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Rasch validation of the oral health impact profile for temporomandibular disorders

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Abstract

Objectives: This study examined the metric properties of the Oral Health Impact Profile for Temporomandibular Disorders (OHIP-TMD) using Factor/Rasch analyses and created a short-form version of the measure.

Subjects and Methods: Aggregated OHIP-TMD data were obtained from a cross-sectional study involving 844 TMD patients with diagnostic criteria for TMDs defined conditions. The dimensionality of the OHIP-TMD was first evaluated with exploratory factor analysis. An eigenvalue >1.0 and oblique oblimin rotation were applied for extracting the factors. Rasch analysis was subsequently performed on the primary dimension using the ConQuest software.

Results: Multi-dimensionality of the OHIP-TMD was observed with the primary dimension comprising ten items. Adequate fit to the Rasch model was noted after deleting item 8 with infit/outfit mean-square values ranging from 0.75 to 1.40 logits. Item difficulty ranged from −0.75 to 1.05 logits, while participants' ability to respond varied from −4.55 to 5.19 logits. The respondent spread was slightly skewed and satisfactory item-response targeting was present.

Conclusions: The 22-item OHIP-TMD demonstrated multi-dimensionality with the primary dimension consisting of nine reliable items with adequate fit to the Rasch model. The 9-item short-form version of the OHIP-TMD (SOHIP-TMD) is a promising tool for evaluating OHRQoL.

KEYWORDS
oral health, quality of life, temporomandibular disorders

1 | INTRODUCTION

Patients' perspective, especially oral health-related quality of life (OHRQoL), has become increasingly important in dental clinical practice, research, and health policy development (Rozier & Pahel, 2008). OHRQoL involves the subjective assessment of an individual's oral health, physical and psychosocial well-being, care satisfaction, and self-esteem (Sischo & Broder, 2011). OHRQoL measures are useful for establishing/monitoring the biopsychosocial impacts of oral conditions on patients' lives and outcomes of health/treatment interventions. Additionally, they can facilitate discussion on the severity/type of problems encountered and treatment priorities (Allen, 2003;

Rozier & Pahel, 2008; Sischo & Broder, 2011). While social indicators and global self-ratings had been used to evaluate OHRQoL, multiple-item surveys are the most popular (Bennadi & Reddy, 2013). A summary of the common multiple-item OHRQoL instruments including the Oral Health Impact Profile (OHIP), General Oral Health Assessment Index (GOHAI), and Oral Impacts on Daily Performance (OIDP) was provided in an earlier review (Allen, 2003).

Temporomandibular disorders (TMDs) are a diverse group of conditions involving pain and dysfunction of the Temporomandibular joints, masticatory musculature, and contiguous structures, affecting up to 15% of the general population (List & Jensen, 2017; Manfredini et al., 2011). Systematic reviews have confirmed the relationship between TMDs and lower OHRQoL and revealed that therapeutic TMD interventions improved the OHRQoL of patients (Bitiniene et al., 2018; Dahlström & Carlsson, 2010; Song & Yap, 2018). However, the cited studies were based largely on generic OHRQoL measures, particularly the OHIP, that may have higher "floor effects" or no impact as the items surveyed might not be relevant or prevalent (Allen, 2003; Sischo & Broder, 2011). Moreover, generic instruments are also anticipated to have lower sensitivity, specificity, and responsiveness than condition-specific ones as they were not created to draw on the symptoms or effects associated with TMDs (Allen, 2003; Sischo & Broder, 2011). To address this lack, Durham et al., developed the Oral Health Impact for TMDs (OHIP-TMD) that was derived from the 49-item original OHIP and qualitative research in patients with TMDs (Durham et al., 2011). The OHIP-TMD had been translated to the Chinese language, and its psychometric properties were established using the classical test theory (CTT) (He & Wang, 2015; Yule et al., 2015). However, the CTT has some inherent problems including the assumption that (a) all items contribute equally to the total score, (b) reliability once estimated remains constant for all levels of oral health, and (c) item and test property estimates depend on the sample investigated (Lozano Rojas et al., 2009; Wong et al., 2011).

