Original Article

Temporomandibular disorders in prospective orthodontic patients: *Their association with malocclusion severity and impact on oral health–related quality of life*

Adrian Ujin Yap[a]; Christine Chen[b]; Hung Chew Wong[c]; Mimi Yow[d]; Elaine Tan[e]

ABSTRACT

Objectives: To determine the prevalence and severity of temporomandibular disorders (TMDs) in prospective orthodontic patients. The association between TMDs and malocclusion severity as well as the impact of TMDs on oral health–related quality of life (OHRQoL) were also examined.

Materials and Methods: A total of 350 consecutive patients seeking orthodontic treatment were invited to participate in the study. The presence of TMDs was established with the Fonseca Anamnestic Index (FAI), while malocclusion severity and OHRQoL were evaluated using the Peer Assessment Rating (PAR) index and Oral Health Impact Profile–14 (OHIP-14), respectively. Data were analyzed using chi-square, Kruskal-Wallis, and Mann-Whitney *U* tests and Spearman's correlation ($P < .05$).

Results: Of the 350 patients, 164 consented to participation. Data from 26 participants were excluded because of incomplete entries, and that from 138 subjects (mean age 21.02 $\pm$ 5.45 years) were examined. TMD-related symptoms were present in two-thirds of the subjects, with 20.3% experiencing moderate/severe TMDs. While no significant difference in PAR scores were observed between the group with no TMDs and those with TMDs, subjects with TMDs had significantly higher OHIP-14 summary/domain scores than those without TMDs. Although a moderately strong correlation was observed between the FAI and summary OHIP-14 scores ($r_s = 0.57$), no association was observed between FAI and PAR index scores.

Conclusions: The prevalence of TMD-related symptoms in prospective orthodontic patients was high, emphasizing the importance of screening the masticatory system before initiating orthodontic therapy. Although the presence of TMDs was not associated with malocclusion severity, it had a significant negative impact on OHRQoL. (*Angle Orthod.* 2021;91:377–383.)

KEY WORDS: Temporomandibular disorders; Orthodontics; Malocclusion; Oral health; Quality of life

INTRODUCTION

Severe malocclusion can have a profound impact on the physical, functional, and psychosocial well-being of individuals, resulting in poorer oral health–related quality of life (OHRQoL).[1] OHRQoL is defined as the "multi-dimensional construct that reflects people's comfort when eating, sleeping and engaging in social interaction; their self-esteem and satisfaction with respect to their oral health."[2] Temporomandibular disorders (TMDs) encompass a diverse group of musculoskeletal and neuromuscular conditions that

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affect the masticatory muscles, temporomandibular joints (TMJs), and/or contiguous structures. TMD signs/symptoms can be pain or function related. Although TMDs affect about 15% of adults, typically women aged between 20 and 40 years,[3] their prevalence may be higher during adolescence and ranges from 7% to 30%.[4] TMDs were reported to impair OHRQoL more than other oral conditions.[5] They have been linked to certain occlusal traits, including posterior crossbite, anterior open bite, and extreme maxillary overjet.[6] Some of these malocclusions may actually be the result rather than the cause of TMDs.

With the elevated occurrence of TMDs during adolescence and continued growth in adult orthodontics, most dentists will come across prospective orthodontic patients with preexisting TMDs. The failure to screen and assess for TMDs prior to commencing orthodontic therapy may result in treatment and medicolegal complications. Limited number of recent studies investigating the prevalence of TMDs in pre-orthodontic patients, none of which were conducted on Southeast Asian populations, have indicated a prevalence ranging from 15% to 40%.[7,8]

The objectives of this study were thus to determine the prevalence and severity of TMDs in Southeast Asian patients seeking orthodontic treatment. It also examined the association between TMDs and malocclusion severity as well as the impact of TMDs on OHRQoL. The interrelationships among TMDs, severity of malocclusion, and OHRQoL were also explored. The null hypotheses were (1) the prevalence of TMDs in prospective orthodontic patients is low, (2) the presence of TMDs is not associated with the severity of malocclusion and does not affect OHRQoL, and (3) TMDs, malocclusion, and OHRQoL are not interrelated.

