zhang S, Tan Y, et al. Anxiety mediates association between sex and jaw function limitation in temporomandibular disorder patients from China. Front Neurol 2024;15:1398788.
35. Kim KH, Park JE, Kim ME, et al. Risk factors of the masticatory function in patients with temporomandibular disorders: a cross-sectional cohort study. J Oral Med Pain 2019;44(3):92–102.
36. Powers SW, Gilman DK, Hershey AD. Headache and psychological functioning in children and adolescents. Headache 2006;46(9):1404–15. doi: 10.1111/j.1526-4610.2006.00583.x.
37. Tonin RH, Iwaki Filho L, Grossmann E, et al. Correlation between age, gender, and the number of diagnoses of temporomandibular disorders through magnetic resonance imaging: a retrospective observational study. Cranio 2020;38(1):34–42. doi: 10.1080/08869634.2018.1476078.
38. Hirsch C, Hoffmann J, Türp JC. Are temporomandibular disorder symptoms and diagnoses associated with pubertal development in adolescents? An epidemiological study. J Orofac Orthop 2012;73(1):6–18. doi: 10.1007/s00056-011-0056-x.
39. Pereira LJ, Pereira-Cenci T, Del Bel Cury AA, et al. Risk indicators of temporomandibular disorder incidences in early adolescence. Pediatr Dent 2010;32(4):324–8.

40. Lim PF, Maixner W, Khan AA. Temporomandibular disorder and comorbid pain conditions. J Am Dent Assoc 2011;142 (12):1365–7. doi: 10.14219/jada.archive.2011.0137.
41. Østensjø V, Moen K, Storesund T, et al. Prevalence of painful temporomandibular disorders and correlation to lifestyle factors among adolescents in Norway. Pain Res Manag 2017;2017:2164825. doi: 10.1155/2017/2164825.
42. List T, Wahlund K, Wenneberg B, et al. TMD in children and adolescents: prevalence of pain, gender differences, and perceived treatment need. J Orofac Pain 1999;13(1):9–20.