The Rasch measurement theory (RMT) is a modern statistical technique for analyzing categorical data (Rasch, 1980). It is founded on the item-response theory (IRT) and has been used in the creation and psychometric evaluation of many QoL measures (Dabaghi et al., 2020; Tennant et al., 2004). The Rasch model maintains that the probability of someone endorsing an item is related to the item's difficulty and the person's ability (amount of latent construct), which are transformed into a common logarithmic continuum and expressed in logits. Subjects with greater ability have higher prospects of responding to the items correctly, and more difficult items should be appropriately answered by those with higher ability. Rasch analysis also offers information on fit statistics indicating how well discrete items describe the subject group and individual subjects fit the group (Da Rocha et al., 2013; Wright & Stone, 1979). Given the growing use of OHIP-TMD in clinical and non-clinical samples, (De Oliveira Chami et al., 2020; Theroux et al., 2019; Yap et al., 2021a) there is a need for comprehensive validation of its metric properties based on the performance of individual items instead of total scores as with the CTT.

For the aforesaid reasons, the objective of this study was to examine the metric properties of the OHIP-TMD, including dimensionality, model fit, degree of item difficulty, and ability to respond in TMD patients, using Factor and Rasch analyses. It also aimed to reduce the number of items of the OHIP-TMD to create a short-form version of the measure. The null hypotheses are that the OHIP-TMD is not multi-dimensional and items of its primary construct do not fit the Rasch model.

2 | SUBJECTS AND METHODS

2.1 | Study participants and TMD diagnoses

This work is part of a large on-going cross-sectional study on the associations between TMDs, psychological distress, sleep quality, and OHRQoL that received approval from the Biomedical Institution Review Committee of Peking University School of Stomatology (protocol number: PKUSSIRB-201732009). Participants were recruited from consecutive adult patients seeking care at the TMD and Orofacial Pain Centre of the Peking University Hospital of Stomatology. The sample size computation was described previously and was estimated to be $n = 770$ based on the Wilcoxon–Mann–Whitney model, 0.50 effect size, 0.05 alpha error probability, 95% power, and allocation ratio of 12 (Yap et al., 2021b). Participant inclusion criteria were (a) aged ≥18 years old and (b) the presence of at least one Axis I TMD diagnoses as defined by the Diagnostic Criteria for TMDs (DC/TMD) (Schiffman et al., 2014). The exclusion criteria were the presence of (a) major trauma and/or operations; (b) major psychiatric disorders and/or drug abuse; (c) major autoimmune and/or metabolic diseases; (d) non-TMD joint and/or muscle diseases; (e) recent consumption of central nervous system agents; and (f) cognitive impairments and/or illiteracy. Contribution to the study was strictly voluntary, and all eligible participants provided written informed consent. Demographic data and medical history were recorded and TMD symptoms were gathered with the DC/TMD Symptom Questionnaire (SQ). The SQ encompasses 14-items on facial pain, headaches, TMJ sounds, closed, as well as open locking, and provides the necessary history for rendering specific TMD diagnosis. A protocolized TMD examination was performed according to the DC/TMD specifications by a sole TMD specialist who was trained and calibrated in the DC/TMD procedures by the International Network for Orofacial Pain and Related Disorders Methodology (INfORM). Axis I TMD diagnoses were subsequently established based on the DC/TMD diagnostic algorithms and categorized into pain-related and intra-articular TMD conditions.

2.2 | OHIP-TMD

The participants were instructed to complete the Chinese language version of the OHIP-TMD that comprised of twenty-two items and seven domains: functional limitation (items 1–2); physical pain (items 3–7); psychological discomfort (items 8–11); physical disability (items 12 and 13); psychological disability (items 14–18); social disability (Items 19 and 20); and handicap (items 21 and 22). The Chinese OHIP-TMD exhibited good internal (Cronbach alpha = 0.92) and test–retest reliability (intraclass correlation coefficient = 0.90), and was significantly correlated to the global oral health rating (He & Wang, 2015). The items are graded on a five-point frequency scale that varied from 0 = never to 4 = very often. Total and domain scores are calculated by adding all twenty-two items and the defined domain questions correspondingly, with higher scores indicating greater impacts and poorer OHRQoL.

