Journal of Oral Rehabilitation

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Universities and research institutions in United Kingdom

Media Ranking in United Kingdom

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INFORMATION

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SCOPE

Journal of Oral Rehabilitation aims to be the most prestigious journal of dental research within all aspects of oral rehabilitation and applied oral physiology. It covers all diagnostic and clinical management aspects necessary to re-establish a subjective and objective harmonious oral function. Oral rehabilitation may become necessary as a result of developmental or acquired disturbances in the orofacial region, orofacial traumas, or a variety of dental and oral diseases (primarily dental caries and periodontal diseases) and orofacial pain conditions. As such, oral rehabilitation in the twenty-first century is a matter of skilful diagnosis and minimal, appropriate intervention, the nature of which is intimately linked to a profound knowledge of oral physiology, oral biology, and dental and oral pathology. The scientific content of the journal therefore strives to reflect the best of evidence-based clinical dentistry. Modern clinical management should be based on solid scientific evidence gathered about diagnostic procedures and the properties and efficacy of the chosen intervention (e.g. material science, biological, toxicological, pharmacological or psychological aspects). The content of the journal also reflects documentation of the possible side-effects of rehabilitation, and includes prognostic perspectives of the treatment modalities chosen.

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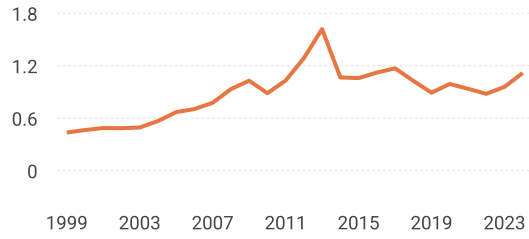

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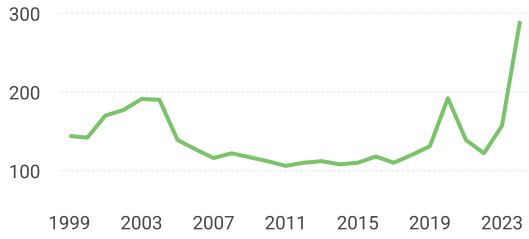

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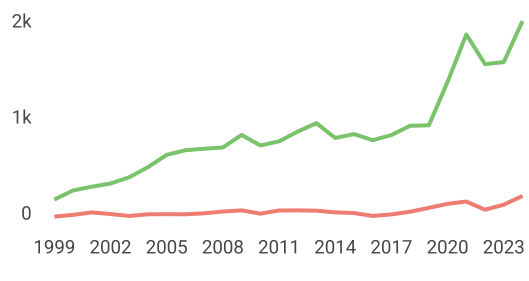

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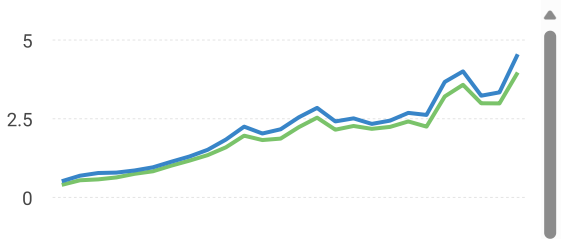

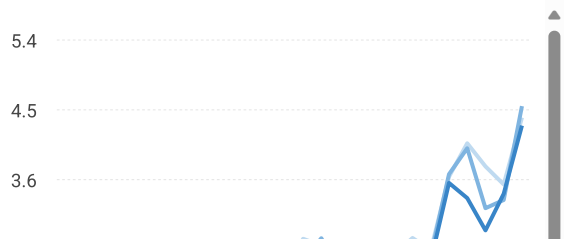

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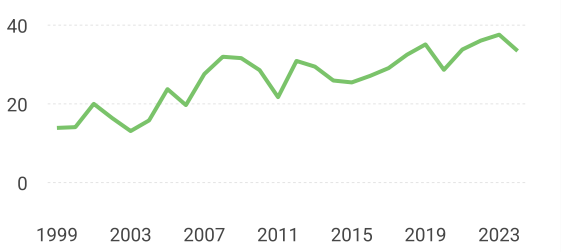

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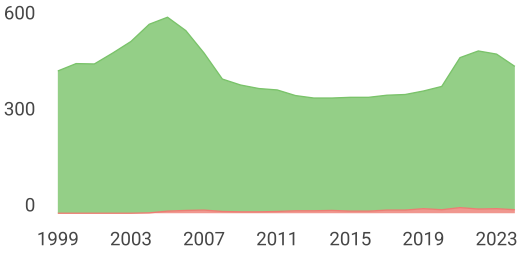

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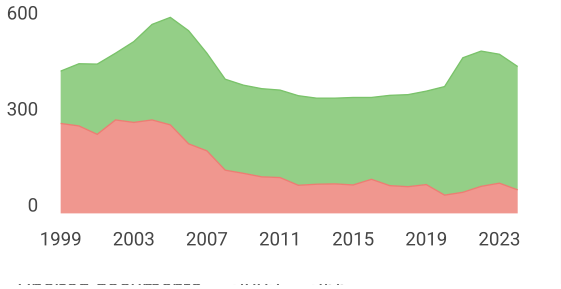

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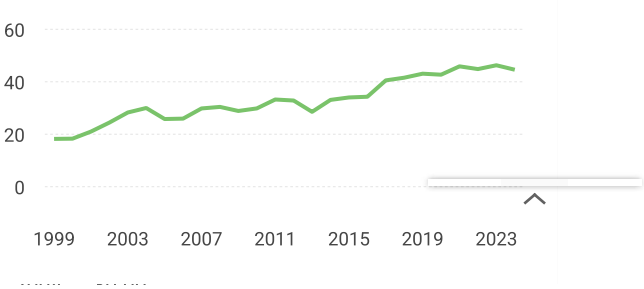

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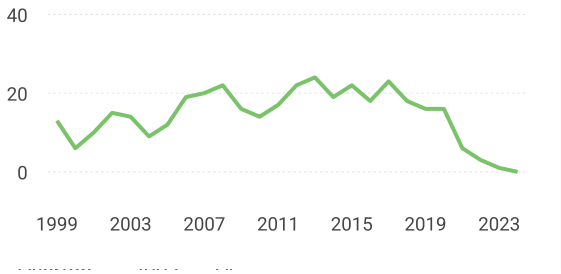

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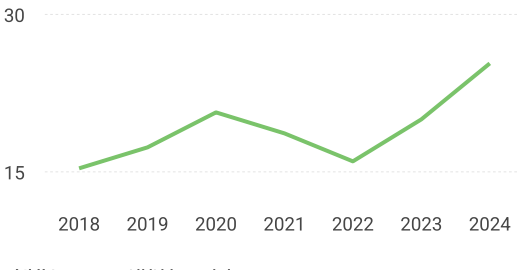

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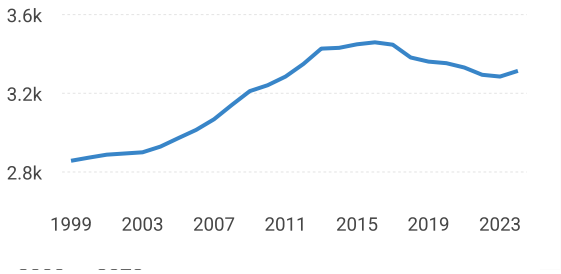

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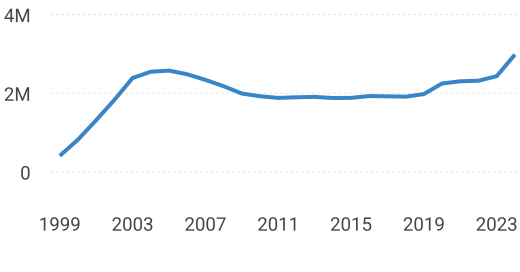

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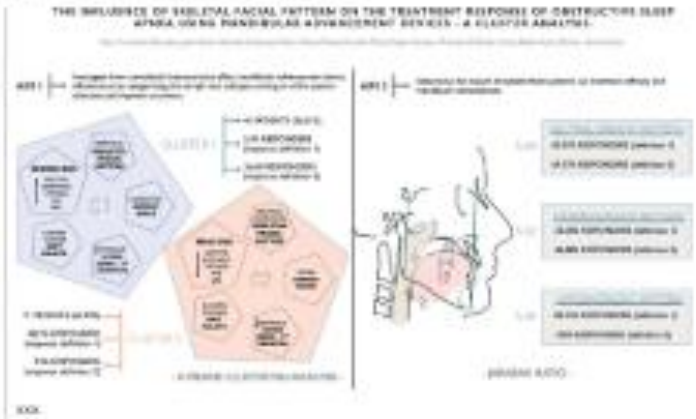

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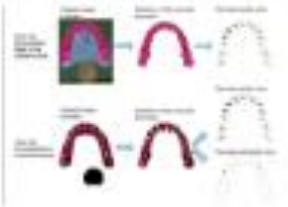

The BruxChecker system provides excellent reliability in measuring the occlusal peeled area for quantitatively assessing the grinding type of sleep bruxism at the dental level in young adults with healthy dentitions. The highest reliability was achieved using the BruxChecker for two or three consecutive nights and scanning by transillumination. This study generated reference values for absolute and relative peeled areas after using the BruxChecker for three nights.