MATERIALS AND METHODS

This study was approved by the SingHealth Centralized Institutional Review Board (RC2017/2783). A total of 350 consecutive first-time patients, aged 15 to 40 years, who presented at the orthodontic clinic of a national dental center were invited to participate. Based on a 95% confidence level, 5% margin of error for confidence interval, target population of 350 first-time orthodontic patients, and a 15% prevalence of TMDs,[8] a minimum sample size of 126 subjects was confirmed with a sample size calculator (https://www.calculator.net/sample-size-calculator.html). Informed consent was obtained from all subjects or their legal guardians (if $<$18 years of age). Subject exclusion criteria included (1) craniofacial syndromes, (2) clinically significant active oral diseases (irreversible pulpitis, advanced periodontitis, etc), (3) prior orthodontic treatment, (4) prior TMD therapy, (5) complex psychiatric disorders, and (6) inability to understand the questionnaires independently. The presence/severity of TMDs, severity of malocclusion, and OHRQoL were assessed using the Fonseca Anamnestic Index (FAI), Peer Assessment Rating (PAR) index, and Oral Health Impact Profile-14 (OHIP-14), respectively.

A self-administered survey comprising demographic information, the FAI, and the OHIP-14 was dispensed at the initial visit. Study models were then obtained, digitized, and analyzed with the 3Shape Ortho Analyzer (3Shape, Copenhagen, Denmark) to establish the subject's PAR index scores, which were subsequently matched to the subject's FAI and OHIP-14 data.

The FAI comprised 10 questions concerning pain (TMJ, masticatory muscle, neck pain, and headache) and function-related (TMJ sounds, opening and jaw movement difficulties) TMD symptoms as well as risk factors (teeth clenching, perception of malocclusion [poor bite], and emotional stress).[9] The items were scored on a 3-point response scale with no $=$ 0 points, sometimes $=$ 5 points, and yes $=$ 10 points. Total scores for all 10 items were calculated, and subjects were allocated afterward into the "no TMDs" (NT; total scores $\leq$15 points) and "with TMDs" (WT; total scores $\geq$20 points) groups. The WT group was further categorized into "mild" (20 to 40 points), "moderate" (45 to 65 points), and "severe" (70 to 100 points) TMD.

The OHIP-14 consisted of 14 items divided into seven conceptual domains, namely, functional limitation, physical pain, psychological discomfort, psychological disability, physical disability, social disability, and handicap.[10] Each domain was assessed by two items that were scored on a 5-point Likert-type scale. Total scores for all 14 items were computed to obtain the summary OHIP-14 score, with higher values indicating greater impairment to quality of life. The PAR index provided a summary score for all occlusal anomalies that may be present in a malocclusion.[11] A zero score represented good alignment and occlusion, and higher scores signified increased levels of irregularity/severity of malocclusion. PAR assessment was performed by a single trained and calibrated examiner with a mean interrater error of 0.35 PAR points between readings.

Statistical Analysis

Statistical analysis was carried out with the Statistical Package for Social Sciences version 25 (IBM Corporation, Armonk, NY), with the significance level set at .05. Because the FAI, PAR index, and OHIP-14 scores were not normally distributed (Shapiro-Wilk test), Kruskal-Wallis and Mann-Whitney *U* tests were used to compare median PAR index and OHIP-14