2.3 | Statistical analyses

All statistical evaluations, including exploratory factor analysis (EFA) for assessing dimensionality, were performed using the IBM SPSS statistics software Version 24.0 (IBM Corporation, Armonk, New York, USA), and Rasch analysis was conducted with the ConQuest software Version 5 (Australian Council for Educational Research, Camberwell, Victoria, Australia). EFA is a statistical method for determining the relationship among a set of measures and establishing the latent factors (dimensions) that explain the covariations between them. To verify the feasibility of EFA, the Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity was carried out to check for sampling adequacy and significance of correlation among items, respectively. KMO values ≥0.6 are considered acceptable, and p-value <0.05 for Bartlett's test signifies that the items are sufficiently correlated for extraction of dimensions (Field, 2009). Spearman's rank correlation between the twenty-two items was also done with values >0.20 indicating adequate relationships (Streiner & Norman, 1995). An eigenvalue >1.0 and oblique oblimin rotation were applied for extracting the dimensions of the OHIP-TMDs. The latter procedure was utilized for rotating the eigenvectors in an attempt to acquire a simple structure as the factors were correlated. Factor loadings of >0.40 were used for allotting the items in their respective dimensions. The internal consistency of the primary (first) dimension that explained most of the variance observed was examined, with Cronbach alpha values >0.70 specifying adequate reliability (Field, 2009).

Rasch analysis was carried out on the items of the primary dimension according to fit statistics. Infit and outfit values were presented as mean-square (MnSq) statistics that span from 0.6 to 1.4 for polytomic items with standardized fit statistics (Zstd) of ±1.9 indicating reasonable fit (Linacre, 2002). MnSq values <0.6 and >1.4 suggest little variability and erratic item scores, respectively. These misfitting items are considered for deletion. The degree of item difficulty was assessed using θ values, and participants' ability to respond was evaluated using the Wright (person-item parameter) map based on the log-odds (logit) scale. Spearman's rank correlation between the sum scores of the 22-item and abridged measures was eventually carried out to confirm the criterion validity.

3 | RESULTS

Out of 860 eligible TMD patients, 15 declined participation, and 1 was omitted due to incomplete OHIP-TMD entry, giving a total of 844 participants. The mean age of the study sample was 33.18 ± 13.54 years with women comprising 81.40% of the cohort. Of these, 52.61% (n = 444/844) was diagnosed with pain-related TMDs (with and without intra-articular conditions) and 47.39% (n = 400/844) with painless intra-articular TMDs.

The KMO value of the OHIP-TMD was 0.96, and p-value for Bartlett's sphericity test was <0.001 specifying that items of the OHIP-TMD were correlated and suitable for Factor analysis. Table 1 shows the correlation matrix of the OHIP-TMD items. Correlation coefficients (r_s) between items were all >0.20 and spanned from 0.22 to 0.86. Table 2 presents the outcomes of EFA. Multi-dimensionality of the OHIP-TMD was observed with three factors explaining 65.8% of the variance and the primary dimension consisting of items 8, 9, 10, 11, 15, 16, 17, 18, 19, and 21. However, item 8 was deleted as it did not conform to fit statistics with an MnSq value >1.4. The remaining nine items formed the short version of the OHIP-TMD (SOHIP-TMD), and their reliability was high with a Cronbach alpha value of 0.95 (Table 3).

Table 4 indicates the fit index of the items and their degree of difficulty. Adequate fit to the Rasch model was observed after deleting item 8 (Have you been worried by jaw or dental problems?) with infit and outfit mean-square (MnSq) values ranging from 0.75 to 1.39 and 0.82 to 1.40, respectively. Infit Zstd values varied from −5.6 to 6.7 while outfit Zstd values spanned from −3.7 to 6.6. The degree of item difficulty (θ values) ranged from −0.75 to 1.05 (mean 0.00 ± 1.51) logits, while the participants' ability to respond varied from −4.55 (best OHRQoL) to 5.19 (worst OHRQoL) (mean 0.01 ± 1.94) logits on the Wright map (Figure 1). Items 19 (Have you been a bit irritable with other people because of problems with your jaws, teeth, or mouth?) and 15 (Have you been upset because of problems with your jaws, teeth, or mouth?) were the most and least difficult questions, respectively. The respondent spread was slightly skewed, and satisfactory targeting between items and responses was observed. Correlation between the sum scores of the 22-item and 9-item measures was significant (p < 0.001) and strong (r_s = 0.95).