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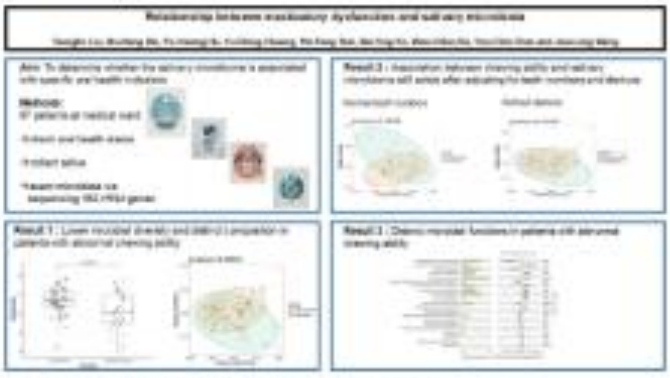
Tsung-Jin Liu, Ma-Heng Wu, Po-Hsiang Hu, Yu-Ching Chuang, Pei-Fang Tsai, Nai-Ying Ko, Wen-Chen Ko, Yen-Chin Chen, Jiun-Ling Wang

Pages: 991-1000 | First Published: 26 March 2025



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Exploring the Four-Dimensional Impact of Pain-Related and/or Intra-Articular Temporomandibular Disorder Symptoms on Oral Health-Related Quality of Life Among Young Adults

Adrian Lijin Yap, Yinghao Xiong, Caroline Marpaung, May Chun Mei Wong

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Association of the Oral Frailty Index-8 With the Diagnosis and Results of Oral Hypofunction Testing

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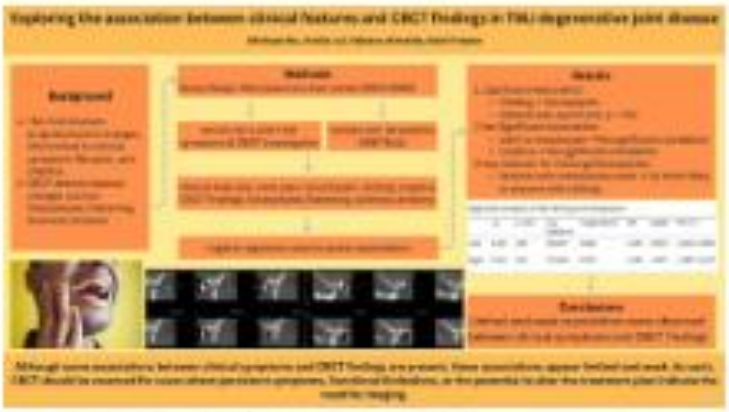

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Effect of Multidirectional Chin Tuck Against Resistance Exercise on Oropharyngeal Muscles and Swallowing Function in Subacute Stroke Patients With Dysphagia: A Randomised Controlled Trial

Ji-Su Park, Young-Seok Cho, Masayoshi Morishita, Ne-Mi Han, Tae-Hyung Yoon

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Charis Van der Sraeven, Noor Cickler, Julian Verbeke, Ineke Van Hecke, Kim Bettens, Kristiane Van Lierde

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REVIEW

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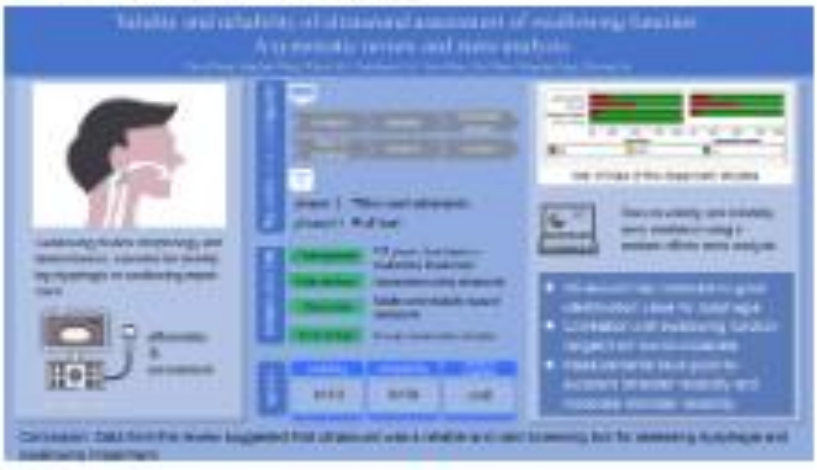

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Association Between Mouth Breathing and the Temporomandibular System: A Narrative Review

Liqun Gu, Kuo Gao, Xiangtao Liu, Jian Wang, Lei Xu, Yafen Zhu

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We accumulated knowledge of association between mouth breathing and the temporomandibular system: (A) Airway obstruction, particularly in the nasal and pharyngeal regions, compels individuals to resort to MB. (B) MB can influence TMJ condylar position, morphology, TMJ disc and skeletal muscle function. (C) Multiple signaling pathways were involved in the pathological process of MB-related TMD.

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ORIGINAL ARTICLE

Exploring the Four-Dimensional Impact of Pain-Related and/or Intra-Articular Temporomandibular Disorder Symptoms on Oral Health-Related Quality of Life Among Young Adults

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Keywords: intra-articular | oral health-related quality of life | pain | symptoms | temporomandibular disorders

ABSTRACT

Objectives: A four-dimensional structure for oral health-related quality of life (OHRQoL) was recently proposed, comprising oral function (OF), orofacial pain (OP), orofacial appearance (OA) and psychosocial impact (PI). This study examined the impact of different temporomandibular disorder (TMD) symptoms on the four OHRQoL dimensions in young adults. It also correlated the four dimensions with the seven Oral Health Impact Profile (OHIP) domains.

Methods: Young adults were recruited from a large university. The quintessential five TMD symptoms (5Ts) and OHIP-14 were used to assess TMD symptoms and OHRQoL. Participants were categorised into no (NT), pain-related (PT), intra-articular (IT) and combined (CT) TMD groups, and total, dimension and domain OHIP scores were computed. Data were evaluated using the chi-square test and non-parametric analyses ($\alpha = 0.05$).

Results: Among the 1097 eligible participants (mean age 19.9 years [SD = 1.3]; 69.7% women), 47.2% reported no TMD symptoms, while 20.5%, 14.9% and 17.4% had PT, IT and CT TMD symptoms, respectively. Significant differences in OHIP scores were noted between individuals with and without TMD symptoms across all dimensions and domains (CT, PT, IT > NT). Additionally, notable distinctions in normalised dimension scores were evident in all participant groups (OP, OA > OF, PI). Moderate to strong correlations were discerned between OHIP dimensions and domain, except for OA with functional limitation ($r_s = 0.35$).

Conclusions: Adopting the four dimensions as the standard metric for assessing OHRQoL can improve study comparability and enhance understanding of TMD impacts.

Adrian Ujin Yap and Yinghao Xiong are co-first authors.

1 | Background

Temporomandibular disorders (TMDs), a cluster of clinical problems involving the masticatory system, are the second most common musculoskeletal condition causing pain and disability, following chronic low back pain [1]. While the estimated prevalence of TMDs is around 34%, up to 75% of the general population experience TMD symptoms, including facial/pre-auricular pain, temporomandibular joint (TMJ) sounds and limitations in jaw movements [2–4]. Using the diagnostic criteria for TMDs (DC/TMD) and its stratified reporting system, TMD diagnoses and symptoms can be classified into three main categories: intra-articular (IT), pain-related (PT) and combined (CT) [5, 6]. Women, particularly those between 20 and 40 years old, have a heightened susceptibility to TMDs [7, 8]. In addition to gender, various bio-psychosocial factors, such as age, trauma, oral parafunction, psychological distress and somatic symptoms, have been implicated in the development of TMDs [9–11]. TMDs, especially those accompanied by pain, have been shown to significantly impair oral health-related quality of life (OHRQoL) in both patient and community samples. This impact appears more pronounced in individuals who experience a higher number of TMD symptoms [12–14]. Conversely, therapeutic TMD interventions, such as psychotherapy, occlusal appliances and TMJ arthrocentesis, have the potential to enhance the OHRQoL of individuals affected by TMDs [15].

OHRQoL is a complex construct concerning the bio-psychosocial (functional, physical and psychosocial) aspects of well-being related to oral health/diseases [14–16]. Its importance in both dental research and clinical practice lies in the increasing recognition that managing oral diseases, including TMDs, should prioritise dental patient-reported outcomes (dPROs) that 'resonate' with patients' subjective experiences, rather than solely concentrating on objective clinical measures [15, 16]. The Oral Health Impact Profile (OHIP), specifically its 14-item short-form version (OHIP-14), is one of the most widely used tools for assessing OHRQoL [16–18]. Derived from Locker's model of oral health, the OHIP-14 consists of seven domains and is frequently employed in TMD research [12, 13, 19, 20]. However, the OHIP's seven-domain structure doesn't align well with empirical data [16, 21]. Instead, a set of four dimensions, namely oral function (OF), orofacial pain (OP), orofacial appearance (OA) and psychosocial impact (PI), were identified using exploratory factor analysis [22]. These dimensions were later verified and validated through further analyses, establishing a more psychometrically robust and clinically plausible structure for OHIP and OHRQoL in general [23–25]. Moreover, the four dimensions were also found to underlie dental patient-reported outcome measures (dPROMs) and were determined to be the primary drivers compelling dental patients to seek care worldwide [26–29]. In light of these discoveries, an international group of oral health researchers recommended adopting the four dimensions as the common metric for assessing the impact of oral diseases and exploring the effectiveness of dental interventions. This involved re-mapping and scoring the OHIP and its iterations, including the OHIP-14 [16, 29, 30].