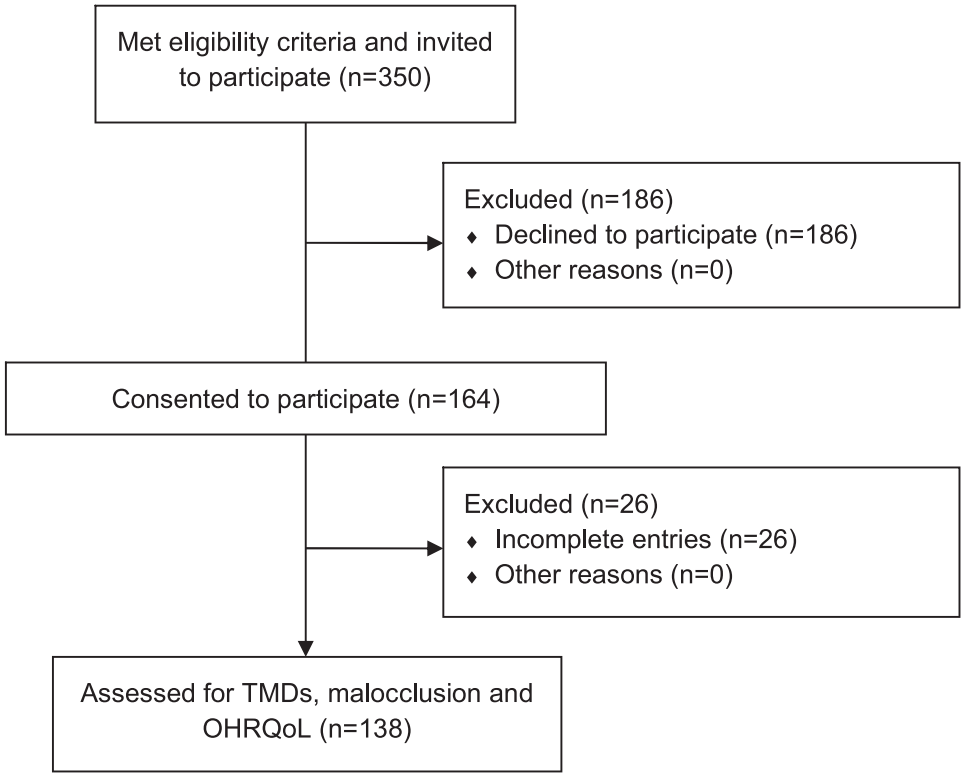

Figure 1. Flow diagram detailing the enrollment of subjects.

scores. In addition, disparity in sex and age distributions was examined using the chi-square test, while correlations between FAI, PAR index, and OHIP-14 scores were ascertained using Spearman's rho correlation (r_s).

RESULTS

Of the 350 consecutive patients, 164 consented to participate, resulting in a response rate of 46.86%. Of these, 26 questionnaires were excluded because of incomplete entries. Data from a total of 138 subjects were subsequently compiled and examined (Figure 1). The subjects were composed of 60 (43.48%) males and 78 (56.52%) females, with a mean age of 21.02 $\pm$ 5.45 years. Of the patients, 47.83% were adolescents (aged 15 to 19 years) whereas the remaining 52.17% were adults (aged 20 to 40 years). Table 1 shows the sex and age group distributions between subjects in the NT and WT groups.

TMD-related symptoms were present in 66.67% of the subjects, with 20.3% (28/138) having moderate to severe TMDs (Table 1). Figure 2 shows the prevalence of the various TMD-related symptoms and risk factors. The frequency ranking of the various pain-related symptoms was neck pain (63.00%) $>$ headaches (51.10%) $>$ TMJ pain (50.00%) $>$ jaw muscle pain (43.50%). The ranking for function-related symptoms was TMJ sounds (62%) $>$ opening difficulty (34.80%) $>$ jaw movement difficulty (18.50%). The occurrence of TMD risk factors was poor occlusion (93.50%) $>$ emotional stress (65.20%) $>$ teeth clenching (51.10%).