4 | DISCUSSION

4.1 | General overview

This study investigated the metric properties of the OHIP-TMD in TMD patients using Factor/Rasch analyses and produced a short-form version of the measure. As the OHIP-TMD was multidimensional and the items of its primary construct fitted the Rasch model, both null hypotheses were rejected. The preponderance of women in the current TMD cohort corroborated past studies and had been attributed to genetic, hormonal, psychosocial, cultural,

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TABLE 1 Description of correlations between the 22 OHIP-TMD items

	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I1	I20	I21
I2	0.59																				
I3	0.60	0.50																			
I4	0.22	0.22	0.38																		
I5	0.28	0.26	0.43	0.45																	
I6	0.74	0.53	0.58	0.25	0.33																
I7	0.41	0.33	0.51	0.43	0.45	0.47															
I8	0.38	0.35	0.36	0.18	0.24	0.38	0.27														
I9	0.32	0.33	0.37	0.25	0.31	0.43	0.39	0.53													
I10	0.50	0.48	0.53	0.31	0.38	0.58	0.47	0.55	0.79												
I11	0.36	0.37	0.49	0.30	0.36	0.43	0.39	0.51	0.72	0.76											
I12	0.57	0.46	0.52	0.26	0.31	0.58	0.40	0.45	0.51	0.61	0.50										
I13	0.43	0.34	0.37	0.30	0.28	0.47	0.43	0.29	0.38	0.47	0.39	0.48									
I14	0.24	0.23	0.36	0.36	0.43	0.34	0.45	0.21	0.39	0.43	0.42	0.31	0.46								
I15	0.37	0.39	0.42	0.27	0.31	0.44	0.38	0.55	0.71	0.77	0.75	0.54	0.40	0.42							
I16	0.35	0.37	0.41	0.29	0.35	0.44	0.43	0.43	0.70	0.73	0.76	0.50	0.43	0.50	0.78						
I17	0.32	0.32	0.36	0.30	0.35	0.42	0.40	0.45	0.72	0.73	0.77	0.50	0.40	0.47	0.79	0.86					
I18	0.37	0.33	0.40	0.33	0.42	0.45	0.48	0.35	0.57	0.61	0.62	0.45	0.46	0.58	0.61	0.60	0.71				
I19	0.33	0.31	0.37	0.33	0.40	0.40	0.45	0.33	0.57	0.61	0.61	0.43	0.43	0.56	0.60	0.70	0.72	0.77			
I20	0.28	0.29	0.35	0.37	0.39	0.35	0.49	0.28	0.46	0.49	0.47	0.37	0.45	0.59	0.47	0.56	0.56	0.65	0.67		
I21	0.52	0.48	0.49	0.30	0.36	0.54	0.44	0.457	0.57	0.69	0.63	0.58	0.45	0.43	0.67	0.66	0.66	0.61	0.64	0.55	
I22	0.35	0.32	0.41	0.32	0.41	0.40	0.47	0.337	0.52	0.56	0.56	0.43	0.39	0.52	0.53	0.61	0.62	0.67	0.70	0.75	0.67

Note: Results of Spearman's rank correlation. For all correlations $p < 0.001$.

TABLE 2 Summary of factor loadings of the OHIP-TMD items in each dimension extracted by Exploratory Factor Analysis

Items	Dimensions 1	2	3
I1. Have you had difficulty chewing any foods because of problems with your jaws, teeth, or mouth?	0.16	0.16	0.84[a]
I2. Have you had difficulties opening or closing your mouth?	0.21	0.12	0.70[a]
I3. Have you had painful aching in your mouth, face or ear?	0.16	0.37	0.69[a]
I4. Have you had a sore jaw?	0.03	0.62[a]	0.22
I5. Have you had headaches because of problems with your jaws, teeth, or mouth?	0.11	0.63[a]	0.26
I6. Have you found it uncomfortable to eat any foods because of problems with your jaws, teeth, or mouth?	0.26	0.24	0.77[a]
I7. Have you felt talking was painful because of problems with your jaws, teeth, or mouth?	0.16	0.62[a]	0.40
I8. Have you been worried by jaw or dental problems?	0.56[a]	−0.04	0.42
I9. Have you been self-conscious because of your jaws, teeth, or mouth?	0.80[a]	0.17	0.24
I10. Have jaw or dental problems made you miserable?	0.74[a]	0.23	0.46
I11. Have you felt tense because of problems with your jaws, teeth, or mouth?	0.80[a]	0.24	0.25
I12. Have you had to avoid eating some foods because of problems with your jaws, teeth, or mouth?	0.43	0.17	0.63[a]
I13. Have you had to interrupt meals because of problems with your jaws, teeth, or mouth?	0.26	0.43[a]	0.41
I14. Has your sleep been interrupted because of problems with your jaws, teeth, or mouth?	0.31	0.71[a]	0.07
I15. Have you been upset because of problems with your jaws, teeth, or mouth?	0.82[a]	0.18	0.28
I16. Have you found it difficult to relax because of problems with your jaws, teeth, or mouth?	0.81[a]	0.34	0.18
I17. Have you felt depressed because of problems with your jaws, teeth, or mouth?	0.84[a]	0.32	0.14
I18. Has your concentration been affected because of problems with your jaws, teeth, or mouth?	0.61[a]	0.57	0.15
I19. Have you been a bit irritable with other people because of problems with your jaws, teeth, or mouth?	0.63[a]	0.58	0.10
I20. Have you had difficulty doing your usual jobs because of problems with your jaws, teeth, or mouth?	0.43	0.71[a]	0.07
I21. Have you felt that life in general was less satisfying because of problems with your jaws, teeth, or mouth?	0.61[a]	0.34	0.43
I22. Have you been unable to work to your full capacity because of problems with your jaws, teeth, or mouth?	0.53	0.61[a]	0.14
Eigenvalue	6.32	4.16	3.99
% of variance explained	28.71	18.92	18.12