The four-dimensional impact of different TMD symptoms on OHRQoL has not been documented among non-clinical young adults in community settings [30, 31]. Furthermore, correlation analyses need to be conducted between the OHIP dimensions and domains to substantiate the use of the physical disability, physical pain, psychological discomfort and handicap domains to represent OF, OP, OA and PI dimensions, respectively [16]. Therefore, the threefold objectives of this study were to (1) investigate the impact of intra-articular and/or pain-related TMD symptoms on the four OHIP dimensions, (2) identify which OHIP dimensions are primarily affected by various TMD symptoms and (3) establish correlations between the four OHIP dimensions and the seven OHIP domains. The research hypotheses were as follows: (a) TMD symptoms significantly diminished the OHRQoL of young adults; (b) the affected OHIP dimensions varied depending on the presence of TMD pain and/or dysfunction; and (c) the physical disability, physical pain, psychological discomfort and handicap domains exhibited moderate to strong correlations with the OF, OP, OA and PI dimensions, correspondingly.

2 | Methods

2.1 | Study Design and Sample

Ethics approval for this research was duly obtained from the Institutional Review Board of Trisakti University School of Dentistry (ID: 377/S1/KEPK/FKG/8/2020). Young adults were recruited from a large university using a non-probabilistic voluntary sampling approach. The recruitment process extended from January to December 2021, leveraging various channels such as the university's intranet portal and direct interpersonal engagement. To attain a 95% confidence level with a 5% margin of error, taking into account the university's student population of 21 000 individuals and a previously reported prevalence rate of 59% for TMD symptoms in a comparable sample, the study required a minimum of 366 participants [32]. The inclusion criteria involved individuals aged 18–24 proficient in English, while the exclusion criteria comprised those with a history of prior orofacial trauma/orthognathic surgery, as well as individuals currently undergoing treatment for debilitating physical and/or psychological conditions that impeded independent living. Additionally, participants with incomplete surveys were also omitted. After providing informed consent, participants were directed to complete a comprehensive online survey, which included demographic information, the quintessential five TMD symptoms of the DC/TMD (5Ts) and the OHIP-14 [4, 18].

2.2 | Study Measures

The 5Ts screening tool involves the five key TMD symptoms specified in the DC/TMD Symptom Questionnaire (SQ), comprising three intra-articular symptoms (TMJ noises, closed and open locking) and two pain-related symptoms (masticatory muscle/TMJ pain and headache) [4, 5]. It demonstrated high accuracy in detecting all TMDs, IT and PT, with corresponding areas under the receiver operating characteristics curves of 0.98, 0.98 and 1.00, respectively [4, 5]. Furthermore, the 5Ts exhibited high sensitivity, ranging from 96.1% to 99.2%, and 100% specificity in identifying the various TMD conditions [4]. Recently, the validity of the 5Ts tool was reaffirmed, and enhancements were made by including options to indicate the frequency and

differentiate muscle/TMJ pain [33]. TMD symptoms were evaluated over 30 days, with participants categorised as either '5Ts-negative' (no TMD symptoms [NT]) if they responded 'no' to all five questions or as '5Ts-positive' (with TMD symptoms [WT]) if they answered 'yes' to any of the five items. The '5Ts-positive' participants were subsequently stratified into subgroups based on the presence of IT, PT or CT symptoms [4, 32].

OHRQoL was assessed using the OHIP-14 questionnaire, which contained 14 items. The items were grouped into four dimensions (OF, OP, OA and PI) and seven domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap), as outlined in Table 1 [16, 18]. A 5-point response scale was employed for scoring the items, where 'never' equated to 0 points, 'hardly' to 1 point, 'occasionally' to 2 points, 'fairly often' to 3 points and 'very often' to 4 points. Severity scores for total OHIP, individual dimensions and domains were calculated by summing the ordinal values of all 14 items or dimension/domain-specific items. To support the comparison of dimensional impacts, normalised severity scores were computed by dividing the sum of dimension scores by the number of stipulated items, thereby normalising the scores with a common score range of 0–4. Larger severity scores indicate more impairments to quality of life and a lower OHRQoL.

2.3 | Statistical Analyses

All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software version 28.0 (IBM Corporation, Armonk, New York, USA), with the significance level set at 0.05. Categorical data were displayed as frequencies with their corresponding percentages, whereas numerical data were depicted using both means with standard deviations and medians with interquartile ranges. Chi-square test was employed to evaluate categorical data. Given the non-normal distribution of OHIP data as per Shapiro–Wilk's test, statistical comparisons among participant groups were performed using Mann–Whitney *U* test or Kruskal–Wallis tests with post hoc Dunn tests and Bonferroni correction, while within-group comparisons were assessed with the Friedman and Wilcoxon signed-rank tests. Correlation analysis between the four OHIP dimensions and seven OHIP domains was conducted using Spearman's rho correlation. The strength of correlation coefficients (r_s) was classified as weak, moderate or strong, with cut-off values of 0.1, 0.4 and 0.7, correspondingly [34].

3 | Results

The study included 1097 eligible participants, with a mean age of 19.9 years (SD = 1.3), and 69.7% were women. Of these, 47.2% were 5Ts-negative (NT), while 52.8% were 5Ts-positive (WT) and experienced TMD symptoms. Among the 5Ts-positive individuals, the proportion with PT (38.8%) was notably higher than those with CT (32.9%) and IT (28.3%). The 5Ts-positive group was somewhat older than the 5Ts-negative group, and no significant difference in sex distribution was noted between the two groups (Table 2).

TABLE 1 | Distribution of OHIP-14 items for the four dimensions and seven domains.

		Dimensions				Domains						
OHIP	**Items**	**OF**	**OP**	**OA**	**PI**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
1.	Speaking/pronouncing	●				●						
2.	Sense of taste	●				●						
3.	Painful aching		●				●					
4.	Uncomfortable eating		●				●					
5.	Self-conscious			●				●				
6.	Tense				●			●				
7.	Unsatisfactory diet	●							●			
8.	Interrupted meals	●							●			
9.	Difficulty relaxing				●					●		
10.	Embarrassed				●					●		
11.	Irritable				●						●	
12.	Occupational difficulties				●						●	
13.	Unsatisfactory life				●							●
14	Unable to function				●							●
Total number of items		4	2	1	7	2	2	2	2	2	2	2

Abbreviations: D1 = functional limitation; D2 = physical pain; D3 = psychological discomfort; D4 = physical disability; D5 = psychological disability; D6 = social disability; D7 = handicap; OA = orofacial appearance; OF = oral function; OP = orofacial pain; PI = psychosocial impact.

TABLE 2 | Demographic characteristics of the study sample.

Variables	Total	5Ts-negative with no TMD symptoms (NT)	5Ts-positive with TMD symptoms (WT)	*p*
n (%)	1078 (100%)	509 (47.2%)	569 (52.8%)	
Age				
Mean (SD)	19.9 (1.3)	19.7 (1.3)	20.0 (1.3)	
Median (IQR)	20.0 (19.0–21.0)	19.0 (19.0–21.0)	20.0 (19.0–21.0)	**< 0.001***
Sex				
Male, *n* (%)	327 (30.3%)	155 (30.5%)	172 (30.2%)	0.937^
Female, *n* (%)	751 (69.7%)	354 (69.5%)	397 (69.8%)	
TMD sub-types				
No TMD, *n* (%)	509 (47.2%)	509 (100%)	—	
Pain-related, *n* (%)	221 (20.5%)	—	221 (38.8%)	—
Intra-articular, *n* (%)	161 (14.9%)	—	161 (28.3%)	
Combined, *n* (%)	187 (17.4%)	—	187 (32.9%)	

Note: Bold indicates $p < 0.05$. Results of *Mann–Whitney *U* and ^chi-square tests.

Table 3 shows the mean/median of OHIP dimension and domain scores for the four participant groups. Individuals with TMD symptoms presented significantly higher scores for all OHIP dimensions and domains compared to their peers without TMD symptoms (CT, PT, IT > NT). Moreover, substantial differences in total OHIP, OP and PI dimension scores, as well as physical pain, physical disability and psychological disability domain scores, were observed between those with CT and IT (CT > IT). Table 4 presents the mean/median normalised OHIP dimension scores. For all participant groups, OP and OA scores were significantly higher than OF and PI scores (OP, OA > OF, PI). Additionally, no significant differences in scores were observed between OP and OA, as well as between OF and PI normalised scores.