The mean/median PAR index and summary OHIP-14 scores are presented in Table 2. No significant difference in median PAR index scores was observed between the NT and WT groups or between subjects

Table 1. Demographics of Participants[a]

Demographics	No TMDs (n = 46)	With TMDs (n = 92)	Mild TMDs (n = 64)	Moderate TMDs (n = 21)	Severe TMDs (n = 7)
Sex (%)					
Male	20 (33.3)	40 (66.7)	28 (46.7)	9 (15.0)	3 (5.0)
Female	26 (33.3)	52 (66.7)	36 (46.2)	12 (15.4)	4 (5.1)
Age, y (%)					
15–19	23 (34.8)	43 (65.2)	28 (42.4)	10 (15.2)	5 (7.6)
20–40	23 (31.9)	49 (68.1)	36 (50.0)	11 (15.3)	2 (2.8)

[a] Chi-square test revealed no significant difference in sex or age distribution. TMD indicates temporomandibular disorder.

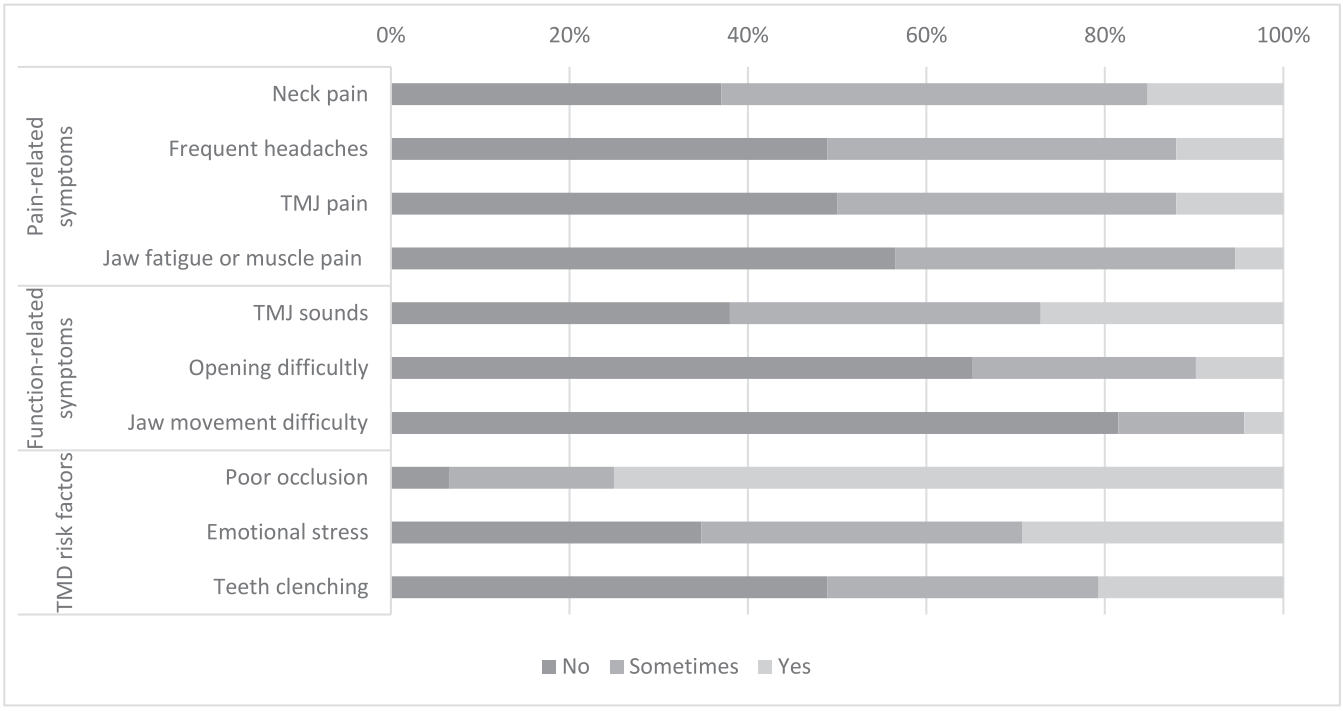

Figure 2. Frequency of the various pain-related symptoms (neck pain, frequent headaches, temporomandibular joints [TMJs], pain, jaw fatigue or muscle pain), function-related symptoms (TMJ sounds, opening difficulty, jaw movement difficulty), and temporomandibular disorder risk factors (poor occlusion, emotional stress, teeth clenching) based on the Fonseca Anamnestic Index questionnaire.