[a]Values ≥0.40 which were considered for relevant factor loadings after oblique rotation.

and environmental factors as well as differences in pain modulation, experience, and treatment-seeking (Bueno et al., 2018). The marginally higher prevalence of pain-related (52.61%) compared to painless intra-articular (47.39%) TMDs was also consistent with earlier studies (Manfredini et al., 2011). Thus far, the metric properties of the OHIP-TMD had only been explored with the CTT, and this study is the first to perform Rasch validation of the measure.

Using classical statistical techniques, the OHIP-TMD was found to have good internal and test–retest reliability as well as good face, content, construct, and convergent validity with similar responsiveness to the OHIP-49 (He & Wang, 2015; Yule et al., 2015). More recently, the discriminative capacity of the OHIP-TMD was also substantiated in community samples (Yap et al., 2020). Despite its positive attributes, the OHIP-TMD has several drawbacks. Besides

TABLE 3 Summary of factor loadings of the items in the primary dimension of the OHIP-TMD excluding item 8, also known as the Short-form OHIP-TMD (SOHIP-TMD)

Items	Dimension 1
I9. Have you been self-conscious because of your jaws, teeth, or mouth?	0.83[a]
I10. Have jaw or dental problems made you miserable?	0.87[a]
I11. Have you felt tense because of problems with your jaws, teeth, or mouth?	0.86[a]
I15. Have you been upset because of problems with your jaws, teeth, or mouth?	0.87[a]
I16. Have you found it difficult to relax because of problems with your jaws, teeth, or mouth?	0.90[a]
I17. Have you felt depressed because of problems with your jaws, teeth, or mouth?	0.91[a]
I18. Has your concentration been affected because of problems with your jaws, teeth, or mouth?	0.81[a]
I19. Have you been a bit irritable with other people because of problems with your jaws, teeth, or mouth?	0.81[a]
I21. Have you felt that life in general was less satisfying because of problems with your jaws, teeth, or mouth?	0.80[a]
Eigenvalue	6.54
% of variance explained	72.61
Cronbach Alpha	0.95