Table 5 indicates the correlations between the four OHIP dimensions and seven OHIP domains. The correlations between dimension and domain scores were highly significant ($p < 0.001$) and generally moderate to strong except for OA with functional limitation ($r_s = 0.35$). The strongest correlations between the four dimensions and discrete domains were as follows: OF and physical disability ($r_s = 0.92$), OP and physical pain ($r_s = 1.00$), OA and psychological discomfort ($r_s = 0.93$) and PI and psychological disability ($r_s = 0.90$).

4 | Discussion

This research is an initial exploration into the impact of different TMD symptoms on the four OHRQoL dimensions in young adults. It identified the dimensions primarily affected by the various symptoms and correlated the four dimensions with the seven OHIP domains. In addition to being more reliable and relevant, adopting the four dimensions as a standardised metric enables comparisons among various OHRQoL measures, oral diseases and dental interventions. It also facilitates decision-making in clinical practice, enhances communication and collaboration and aids in policy development [23–25]. Given the significant impact on OHRQoL caused by TMD symptoms and the largely moderate to strong correlations between OHIP dimensions and domains, the first and third research hypotheses were supported. However, the second research hypothesis was not upheld, as the primarily affected OHIP dimensions were consistent across all participant groups. University students were selected as the young adult population due to their vulnerability to chronic pain, including TMDs, which may stem from psychological distress induced by academic stress, social pressures and lifestyle adjustments [35, 36]. The prevalence of TMD symptoms observed fell within the documented range for the general population [3, 37]. Participants experiencing TMD symptoms tended to be slightly older, which could be associated with increased academic stressors and class hours as courses progressed [38].

4.1 | Comparison of TMD Symptoms

The presence of TMD pain and/or dysfunction significantly impaired overall OHRQoL as well as all OHIP dimensions and domains. Additionally, the combination of pain-related and intra-articular TMD symptoms reduced overall OHRQoL and negatively affected the OP and PI dimensions, along with the physical pain, physical disability and psychological disability domains, when contrasted with painless intra-articular symptoms alone. This could be partially attributed to the increased likelihood of young adults with CT experiencing more TMD pain and dysfunction, possibly linked to elevated levels of psychological distress and reliance on maladaptive coping strategies, including oral parafunction [32, 39]. Findings corroborated those of previous studies, emphasising the significant influence of TMDs on OHRQoL, particularly concerning the physical and psychosocial aspects [12, 13, 20, 40].

TABLE 3 | Mean/median OHIP dimension and domain scores for the four participant groups.

Variables	No TMD (NT)	Pain-related TMD (PT)	Intra-articular TMD (IT)	Combined TMD (CT)	*p**	Post hoc^
Total OHIP-14						
Mean (SD)	8.7 (8.7)	13.8 (9.6)	12.6 (11.3)	15.4 (10.5)		
Median (IQR)	6.0 (2–13)	12.0 (6.0–19.5)	10.0 (3.5–18.0)	14.0 (7.0–22.0)	**< 0.001**	CT, PT, IT > NT CT > IT
Dimensions						
Oral function (OF)						
Mean (SD)	2.2 (2.7)	3.6 (2.9)	3.2 (3.2)	3.8 (3.2)		
Median (IQR)	1.0 (0.0–4.0)	3.0 (1.0–6.0)	2.0 (0.5–5.0)	3.0 (2.0–6.0)	**< 0.001**	CT, PT, IT > NT
Orofacial pain (OP)						
Mean (SD)	1.7 (1.6)	2.6 (1.9)	2.4 (2.0)	3.0 (2.0)		
Median (IQR)	2.0 (0.0–3.0)	2.0 (1.0–4.0)	2.0 (1.0–4.0)	3.0 (2.0–4.0)	**< 0.001**	CT, PT, IT > NT, CT > IT
Orofacial appearance (OA)						
Mean (SD)	1.1 (1.2)	1.6 (1.3)	1.5 (1.3)	1.8 (1.5)		
Median (IQR)	1.0 (0.0–2.0)	2.0 (0.0–3.0)	2.0 (0.0–3.0)	2.0 (0.0–3.0)	**< 0.001**	CT, PT, IT > NT
Psychosocial impact (PI)						
Mean (SD)	3.6 (4.6)	6.1 (5.5)	5.5 (5.9)	6.8 (5.7)		
Median (IQR)	2.0 (0.0–6.0)	4.0 (2.0–9.0)	4.0 (1.0–8.0)	6.0 (2.0–10.0)	**< 0.001**	CT, PT, IT > NT CT > IT
Domains						
Functional limitation (D1)						
Mean (SD)	0.8 (1.3)	1.3 (1.6)	1.2 (1.7)	1.2 (1.5)		
Median (IQR)	0.0 (0.0–1.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	**< 0.001**	CT, PT, IT > NT
Physical pain (D2)						
Mean (SD)	1.7 (1.6)	2.6 (1.9)	2.4 (2.0)	3.0 (2.0)		
Median (IQR)	2.0 (0.0–3.0)	2.0 (1.0–4.0)	2.0 (1.0–4.0)	3.0 (2.0–4.0)	**< 0.001**	CT, PT, IT > NT CT > IT
Psychological discomfort (D3)						
Mean (SD)	1.6 (1.8)	2.5 (2.2)	2.2 (2.1)	2.8 (2.2)		
Median (IQR)	1.0 (0.0–3.0)	2.0 (0.0–4.0)	2.0 (0.0–4.0)	2.0 (1.0–4.0)	**< 0.001**	CT, PT, IT > NT

(Continues)

TABLE 3 | (Continued)

Variables	No TMD (NT)	Pain-related TMD (PT)	Intra-articular TMD (IT)	Combined TMD (CT)	*p**	Post hoc^
Physical disability (D4)						
Mean (SD)	1.4 (1.7)	2.3 (2.0)	1.9 (1.9)	2.6 (2.1)		
Median (IQR)	1.0 (0.0–2.0)	2.0 (0.0–4.0)	2.0 (0.0–3.0)	2.0 (1.0–4.0)	**<0.001**	CT, PT, IT > NT CT > IT
Psychological disability (D5)						
Mean (SD)	1.3 (1.7)	2.2 (2.0)	2.1 (2.1)	2.6 (2.0)		
Median (IQR)	1.0 (0.0–2.0)	2.0 (0.0–4.0)	2.0 (0.0–4.0)	2.0 (1.0–4.0)	**<0.001**	CT, PT, IT > NT CT > IT
Social disability (D6)						
Mean (SD)	0.9 (1.5)	1.5 (1.9)	1.3 (1.8)	1.6 (1.9)		
Median (IQR)	0.0 (0.0–1.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–3.0)	**<0.001**	CT, PT, IT > NT
Handicap (D7)						
Mean (SD)	0.9 (1.4)	1.5 (1.7)	1.4 (1.8)	1.6 (1.8)		
Median (IQR)	0.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–3.0)	**<0.001**	CT, PT, IT > NT

Note: Bold indicates $p < 0.05$. Results of *Kruskal–Wallis and ^Dunn tests with Bonferroni correction.

4.2 | Comparison of OHIP Dimensions

The use of normalised scores allowed for the standardised evaluation of the four OHIP dimensions. In all participant groups, the OP and OA dimensions were significantly more affected than the OF and PI dimensions. While the disparity in impact between the OP and OF/PI dimensions is evident, the significance of the OA dimension warrants further clarification, especially since it was also observed in participants without TMD symptoms [30]. According to the recommended mapping, the OA dimension is only assessed by a single question in the OHIP-14: 'Have you been self-conscious because of your teeth, mouth or jaws? (item 5)' [16, 29]. As dental malocclusion, which may be related to dentofacial disharmonies, has considerable effects on OA and is associated with OHRQoL, much of the impact on OA may result from untreated malocclusion [41, 42]. Nevertheless, a recent study of prospective orthodontic patients found that TMDs influenced OHRQoL more than the severity of malocclusion [43]. The moderate to strong correlations of OA with OP, OF and PI ($r_s = 0.465–0.674$) provided some evidence to support this.

Montero et al. [44], employing both exploratory and confirmatory factor analyses, determined that the OHIP-14 has a three-dimensional structure, comprising only OF, OP and PI. Their model was subsequently applied in TMD research, revealing that the OP and PI dimensions, which exhibited moderate to strong relationships, were more impacted than the OF dimension [31]. The three-dimensional structure of the OHIP-14 might be better suited for TMD research, as it corresponds with existing literature and the limited relevance of OA to TMDs, except in situations of dentofacial deformities resulting from severe TMJ degeneration [31]. Considering the aforementioned information, it is advisable to minimise or even omit emphasis on the OA dimension when using the OHIP-14 mapping recommended by the international workgroup for TMD research.

4.3 | Correlations Between OHIP Dimensions and Domains

Correlational analyses were conducted to confirm the international workgroup's recommendation to use the physical disability, physical pain, psychological discomfort and handicap domains as representations of the OF, OP, OA and PI dimensions, correspondingly, in OHIP assessments [16, 29]. While the strongest correlations for OF, OP and OA were consistent with those proposed by the international workgroup, there was a variation for the PI dimension. The highest correlation coefficient was noted between PI and psychological disability, with additional strong associations evident in the psychological discomfort ($r_s = 0.78$), social disability ($r_s = 0.78$) and handicap domains ($r_s = 0.83$). Similarly, strong correlations were discerned between OF and functional limitation ($r_s = 0.75$), as well as between OA and psychological disability ($r_s = 0.71$). This implies that there may be some overlap in the concepts measured by the various OHIP-14 domains [45]. As such, the handicap domain

TABLE 4 | Normalised mean/median OHIP dimension scores for the four participant groups.