with varying severity of TMDs. However, the WT group exhibited significantly higher summary OHIP-14 scores than the NT group did ($P < .001$). In addition, post hoc comparisons using the Mann-Whitney *U* test showed that subjects with moderate and severe TMDs had significantly greater summary OHIP-14 scores than those with mild TMDs ($P < .001$ and $P = .036$, respectively). The difference in median summary OHIP-14 scores between those with moderate and severe TMDs was not statistically significant ($P = 1.00$).

Table 2. Mean and Median PAR Index and Summary OHIP-14 Scores[a]

TMD Severity	PAR Index Score	*P* Value	Summary OHIP-14 Score	*P* Value
No TMDs				
Mean ± SD	33.91 ± 12.75	.602	7.59 ± 6.01	<.001*
Median (IQR)	33 (20.75)		6 (9.25)	
With TMDs				
Mean ± SD	34.98 ± 13.09		16.33 ± 10.02	
Median (IQR)	36 (20.00)		15 (14.00)	
Mild TMDs				
Mean ± SD	33.88 ± 13.04	.390	12.77 ± 7.09	<.001*
Median (IQR)	33 (20.25)		12 (10.00)	
Moderate TMDs				
Mean ± SD	37.57 ±14.32		25.38 ± 11.62	
Median (IQR)	44 (21.50)		28 (17.00)	
Severe TMDs				
Mean ± SD	37.29 ± 9.23		21.71 ± 9.41	
Median (IQR)	38 (19.00)		21 (16.00)	

[a] IQR indicates interquartile range; OHIP-14; Oral Health Impact Profile–14; PAR, Peer Assessment Rating; SD, standard deviation; TMD, temporomandibular disorder.

* Statistically significant differences in scores ($P < .05$).

Table 3 displays the mean/median OHIP-14 domain scores for the subjects without and with TMDs. Significant differences in the median OHIP-14 domain scores were observed for all seven areas ($P \leq .001$), with psychological discomfort, psychological disability, and physical pain exhibiting the highest scores. The correlations between FAI, PAR index, and summary OHIP-14 scores are shown in Table 4. The correlation between the FAI and summary OHIP-14 score was moderately strong ($r_s = 0.57$), while that between the PAR index and summary OHIP-14 was weak ($r_s = 0.28$). No association was noted between FAI and PAR index scores.

DISCUSSION

Although similar studies have been conducted with other populations,[7] this is the first such study to be conducted on Southeast Asian subjects. As TMD-related symptoms were present in a large proportion (66.67%) of the prospective orthodontic patients, the first null hypothesis was duly rejected. Although TMDs were not associated with malocclusion severity, they negatively affected OHRQoL. While FAI and PAR index scores were related to OHIP-14 scores, no correlation was observed between FAI and PAR index

Table 3. Mean and Median OHIP-14 Domain Scores for Subjects Without and With TMDs[a]

OHIP-14 Domain (Score Range)	No TMDs (n = 46)	With TMDs (n = 92)	*P* Value
Functional limitation (0–8)			
Mean ± SD	0.52 ± 0.89	1.40 ± 1.63	.001*
Median (IQR)	0 (1.00)	1 (2.00)	
Physical pain (0–8)			
Mean ± SD	1.5 ± 1.36	2.84 ± 1.77	<.001*
Median (IQR)	1 (2.25)	3 (2.75)	
Psychological discomfort (0–8)			
Mean ± SD	2.15 ± 1.81	4.09 ± 1.99	<.001*
Median (IQR)	2 (2.00)	4 (2.75)	
Physical disability (0–8)			
Mean ± SD	0.46 ± 0.84	1.29 ± 1.54	<.001*
Median (IQR)	0 (1.00)	1 (2.00)	
Psychological disability (0–8)			
Mean ± SD	1.59 ± 1.33	3.37 ± 2.08	<.001*
Median (IQR)	1 (1.53)	3 (3.00)	
Social disability (0–8)			
Mean ± SD	0.61 ± 1.02	1.72 ± 2.00	<.001*
Median (IQR)	0 (1.00)	1 (3.00)	
Handicap (0–8)			
Mean ± SD	0.76 ± 0.84	1.61 ± 1.52	.001*
Median (IQR)	1 (1.00)	1 (2.00)	
Summary OHIP-14 (0–56)			
Mean ± SD	7.59 ± 6.00	16.33 ± 10.02	.000*
Median (IQR)	6 (9.25)	15 (14.00)	