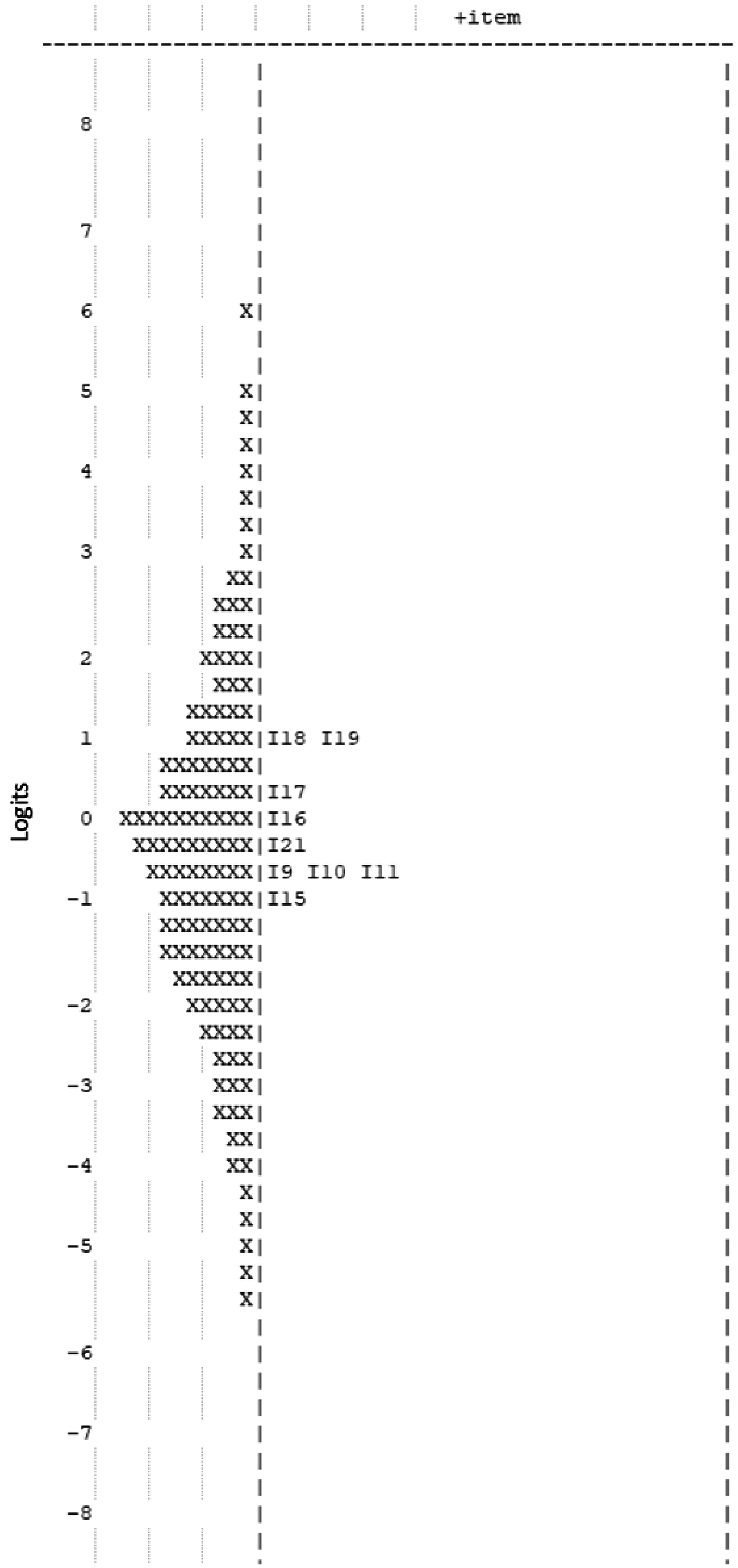
[a]Values ≥0.40 which were considered for relevant factor loadings after oblique rotation.

TABLE 4 Fit index for the items and their degree of difficulty

Items	Measure (θ)	SE	Infit MnSq	Infit Zstd	Outfit MnSq	Outfit Zstd	Point-measures correlation
I9. Have you been self-conscious because of your jaws, teeth, or mouth?	−0.43	0.04	1.22	4.3	1.21	3.9	0.83
I10. Have jaw or dental problems made you miserable?	−0.66	0.04	0.85	−3.2	0.93	−1.5	0.87
I11. Have you felt tense because of problems with your jaws, teeth, or mouth?	−0.46	0.04	1.00	0.0	1.01	0.2	0.86
I15. Have you been upset because of problems with your jaws, teeth, or mouth?	−0.75	0.04	0.89	−2.4	0.95	−0.9	0.87
I16. Have you found it difficult to relax because of problems with your jaws, teeth, or mouth?	0.17	0.04	0.75	−5.6	0.82	−3.7	0.89
I17. Have you felt depressed because of problems with your jaws, teeth, or mouth?	0.33	0.04	0.78	−5.0	0.86	−2.9	0.89
I18. Has your concentration been affected because of problems with your jaws, teeth, or mouth?	0.97	0.04	1.31	5.8	1.24	4.4	0.81
I19. Have you been a bit irritable with other people because of problems with your jaws, teeth, or mouth?	1.05	0.04	1.35	6.5	1.35	6.0	0.79
I21. Have you felt that life in general was less satisfying because of problems with your jaws, teeth, or mouth?	−0.23	0.10	1.39	6.7	1.40	6.6	0.80

Abbreviations: MnSq, mean-square; Zstd, Z-standardized; θ, theta (item difficulty index).

being longer than the widely used OHIP-14 (a short-form version of the OHIP-49) (Slade, 1997), it is TMD-specific and cannot be employed to compare OHRQoL impacts across different orofacial pain conditions and with other oral diseases (Durham et al., 2011). Although lengthy health questionnaires often have better validity, they are more arduous to administer and are associated with



Right side of the map indicates item difficulty while the left side indicates person's ability with each 'X' signifying 6.5 respondents.