Variables	Oral function (OF)	Orofacial pain (OP)	Orofacial appearance (OA)	Psychosocial impact (PI)	*p**	Post hoc^
5Ts-negative						
No TMD symptoms (NT)						
Mean (SD)	0.6 (0.7)	0.9 (0.8)	1.1 (1.2)	0.5 (0.7)		
Median (IQR)	0.3 (0.0–1.0)	1.0 (0.0–1.5)	1.0 (0.0–2.0)	0.3 (0.0–0.9)	**< 0.001**	OA, OP > OF, PI
5Ts-positive						
With TMD symptoms (WT)						
Mean (SD)	0.9 (0.8)	1.3 (1.0)	1.6 (1.4)	0.9 (0.8)		
Median (IQR)	0.8 (0.3–1.3)	1.0 (0.5–2.0)	2.0 (0.0–3.0)	0.6 (0.3–1.3)	**< 0.001**	OA, OP > OF, PI
Intra-articular TMD (IT)						
Mean (SD)	0.8 (0.8)	1.2 (1.0)	1.5 (1.3)	0.8 (0.8)		
Median (IQR)	0.5 (0.1–1.3)	1.0 (0.5–2.0)	2.0 (0.0–3.0)	0.6 (0.1–1.1)	**< 0.001**	OA, OP > PI, OF
Pain-related TMD (PT)						
Mean (SD)	0.9 (0.7)	1.3 (1.0)	1.6 (1.3)	0.9 (0.8)		
Median (IQR)	0.8 (0.3–1.5)	1.0 (0.5–2.0)	2.0 (0.0–3.0)	0.6 (0.3–1.3)	**< 0.001**	OA, OP > OF, PI
Combined TMD (CT)						
Mean (SD)	0.9 (0.8)	1.5 (1.0)	1.8 (1.5)	1.0 (0.8)		
Median (IQR)	0.8 (0.5–1.5)	1.5 (1.0–2.0)	2.0 (0.0–3.0)	0.9 (0.3–1.4)	**< 0.001**	OP, OA > PI, OF

Note: Bold indicates $p < 0.05$. Results of *Friedman and ^Wilcoxon signed-rank tests with Bonferroni correction.

can still be used to reflect the PI domain given their close to very strong relationships.

4.4 | Study Limitations

The study was subject to some limitations. Firstly, the use of a cross-sectional design limits the ability to establish causality between TMD symptoms and the dimensions and domains of OHRQoL. To determine causal relationships, a longitudinal study would be necessary. Secondly, the study focused solely on TMDs and did not assess other oral conditions, such as caries, periodontal disease and malocclusion, which could also affect OHRQoL [46]. Thirdly, the findings may not be easily generalised to other age groups or TMD patient populations, as the study involved young adults from a single university. Moreover, the sample had a higher proportion of female participants, likely due to women's greater tendency to engage in online surveys [47]. However, the strong alignment of the results with those from more diverse populations suggests that the underlying mechanisms are robust, reinforcing the strength of the findings despite differences in the study population and lending support to their cautious generalisability [16, 26]. Lastly, although the measures for assessing TMD symptoms and OHRQoL were validated, they are self-reported, which can introduce information partialities, including recall and social desirability biases [48]. That said, the four-dimensional impact of PT and/or IT symptoms in this study appears to have mitigated these potential biases. Future research should prioritise longitudinal studies to establish causality between TMD symptoms and OHRQoL, with consideration for both general and TMD patient populations to enhance generalisability. Additionally, TMDs and a broader range of oral conditions should be physically assessed to minimise biases in self-reported measures.

5 | Conclusion

This study represents the first large-scale validation of the four-dimensional impact framework in a non-clinical sample of young adults, specifically addressing the consequences of TMD symptoms. Pain-related and/or intra-articular TMD symptoms are common among young adults, affecting approximately 53% of the participants in the study. TMD pain and dysfunction,

TABLE 5 | Correlations between the four OHIP dimensions and seven OHIP domains for all participants.

Variables	OHIP dimensions			
	Oral function (OF)	**Orofacial pain (OP)**	**Orofacial appearance (OA)**	**Psychosocial impact (PI)**
OHIP dimensions				
Oral function (OF)	—	0.68	0.47	0.67
Orofacial pain (OP)	0.68	—	0.49	0.60
Orofacial appearance (OA)	0.47	0.49	—	0.67
Psychosocial impact (PI)	0.67	0.60	0.67	—
OHIP domains				
Functional limitation (D1)	0.75	0.49	0.35	0.46
Physical pain (D2)	0.68	**1.00**	0.49	0.60
Psychological discomfort (D3)	0.55	0.56	**0.93**	0.78
Physical disability (D4)	**0.92**	0.65	0.44	0.65
Psychological disability (D5)	0.60	0.58	0.71	**0.90**
Social disability (D6)	0.56	0.46	0.40	0.78
Handicap (D7)	0.53	0.44	0.53	0.83

Note: Results of Spearman's correlation. All displayed associations were significant ($p < 0.001$). Bold indicates the strongest correlations.

especially when concurrent, can significantly impair the OF, OP, OA and PI dimensions of OHRQoL. The dimensions concerning OP and OA seem to be more affected than those associated with OF and PI, even in individuals without TMD symptoms. As dental malocclusion and related conditions exert considerable effects on OA and are associated with OHRQoL, it is advisable to minimise or even omit emphasis on the OA dimension when using the OHIP-14 mapping recommended by the international workgroup for TMD research. Apart from OA and functional limitation, moderate to strong associations were observed among OHIP dimensions and domains. The strong correlations observed between the physical disability, physical pain, psychological discomfort and handicap domains and the OF, OP, OA and PI dimensions confirmed their suitability as representations for the four dimensions. However, within the field of TMD, there exists some degree of overlap in the concepts measured by the four dimensions, warranting further investigation. The adoption of the four dimensions as the standardised metric for assessing OHRQoL can facilitate comparability between studies and enhance understanding of the impacts of TMDs, as well as the outcomes of bio-psychosocial interventions aimed at addressing them.

Author Contributions

Adrian Ujin Yap contributed to conceptualisation, data curation, formal analysis, investigation, methodology, project administration, resources, supervision, validation, visualisation and writing the original draft. Yinghao Xiong contributed to data curation, formal analysis, resources, software, validation, visualisation and review and editing. Carolina Marpaung and May Chun Mei Wong contributed to data curation, formal analysis, investigation, methodology, project administration, resources, software, supervision, validation and review and editing.

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Ethics Statement

Ethics approval for this research was duly obtained from the Institutional Review Board of Trisakti University School of Dentistry (ID: 377/S1/KEPK/FKG/8/2020).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Peer Review

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Exploring the Four-Dimensional Impact of Pain-Related and/or Intra-Articular Temporomandibular Disorder Symptoms on Oral Health-Related Quality of Life Among Young Adults

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ORIGINAL ARTICLE

Exploring the Four-Dimensional Impact of Pain-Related and/or Intra-Articular Temporomandibular Disorder Symptoms on Oral Health-Related Quality of Life Among Young Adults

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ABSTRACT

Objectives: A four-dimensional structure for oral health-related quality of life (OHRQoL) was recently proposed, comprising oral function (OF), orofacial pain (OP), orofacial appearance (OA) and psychosocial impact (PI). This study examined the impact of different temporomandibular disorder (TMD) symptoms on the four OHRQoL dimensions in young adults. It also correlated the four dimensions with the seven Oral Health Impact Profile (OHIP) domains.

Methods: Young adults were recruited from a large university. The quintessential five TMD symptoms (5Ts) and OHIP-14 were used to assess TMD symptoms and OHRQoL. Participants were categorised into no (NT), pain-related (PT), intra-articular (IT) and combined (CT) TMD groups, and total, dimension and domain OHIP scores were computed. Data were evaluated using the chi-square test and non-parametric analyses ($\alpha = 0.05$).

Results: Among the 1097 eligible participants (mean age 19.9 years [SD = 1.3]; 69.7% women), 47.2% reported no TMD symptoms, while 20.5%, 14.9% and 17.4% had PT, IT and CT TMD symptoms, respectively. Significant differences in OHIP scores were noted between individuals with and without TMD symptoms across all dimensions and domains (CT, PT, IT > NT). Additionally, notable distinctions in normalised dimension scores were evident in all participant groups (OP, OA > OF, PI). Moderate to strong correlations were discerned between OHIP dimensions and domain, except for OA with functional limitation ($r_s = 0.35$).

Conclusions: Adopting the four dimensions as the standard metric for assessing OHRQoL can improve study comparability and enhance understanding of TMD impacts.

Adrian Ujin Yap and Yinghao Xiong are co-first authors.