[a] IQR indicates interquartile range; OHIP-14; Oral Health Impact Profile–14; SD, standard deviation; TMD, temporomandibular disorder.
* Statistically significant differences in scores ($P < .05$).

measures. When considering these results, the second and third null hypotheses could not be entirely discarded.

The FAI was selected as it has been shown to be consistent with other instruments for screening/diagnosing TMDs, including the Helkimo index and American Academy of Orofacial Pain questionnaire.[12] In addition, it was used in a recent related study involving South Asian subjects.[8] The reliability of the FAI is well established, and it has been validated against both the Research Diagnostic Criteria as well as the Diagnostic Criteria for TMDs (DC-TMD).[13,14] Because of its relative simplicity and efficiency, the FAI had been widely employed in both clinical and community-based TMDs studies.[8,9,13] In addition, it provided an indication of TMDs severity with less examiner effect and measurement variability.[9]

TMD Prevalence and Severity

Two-thirds of the prospective orthodontic patients experienced TMD-related symptoms, and one-fifth (20.3%) had moderate to severe TMDs. This prevalence rate was much higher than that reported for South Asian orthodontic patients (22.56%)[8] as well as for Southeast Asian youths (41.80%).[15] In a recent systematic review, pain- and function-related TMD symptoms were found to be present in up to 65.70% and 40.80% of patients seeking orthodontic therapy, respectively.[7] Although the frequency of pain-related TMD symptoms was similar, that for function-related symptoms was substantially higher in the present study and ranged from 18.50% (jaw movement difficulty) to 62.00% (TMJ sounds). The incidence of emotional stress (65.20%) and teeth clenching (51.10%), which are recognized TMD risk factors, was also high.[16] Given the elevated prevalence of TMD-related symptoms and risk factors, it is prudent that all prospective orthodontic patients be assessed for TMDs before starting any orthodontic therapy.

Table 4. Correlations Among FAI, PAR Index, and Summary OHIP-14 Scores[a]

Score	FAI	PAR	Summary OHIP-14
FAI		0.09	0.57*
PAR	0.09		0.28*
Summary OHIP-14	0.57*	0.28*	

[a] FAI, Fonseca Anamnestic Index; PAR, Peer Assessment Rating; OHIP-14; Oral Health Impact Profile–14.
* Statistically significant correlations ($P < .05$).

TMDs and Severity of Malocclusion

The relationship between TMDs and malocclusion has been frequently debated. Manfredini et al.[17] and Gesch et al.[18] performed two separate systematic reviews on the association between TMDs and dental occlusion and determined that there was no clinically relevant link between the two. However, the number of studies exploring the connection between TMDs and severity of malocclusion is still limited. The PAR index was selected over the Index of Orthodontic Treatment Need as it has been employed in similar, previous TMD research. In a study spanning more than 30 years, Mohlin et al.[19] found PAR index scores to be significantly higher only in subjects with very severe TMDs. In the present study, PAR index scores between the NT and WT groups as well as in subjects with mild to severe TMDs were observed to be statistically nonsignificant. This, in addition to the lack of any correlation between FAI and PAR index scores, this lends further support to the notion that TMDs are not associated with the severity of malocclusion.