FIGURE 1 Wright map of persons and items, considering the degree of item difficulty and participants' ability to respond greater participant response burden, response bias/errors, and nonresponse rates (Rolstad et al., 2011). It is thus advantageous to reduce the number of items of the OHIP-TMD to improve its research/clinical utility.

4.2 | Dimensionality of the OHIP-TMD

Locker adapted the World Health Organization's international classification of impairment, disability, and handicap to develop a conceptual model for explaining the pathways by which oral diseases/conditions influence quality of life (Locker, 1988). The OHIP-TMD was founded on Locker's framework and consists of twenty-two questions encompassing the seven domains. The OHIP-TMD was observed to be multi-dimensional with three factors explaining 65.8% of the variance. The primary (first) dimension that contributed most to the variance comprised nine items (minus item 8 due to poor fit statistics). These items constituted the shortened OHIP-TMD (SOHIP-TMD) and involved the psychological discomfort (items 9, 10, and 11), psychological disability (15, 16, 17, and 18), social disability (item 19), and handicap (item 21) domains. The internal consistency of the SOHIP-TMD was very good with a Cronbach alpha value of 0.95 (Table 3) specifying that the nine items were closely related as a group. This finding was consistent with the "biopsychosocial model of illness" theorized for TMDs based on the OPPERA prospective cohort study (Slade et al., 2013). Dimensions 2 and 3 consisted of seven (items 4, 5, 7, 13, 14, 20, and 22) and five (items 1, 2, 3, 6, and 12) items each. While dimension 2 involved mainly the physical pain domain, dimension 3 concerned both functional limitations and physical pain domains. Outcomes were in agreement with prior OHRQoL research, suggesting that "psychological and physical ailments" associated with TMDs lowered quality of life in patients with TMDs (Bitiniene et al., 2018).

Psychological factors play an important role in the etiology of TMDs as evidenced by the elevated levels of depression, anxiety, stress, and somatization in individuals with TMDs (Manfredini et al., 2003; De La Torre Canales et al., 2018). Seven out of the nine items in the SOHIP-TMD were related to psychological discomfort/disability and may be partial to the psychological distress experienced by TMD patients. Recently, the correlations between depression, anxiety, stress, and OHIP-TMD scores were found to be moderately strong to strong in adult TMD patients (Yap et al., 2021a). Stronger associations between psychological distress and OHRQoL were observed for older patients (r_s = 0.73–0.79) than younger ones (r_s = 0.47–0.54). The reported self-consciousness, misery, tension, distraught, difficulty relaxing, depressed feelings, and difficulty concentrating associated with the participants' jaws/mouth could thus be psychologically moderated. Moreover, TMD symptoms had been posited to be somatic metaphors that express/resolve pre-existing or concurrent psychological distress (Dworkin et al., 1990).

4.3 | Rasch analysis of the OHIP-TMD

Although Rasch measurement is an "influential approach" in psychometric modeling and had been widely employed in medical research (Aryadoust et al., 2019), its use in dentistry is still limited. This may be contributed partly by its deficiencies when compared to the CTT including (a) the need for specialized software and complex calculations, (b) incapacity for measurement should data not fit the model, and (c) low awareness among dental researchers (Wong et al., 2011). As the Rasch model is probability-based, some nonconformity in OHIP-TMD items is anticipated. MnSq fit statistics indicate the magnitude of randomness, more specifically the measurement system distortion. Item 8 (worried by jaw problems) had an MnSq >1.4 specifying that it was not measuring the same construct as the other OHIP-TMD items. Since it did not fit the model, item 8 was duly removed from the primary dimension. For the remaining items that formed the SOHIP-TMD, infit (inlier-sensitive or information-weighted fit) MnSq that is more sensitive to the pattern of responses to items near a participant's ability level, varied from 0.75 to 1.39. Similarly, outfit (outlier-sensitive) MnSq, which is more sensitive to responses to items with difficulty far from a participant's level of ability, ranged from 0.82 to 1.40. MnSq near 1.0 implies little distortion of the measurement system, and values spanning from 0.6 to 1.4 are considered acceptable. Zstd expresses the data improbability should they fit the model perfectly and are attained by transforming MnSq statistics to normally distributed z-standardized ones with sample size correction. Several of the items of the SOHIP-TMD had Zstd values greater than ±1.9, suggesting that the data may be unpredictable or unexpected. While the range of misfit values is anticipated to be smaller with large sample sizes, the wide array of Zstd values observed could be attributed to the involvement of participants with pain-related and/or intra-articular TMDs in the present study. Individuals with painful and non-painful TMD subtypes have different psychological profiles that has bearing on psychological components of the OHIP-TMD (Manfredini et al., 2004).