1 | Background

Temporomandibular disorders (TMDs), a cluster of clinical problems involving the masticatory system, are the second most common musculoskeletal condition causing pain and disability, following chronic low back pain [1]. While the estimated prevalence of TMDs is around 34%, up to 75% of the general population experience TMD symptoms, including facial/pre-auricular pain, temporomandibular joint (TMJ) sounds and limitations in jaw movements [2–4]. Using the diagnostic criteria for TMDs (DC/TMD) and its stratified reporting system, TMD diagnoses and symptoms can be classified into three main categories: intra-articular (IT), pain-related (PT) and combined (CT) [5, 6]. Women, particularly those between 20 and 40 years old, have a heightened susceptibility to TMDs [7, 8]. In addition to gender, various bio-psychosocial factors, such as age, trauma, oral parafunction, psychological distress and somatic symptoms, have been implicated in the development of TMDs [9–11]. TMDs, especially those accompanied by pain, have been shown to significantly impair oral health-related quality of life (OHRQoL) in both patient and community samples. This impact appears more pronounced in individuals who experience a higher number of TMD symptoms [12–14]. Conversely, therapeutic TMD interventions, such as psychotherapy, occlusal appliances and TMJ arthrocentesis, have the potential to enhance the OHRQoL of individuals affected by TMDs [15].

OHRQoL is a complex construct concerning the bio-psychosocial (functional, physical and psychosocial) aspects of well-being related to oral health/diseases [14–16]. Its importance in both dental research and clinical practice lies in the increasing recognition that managing oral diseases, including TMDs, should prioritise dental patient-reported outcomes (dPROs) that 'resonate' with patients' subjective experiences, rather than solely concentrating on objective clinical measures [15, 16]. The Oral Health Impact Profile (OHIP), specifically its 14-item short-form version (OHIP-14), is one of the most widely used tools for assessing OHRQoL [16–18]. Derived from Locker's model of oral health, the OHIP-14 consists of seven domains and is frequently employed in TMD research [12, 13, 19, 20]. However, the OHIP's seven-domain structure doesn't align well with empirical data [16, 21]. Instead, a set of four dimensions, namely oral function (OF), orofacial pain (OP), orofacial appearance (OA) and psychosocial impact (PI), were identified using exploratory factor analysis [22]. These dimensions were later verified and validated through further analyses, establishing a more psychometrically robust and clinically plausible structure for OHIP and OHRQoL in general [23–25]. Moreover, the four dimensions were also found to underlie dental patient-reported outcome measures (dPROMs) and were determined to be the primary drivers compelling dental patients to seek care worldwide [26–29]. In light of these discoveries, an international group of oral health researchers recommended adopting the four dimensions as the common metric for assessing the impact of oral diseases and exploring the effectiveness of dental interventions. This involved re-mapping and scoring the OHIP and its iterations, including the OHIP-14 [16, 29, 30].

The four-dimensional impact of different TMD symptoms on OHRQoL has not been documented among non-clinical young adults in community settings [30, 31]. Furthermore, correlation analyses need to be conducted between the OHIP dimensions and domains to substantiate the use of the physical disability, physical pain, psychological discomfort and handicap domains to represent OF, OP, OA and PI dimensions, respectively [16]. Therefore, the threefold objectives of this study were to (1) investigate the impact of intra-articular and/or pain-related TMD symptoms on the four OHIP dimensions, (2) identify which OHIP dimensions are primarily affected by various TMD symptoms and (3) establish correlations between the four OHIP dimensions and the seven OHIP domains. The research hypotheses were as follows: (a) TMD symptoms significantly diminished the OHRQoL of young adults; (b) the affected OHIP dimensions varied depending on the presence of TMD pain and/or dysfunction; and (c) the physical disability, physical pain, psychological discomfort and handicap domains exhibited moderate to strong correlations with the OF, OP, OA and PI dimensions, correspondingly.

2 | Methods

2.1 | Study Design and Sample

Ethics approval for this research was duly obtained from the Institutional Review Board of Trisakti University School of Dentistry (ID: 377/S1/KEPK/FKG/8/2020). Young adults were recruited from a large university using a non-probabilistic voluntary sampling approach. The recruitment process extended from January to December 2021, leveraging various channels such as the university's intranet portal and direct interpersonal engagement. To attain a 95% confidence level with a 5% margin of error, taking into account the university's student population of 21 000 individuals and a previously reported prevalence rate of 59% for TMD symptoms in a comparable sample, the study required a minimum of 366 participants [32]. The inclusion criteria involved individuals aged 18–24 proficient in English, while the exclusion criteria comprised those with a history of prior orofacial trauma/orthognathic surgery, as well as individuals currently undergoing treatment for debilitating physical and/or psychological conditions that impeded independent living. Additionally, participants with incomplete surveys were also omitted. After providing informed consent, participants were directed to complete a comprehensive online survey, which included demographic information, the quintessential five TMD symptoms of the DC/TMD (5Ts) and the OHIP-14 [4, 18].

2.2 | Study Measures

The 5Ts screening tool involves the five key TMD symptoms specified in the DC/TMD Symptom Questionnaire (SQ), comprising three intra-articular symptoms (TMJ noises, closed and open locking) and two pain-related symptoms (masticatory muscle/TMJ pain and headache) [4, 5]. It demonstrated high accuracy in detecting all TMDs, IT and PT, with corresponding areas under the receiver operating characteristics curves of 0.98, 0.98 and 1.00, respectively [4, 5]. Furthermore, the 5Ts exhibited high sensitivity, ranging from 96.1% to 99.2%, and 100% specificity in identifying the various TMD conditions [4]. Recently, the validity of the 5Ts tool was reaffirmed, and enhancements were made by including options to indicate the frequency and

differentiate muscle/TMJ pain [33]. TMD symptoms were evaluated over 30 days, with participants categorised as either '5Ts-negative' (no TMD symptoms [NT]) if they responded 'no' to all five questions or as '5Ts-positive' (with TMD symptoms [WT]) if they answered 'yes' to any of the five items. The '5Ts-positive' participants were subsequently stratified into subgroups based on the presence of IT, PT or CT symptoms [4, 32].

OHRQoL was assessed using the OHIP-14 questionnaire, which contained 14 items. The items were grouped into four dimensions (OF, OP, OA and PI) and seven domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap), as outlined in Table 1 [16, 18]. A 5-point response scale was employed for scoring the items, where 'never' equated to 0 points, 'hardly' to 1 point, 'occasionally' to 2 points, 'fairly often' to 3 points and 'very often' to 4 points. Severity scores for total OHIP, individual dimensions and domains were calculated by summing the ordinal values of all 14 items or dimension/domain-specific items. To support the comparison of dimensional impacts, normalised severity scores were computed by dividing the sum of dimension scores by the number of stipulated items, thereby normalising the scores with a common score range of 0–4. Larger severity scores indicate more impairments to quality of life and a lower OHRQoL.

2.3 | Statistical Analyses

All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software version 28.0 (IBM Corporation, Armonk, New York, USA), with the significance level set at 0.05. Categorical data were displayed as frequencies with their corresponding percentages, whereas numerical data were depicted using both means with standard deviations and medians with interquartile ranges. Chi-square test was employed to evaluate categorical data. Given the non-normal distribution of OHIP data as per Shapiro–Wilk's test, statistical comparisons among participant groups were performed using Mann–Whitney *U* test or Kruskal–Wallis tests with post hoc Dunn tests and Bonferroni correction, while within-group comparisons were assessed with the Friedman and Wilcoxon signed-rank tests. Correlation analysis between the four OHIP dimensions and seven OHIP domains was conducted using Spearman's rho correlation. The strength of correlation coefficients (r_s) was classified as weak, moderate or strong, with cut-off values of 0.1, 0.4 and 0.7, correspondingly [34].

3 | Results

The study included 1097 eligible participants, with a mean age of 19.9 years (SD = 1.3), and 69.7% were women. Of these, 47.2% were 5Ts-negative (NT), while 52.8% were 5Ts-positive (WT) and experienced TMD symptoms. Among the 5Ts-positive individuals, the proportion with PT (38.8%) was notably higher than those with CT (32.9%) and IT (28.3%). The 5Ts-positive group was somewhat older than the 5Ts-negative group, and no significant difference in sex distribution was noted between the two groups (Table 2).

TABLE 1 | Distribution of OHIP-14 items for the four dimensions and seven domains.

		Dimensions				Domains						
OHIP	Items	OF	OP	OA	PI	D1	D2	D3	D4	D5	D6	D7
1.	Speaking/pronouncing	●				●						
2.	Sense of taste	●				●						
3.	Painful aching		●				●					
4.	Uncomfortable eating		●				●					
5.	Self-conscious			●				●				
6.	Tense				●			●				
7.	Unsatisfactory diet	●							●			
8.	Interrupted meals	●							●			
9.	Difficulty relaxing				●					●		
10.	Embarrassed				●					●		
11.	Irritable				●						●	
12.	Occupational difficulties				●						●	
13.	Unsatisfactory life				●							●
14	Unable to function				●							●
Total number of items		4	2	1	7	2	2	2	2	2	2	2

Abbreviations: D1 = functional limitation; D2 = physical pain; D3 = psychological discomfort; D4 = physical disability; D5 = psychological disability; D6 = social disability; D7 = handicap; OA = orofacial appearance; OF = oral function; OP = orofacial pain; PI = psychosocial impact.