TMDs and OHRQoL

The OHIP-14 is a well-established instrument for evaluating the impact of TMDs on OHRQoL.[5] In this study, the WT group had significantly higher summary OHIP-14 scores (ie, poorer quality of life) than the NT group did. In addition, subjects with moderate and severe TMDs had significantly higher scores than those with mild TMDs. Our findings supported those of

previous work, which found that the negative effect on OHRQoL was more marked in patients with more TMD signs/symptoms.[5] The results were also consistent with those of a community study on Southeast Asian youths using the FAI and OHIP-TMDs (a TMDs-specific measure) that showed significant differences in OHIP domain scores across varying TMD severity.[15] This was further validated by the significant and moderately strong correlation between FAI and summary OHIP-14 scores ($r_s = 0.57$). Patients with more TMD-related symptoms were thus found to have more impaired OHRQoL.

Although all seven OHIP domain scores were significantly different between the WT and NT groups, the highest scores were observed for psychological discomfort, psychological disability, and physical pain. The higher scores for psychological discomfort and disability were anticipated considering the association between TMDs and psychological distress, including depression, anxiety, and stress in both Southeast Asian community and patient samples.[15,20] The higher domain scores for physical pain were also conceivable, especially because orofacial pain and functional discomfort are cardinal signs of TMDs.[3]

Interrelationships Between TMDs, Malocclusion Severity, and OHRQoL

Although no association existed between FAI and PAR index scores, the correlation between FAI and OHIP-14 scores was moderately strong ($r_s = 0.57$). The correlation between PAR and OHIP-14 scores, although significant, was weak ($r_s = 0.28$). This observation was consistent with that of Silvola et al.,[21] who reported that PAR index and OHIP-14 scores were correlated only after orthodontic treatment and not before. However, Rusanen et al.[22] found that the association between malocclusion severity (PAR index) and OHRQoL (OHIP-14) may be gender dependent and concluded that patients with severe malocclusion and TMDs frequently had impaired OHRQoL. Based on the relative correlation coefficients, the presence of TMDs appeared to affect OHRQoL more than the severity of malocclusion in patients seeking orthodontic treatment. This may have implications for other research pertaining to malocclusion and OHRQoL. Although several studies have investigated this matter and concluded that more severe malocclusion was linked to poorer physical and psychosocial aspects of OHRQoL,[1] most had not examined TMDs as a possible confounding or explanatory variable. Going forward, it is prudent that the presence of TMDs be considered when designing such studies.

Study Limitations

The present study and the instruments selected had several limitations. First, subject refusal to participate is a specific problem concerning cross-sectional studies and might lead to bias in outcome measures. Although this may well have contributed to the high frequency of TMD-related symptoms observed, the correspondingly high prevalence of TMDs in other related studies does lend support to the current work.[7] Second, the presence of TMDs was established using a self-reported anamnestic index and did not involve clinical examination, diagnostic imaging, or TMD diagnostic subtypes. The latter is best accomplished with internationally accepted criteria such as the DC-TMD.[23] This can offer insights into the occurrence of different TMD subtypes (eg, TMJ or masticatory muscle disorders) and their impact on OHRQoL in orthodontic patients. Lastly, the OHIP-14 used was a generic and not a condition-specific OHRQoL measure. Although OHIP-14 may be less sensitive for identifying and measuring TMD-related variations, it allowed for comparison of results across different oral conditions, including malocclusion.

CONCLUSIONS

- The prevalence of TMD-related symptoms in prospective Southeast Asian orthodontic patients was found to be high (66.67%), with about 20% experiencing moderate to severe TMDs. The frequency of pain-related TMD symptoms was generally greater than that for function-related TMD symptoms, with the exception of TMJ sounds.
- Although the presence of TMDs was not associated with the severity of malocclusion, it significantly affected OHRQoL. Subjects with more severe TMDs exhibited significantly lower quality of life. TMDs appeared to influence OHRQoL more than the severity of malocclusion. Collectively, the results underscore the importance of TMDs assessment when determining the effect of malocclusion on OHRQoL and TMDs screening prior to starting orthodontic treatment.

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