With the Rasch model, items and persons are measured on the same linear (logit) scale and are represented by the Wright map (Figure 1). On the right side of the map, Item measures are presented in order of difficulty with the most challenging item at the top and easiest at the bottom (highest to lowest θ values). On the left side, person measures are plotted and ordered based on participants' ability to respond. Those having the worst and best OHRQoL are placed at the top and bottom correspondingly (highest to lowest OHIP-TMD scores). Items exhibiting higher difficulties than the ability level of the participants will have a lower probability of being answered correctly when compared to those with difficulties below the participant's ability. Item 19 (irritable with others because of jaw problems) was deemed to be the most difficult (1.05 logit) and could be contributed by problems in defining the "irritability" (quality of being annoyed very easily) construct. The spread of the respondents surpassed that of the items at both ends and was skewed slightly toward the lower end of OHRQoL. The latter was expected given the known negative impact of TMDs on OHRQoL (Bitiniene et al., 2018; Dahlström & Carlsson, 2010). Satisfactory targeting between items and participants' responses were observed with mean ability to respond (0.00 ± 1.51 logits) being similar to mean item difficulty (0.01 ± 1.94 logits). Nonetheless, targeting may not be optimal considering the narrow range.

4.4 | Study limitations

This study has several limitations, which will be elaborated upon. First, the TMD patients were considered as a group, and participants with pain-related and intra-articular TMDs were not distinguished. As orofacial pain has been associated with psychological distress, poorer adaptive capacity, and OHRQoL (Bäck et al., 2020), future Rasch modeling ought to differentiate between the two major TMD categories. Rasch validation of the OHIP-TMD should also be undertaken in community samples with and without TMDs as the OHIP-TMD was explicitly designed for TMD patients. This will enable the functionality of the OHIP-TMD and its short-form derivative to be confirmed for non-clinical populations. Second, just the Chinese version of the OHIP-TMD was examined. The original English and other language versions of the OHIP-TMD also need to be validated before findings can be generalized as racial/ethnic variations could well affect the outcomes of self-reported measures. Third, the Rasch model may be somewhat restrictive or prescriptive. Although the RMT is based on the IRT, its approach to measuring and evaluating item sets differs considerably. While the IRT concentrates on the data and aims to establish the item-response model that best explains the data, the RMT prioritizes the Rasch model, and hypotheses are revisited should the data not fit (Petrillo et al., 2015). Despite its limitations, the study yielded the SOHIP-TMD which offers several distinct advantages in research and clinical settings. Besides being simpler and faster to administer and compute, it also reduces response burden and errors and may improve research participation rates (Rolstad et al., 2011; Sahlqvist et al., 2011). Although the SOHIP-TMD has a psychosocial predilection, it showed good criterion validity with a strong correlation (r_s = 0.95) to the 22-item measure.

5 | CONCLUSION

This study is the first to evaluate the metric properties of the OHIP-TMD using Factor and Rasch analyses. Multi-dimensionality of the OHIP-TMD was established with the primary dimension consisting of items 8, 9, 10, 11, 15, 16, 17, 18, 19, and 21. Item 8 was deleted due to poor fit statistics, and the remaining nine items showed very good reliability (Cronbach alpha = 0.95) and adequate fit to the Rasch model.

The respondent spread surpassed that of the items at both ends and was slightly skewed with satisfactory targeting between items and responses. The 9-item SOHIP-TMD holds promise as a shortened measure for assessing the OHRQoL of individuals with TMDs in both research and clinical settings.

CONFLICT OF INTEREST

The authors declare that they have no financial or personal interests related to the present work.

AUTHOR CONTRIBUTIONS

Adrian Yap: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Visualization; Writing-original draft. **Ye Cao:** Data curation; Formal analysis; Methodology; Project administration; Resources; Software; Validation; Writing-review & editing. **May Chun Mei Wong:** Data curation; Formal analysis; Methodology; Validation; Visualization; Writing-review & editing. **Kai-Yuan Fu:** Conceptualization; Data curation; Funding acquisition; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Writing-review & editing.

PATIENT CONSENT STATEMENT

The authors declare that informed consent was obtained from the participants and that the study was performed in accordance with the Declaration of Helsinki.

PEER REVIEW

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