TABLE 2 | Demographic characteristics of the study sample.

Variables	Total	5Ts-negative with no TMD symptoms (NT)	5Ts-positive with TMD symptoms (WT)	*p*
n (%)	1078 (100%)	509 (47.2%)	569 (52.8%)	
Age				
Mean (SD)	19.9 (1.3)	19.7 (1.3)	20.0 (1.3)	
Median (IQR)	20.0 (19.0–21.0)	19.0 (19.0–21.0)	20.0 (19.0–21.0)	**< 0.001***
Sex				
Male, *n* (%)	327 (30.3%)	155 (30.5%)	172 (30.2%)	0.937^
Female, *n* (%)	751 (69.7%)	354 (69.5%)	397 (69.8%)	
TMD sub-types				
No TMD, *n* (%)	509 (47.2%)	509 (100%)	—	
Pain-related, *n* (%)	221 (20.5%)	—	221 (38.8%)	—
Intra-articular, *n* (%)	161 (14.9%)	—	161 (28.3%)	
Combined, *n* (%)	187 (17.4%)	—	187 (32.9%)	

Note: Bold indicates $p < 0.05$. Results of *Mann–Whitney *U* and ^chi-square tests.

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Table 3 shows the mean/median of OHIP dimension and domain scores for the four participant groups. Individuals with TMD symptoms presented significantly higher scores for all OHIP dimensions and domains compared to their peers without TMD symptoms (CT, PT, IT > NT). Moreover, substantial differences in total OHIP, OP and PI dimension scores, as well as physical pain, physical disability and psychological disability domain scores, were observed between those with CT and IT (CT > IT). Table 4 presents the mean/median normalised OHIP dimension scores. For all participant groups, OP and OA scores were significantly higher than OF and PI scores (OP, OA > OF, PI). Additionally, no significant differences in scores were observed between OP and OA, as well as between OF and PI normalised scores.

Table 5 indicates the correlations between the four OHIP dimensions and seven OHIP domains. The correlations between dimension and domain scores were highly significant ($p < 0.001$) and generally moderate to strong except for OA with functional limitation ($r_s = 0.35$). The strongest correlations between the four dimensions and discrete domains were as follows: OF and physical disability ($r_s = 0.92$), OP and physical pain ($r_s = 1.00$), OA and psychological discomfort ($r_s = 0.93$) and PI and psychological disability ($r_s = 0.90$).

4 | Discussion

This research is an initial exploration into the impact of different TMD symptoms on the four OHRQoL dimensions in young adults. It identified the dimensions primarily affected by the various symptoms and correlated the four dimensions with the seven OHIP domains. In addition to being more reliable and relevant, adopting the four dimensions as a standardised metric enables comparisons among various OHRQoL measures, oral diseases and dental interventions. It also facilitates decision-making in clinical practice, enhances communication and collaboration and aids in policy development [23–25]. Given the significant impact on OHRQoL caused by TMD symptoms and the largely moderate to strong correlations between OHIP dimensions and domains, the first and third research hypotheses were supported. However, the second research hypothesis was not upheld, as the primarily affected OHIP dimensions were consistent across all participant groups. University students were selected as the young adult population due to their vulnerability to chronic pain, including TMDs, which may stem from psychological distress induced by academic stress, social pressures and lifestyle adjustments [35, 36]. The prevalence of TMD symptoms observed fell within the documented range for the general population [3, 37]. Participants experiencing TMD symptoms tended to be slightly older, which could be associated with increased academic stressors and class hours as courses progressed [38].

4.1 | Comparison of TMD Symptoms

The presence of TMD pain and/or dysfunction significantly impaired overall OHRQoL as well as all OHIP dimensions and domains. Additionally, the combination of pain-related and intra-articular TMD symptoms reduced overall OHRQoL and negatively affected the OP and PI dimensions, along with the physical pain, physical disability and psychological disability domains, when contrasted with painless intra-articular symptoms alone. This could be partially attributed to the increased likelihood of young adults with CT experiencing more TMD pain and dysfunction, possibly linked to elevated levels of psychological distress and reliance on maladaptive coping strategies, including oral parafunction [32, 39]. Findings corroborated those of previous studies, emphasising the significant influence of TMDs on OHRQoL, particularly concerning the physical and psychosocial aspects [12, 13, 20, 40].

TABLE 3 | Mean/median OHIP dimension and domain scores for the four participant groups.

Variables	No TMD (NT)	Pain-related TMD (PT)	Intra-articular TMD (IT)	Combined TMD (CT)	*p**	Post hoc^
Total OHIP-14						
Mean (SD)	8.7 (8.7)	13.8 (9.6)	12.6 (11.3)	15.4 (10.5)		
Median (IQR)	6.0 (2–13)	12.0 (6.0–19.5)	10.0 (3.5–18.0)	14.0 (7.0–22.0)	**<0.001**	CT, PT, IT > NT CT > IT
Dimensions						
Oral function (OF)						
Mean (SD)	2.2 (2.7)	3.6 (2.9)	3.2 (3.2)	3.8 (3.2)		
Median (IQR)	1.0 (0.0–4.0)	3.0 (1.0–6.0)	2.0 (0.5–5.0)	3.0 (2.0–6.0)	**<0.001**	CT, PT, IT > NT
Orofacial pain (OP)						
Mean (SD)	1.7 (1.6)	2.6 (1.9)	2.4 (2.0)	3.0 (2.0)		
Median (IQR)	2.0 (0.0–3.0)	2.0 (1.0–4.0)	2.0 (1.0–4.0)	3.0 (2.0–4.0)	**<0.001**	CT, PT, IT > NT, CT > IT
Orofacial appearance (OA)						
Mean (SD)	1.1 (1.2)	1.6 (1.3)	1.5 (1.3)	1.8 (1.5)		
Median (IQR)	1.0 (0.0–2.0)	2.0 (0.0–3.0)	2.0 (0.0–3.0)	2.0 (0.0–3.0)	**<0.001**	CT, PT, IT > NT
Psychosocial impact (PI)						
Mean (SD)	3.6 (4.6)	6.1 (5.5)	5.5 (5.9)	6.8 (5.7)		
Median (IQR)	2.0 (0.0–6.0)	4.0 (2.0–9.0)	4.0 (1.0–8.0)	6.0 (2.0–10.0)	**<0.001**	CT, PT, IT > NT CT > IT
Domains						
Functional limitation (D1)						
Mean (SD)	0.8 (1.3)	1.3 (1.6)	1.2 (1.7)	1.2 (1.5)		
Median (IQR)	0.0 (0.0–1.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	**<0.001**	CT, PT, IT > NT
Physical pain (D2)						
Mean (SD)	1.7 (1.6)	2.6 (1.9)	2.4 (2.0)	3.0 (2.0)		
Median (IQR)	2.0 (0.0–3.0)	2.0 (1.0–4.0)	2.0 (1.0–4.0)	3.0 (2.0–4.0)	**<0.001**	CT, PT, IT > NT CT > IT
Psychological discomfort (D3)						
Mean (SD)	1.6 (1.8)	2.5 (2.2)	2.2 (2.1)	2.8 (2.2)		
Median (IQR)	1.0 (0.0–3.0)	2.0 (0.0–4.0)	2.0 (0.0–4.0)	2.0 (1.0–4.0)	**<0.001**	CT, PT, IT > NT

(Continues)

TABLE 3 | (Continued)

Variables	No TMD (NT)	Pain-related TMD (PT)	Intra-articular TMD (IT)	Combined TMD (CT)	*p**	Post hoc^
Physical disability (D4)						
Mean (SD)	1.4 (1.7)	2.3 (2.0)	1.9 (1.9)	2.6 (2.1)		
Median (IQR)	1.0 (0.0–2.0)	2.0 (0.0–4.0)	2.0 (0.0–3.0)	2.0 (1.0–4.0)	**<0.001**	CT, PT, IT > NT CT > IT
Psychological disability (D5)						
Mean (SD)	1.3 (1.7)	2.2 (2.0)	2.1 (2.1)	2.6 (2.0)		
Median (IQR)	1.0 (0.0–2.0)	2.0 (0.0–4.0)	2.0 (0.0–4.0)	2.0 (1.0–4.0)	**<0.001**	CT, PT, IT > NT CT > IT
Social disability (D6)						
Mean (SD)	0.9 (1.5)	1.5 (1.9)	1.3 (1.8)	1.6 (1.9)		
Median (IQR)	0.0 (0.0–1.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–3.0)	**<0.001**	CT, PT, IT > NT
Handicap (D7)						
Mean (SD)	0.9 (1.4)	1.5 (1.7)	1.4 (1.8)	1.6 (1.8)		
Median (IQR)	0.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–2.0)	1.0 (0.0–3.0)	**<0.001**	CT, PT, IT > NT

Note: Bold indicates $p<0.05$. Results of *Kruskal–Wallis and ^Dunn tests with Bonferroni correction.

4.2 | Comparison of OHIP Dimensions

The use of normalised scores allowed for the standardised evaluation of the four OHIP dimensions. In all participant groups, the OP and OA dimensions were significantly more affected than the OF and PI dimensions. While the disparity in impact between the OP and OF/PI dimensions is evident, the significance of the OA dimension warrants further clarification, especially since it was also observed in participants without TMD symptoms [30]. According to the recommended mapping, the OA dimension is only assessed by a single question in the OHIP-14: 'Have you been self-conscious because of your teeth, mouth or jaws? (item 5)' [16, 29]. As dental malocclusion, which may be related to dentofacial disharmonies, has considerable effects on OA and is associated with OHRQoL, much of the impact on OA may result from untreated malocclusion [41, 42]. Nevertheless, a recent study of prospective orthodontic patients found that TMDs influenced OHRQoL more than the severity of malocclusion [43]. The moderate to strong correlations of OA with OP, OF and PI ($r_s = 0.465–0.674$) provided some evidence to support this.

Montero et al. [44], employing both exploratory and confirmatory factor analyses, determined that the OHIP-14 has a three-dimensional structure, comprising only OF, OP and PI. Their model was subsequently applied in TMD research, revealing that the OP and PI dimensions, which exhibited moderate to strong relationships, were more impacted than the OF dimension [31]. The three-dimensional structure of the OHIP-14 might be better suited for TMD research, as it corresponds with existing literature and the limited relevance of OA to TMDs, except in situations of dentofacial deformities resulting from severe TMJ degeneration [31]. Considering the aforementioned information, it is advisable to minimise or even omit emphasis on the OA dimension when using the OHIP-14 mapping recommended by the international workgroup for TMD research.

4.3 | Correlations Between OHIP Dimensions and Domains

Correlational analyses were conducted to confirm the international workgroup's recommendation to use the physical disability, physical pain, psychological discomfort and handicap domains as representations of the OF, OP, OA and PI dimensions, correspondingly, in OHIP assessments [16, 29]. While the strongest correlations for OF, OP and OA were consistent with those proposed by the international workgroup, there was a variation for the PI dimension. The highest correlation coefficient was noted between PI and psychological disability, with additional strong associations evident in the psychological discomfort ($r_s = 0.78$), social disability ($r_s = 0.78$) and handicap domains ($r_s = 0.83$). Similarly, strong correlations were discerned between OF and functional limitation ($r_s = 0.75$), as well as between OA and psychological disability ($r_s = 0.71$). This implies that there may be some overlap in the concepts measured by the various OHIP-14 domains [45]. As such, the handicap domain

TABLE 4 | Normalised mean/median OHIP dimension scores for the four participant groups.

Variables	Oral function (OF)	Orofacial pain (OP)	Orofacial appearance (OA)	Psychosocial impact (PI)	*p**	Post hoc^
5Ts-negative						
No TMD symptoms (NT)						
Mean (SD)	0.6 (0.7)	0.9 (0.8)	1.1 (1.2)	0.5 (0.7)		
Median (IQR)	0.3 (0.0–1.0)	1.0 (0.0–1.5)	1.0 (0.0–2.0)	0.3 (0.0–0.9)	**<0.001**	OA, OP > OF, PI
5Ts-positive						
With TMD symptoms (WT)						
Mean (SD)	0.9 (0.8)	1.3 (1.0)	1.6 (1.4)	0.9 (0.8)		
Median (IQR)	0.8 (0.3–1.3)	1.0 (0.5–2.0)	2.0 (0.0–3.0)	0.6 (0.3–1.3)	**<0.001**	OA, OP > OF, PI
Intra-articular TMD (IT)						
Mean (SD)	0.8 (0.8)	1.2 (1.0)	1.5 (1.3)	0.8 (0.8)		
Median (IQR)	0.5 (0.1–1.3)	1.0 (0.5–2.0)	2.0 (0.0–3.0)	0.6 (0.1–1.1)	**<0.001**	OA, OP > PI, OF
Pain-related TMD (PT)						
Mean (SD)	0.9 (0.7)	1.3 (1.0)	1.6 (1.3)	0.9 (0.8)		
Median (IQR)	0.8 (0.3–1.5)	1.0 (0.5–2.0)	2.0 (0.0–3.0)	0.6 (0.3–1.3)	**<0.001**	OA, OP > OF, PI
Combined TMD (CT)						
Mean (SD)	0.9 (0.8)	1.5 (1.0)	1.8 (1.5)	1.0 (0.8)		
Median (IQR)	0.8 (0.5–1.5)	1.5 (1.0–2.0)	2.0 (0.0–3.0)	0.9 (0.3–1.4)	**<0.001**	OP, OA > PI, OF

Note: Bold indicates $p < 0.05$. Results of *Friedman and ^Wilcoxon signed-rank tests with Bonferroni correction.

can still be used to reflect the PI domain given their close to very strong relationships.

4.4 | Study Limitations

The study was subject to some limitations. Firstly, the use of a cross-sectional design limits the ability to establish causality between TMD symptoms and the dimensions and domains of OHRQoL. To determine causal relationships, a longitudinal study would be necessary. Secondly, the study focused solely on TMDs and did not assess other oral conditions, such as caries, periodontal disease and malocclusion, which could also affect OHRQoL [46]. Thirdly, the findings may not be easily generalised to other age groups or TMD patient populations, as the study involved young adults from a single university. Moreover, the sample had a higher proportion of female participants, likely due to women's greater tendency to engage in online surveys [47]. However, the strong alignment of the results with those from more diverse populations suggests that the underlying mechanisms are robust, reinforcing the strength of the findings despite differences in the study population and lending support to their cautious generalisability [16, 26]. Lastly, although the measures for assessing TMD symptoms and OHRQoL were validated, they are self-reported, which can introduce information partialities, including recall and social desirability biases [48]. That said, the four-dimensional impact of PT and/or IT symptoms in this study appears to have mitigated these potential biases. Future research should prioritise longitudinal studies to establish causality between TMD symptoms and OHRQoL, with consideration for both general and TMD patient populations to enhance generalisability. Additionally, TMDs and a broader range of oral conditions should be physically assessed to minimise biases in self-reported measures.

5 | Conclusion

This study represents the first large-scale validation of the four-dimensional impact framework in a non-clinical sample of young adults, specifically addressing the consequences of TMD symptoms. Pain-related and/or intra-articular TMD symptoms are common among young adults, affecting approximately 53% of the participants in the study. TMD pain and dysfunction,

TABLE 5 | Correlations between the four OHIP dimensions and seven OHIP domains for all participants.

Variables	OHIP dimensions			
	Oral function (OF)	Orofacial pain (OP)	Orofacial appearance (OA)	Psychosocial impact (PI)
OHIP dimensions				
Oral function (OF)	—	0.68	0.47	0.67
Orofacial pain (OP)	0.68	—	0.49	0.60
Orofacial appearance (OA)	0.47	0.49	—	0.67
Psychosocial impact (PI)	0.67	0.60	0.67	—
OHIP domains				
Functional limitation (D1)	0.75	0.49	0.35	0.46
Physical pain (D2)	0.68	**1.00**	0.49	0.60
Psychological discomfort (D3)	0.55	0.56	**0.93**	0.78
Physical disability (D4)	**0.92**	0.65	0.44	0.65
Psychological disability (D5)	0.60	0.58	0.71	**0.90**
Social disability (D6)	0.56	0.46	0.40	0.78
Handicap (D7)	0.53	0.44	0.53	0.83

Note: Results of Spearman's correlation. All displayed associations were significant ($p < 0.001$). Bold indicates the strongest correlations.

especially when concurrent, can significantly impair the OF, OP, OA and PI dimensions of OHRQoL. The dimensions concerning OP and OA seem to be more affected than those associated with OF and PI, even in individuals without TMD symptoms. As dental malocclusion and related conditions exert considerable effects on OA and are associated with OHRQoL, it is advisable to minimise or even omit emphasis on the OA dimension when using the OHIP-14 mapping recommended by the international workgroup for TMD research. Apart from OA and functional limitation, moderate to strong associations were observed among OHIP dimensions and domains. The strong correlations observed between the physical disability, physical pain, psychological discomfort and handicap domains and the OF, OP, OA and PI dimensions confirmed their suitability as representations for the four dimensions. However, within the field of TMD, there exists some degree of overlap in the concepts measured by the four dimensions, warranting further investigation. The adoption of the four dimensions as the standardised metric for assessing OHRQoL can facilitate comparability between studies and enhance understanding of the impacts of TMDs, as well as the outcomes of bio-psychosocial interventions aimed at addressing them.

Author Contributions

Adrian Ujin Yap contributed to conceptualisation, data curation, formal analysis, investigation, methodology, project administration, resources, supervision, validation, visualisation and writing the original draft. Yinghao Xiong contributed to data curation, formal analysis, resources, software, validation, visualisation and review and editing. Carolina Marpaung and May Chun Mei Wong contributed to data curation, formal analysis, investigation, methodology, project administration, resources, software, supervision, validation and review and editing.

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Ethics Statement

Ethics approval for this research was duly obtained from the Institutional Review Board of Trisakti University School of Dentistry (ID: 377/S1/KEPK/FKG/8/2020).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Peer Review

The peer review history for this article is available at https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/joor.13965.

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