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Evaluating oral health-related quality of life measure for children and preadolescents with temporomandibular disorder

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Abstract

Background: Oral health-related quality of life (OHRQoL) in children and adolescents with signs and symptoms of temporomandibular disorder (TMD) has not yet been measured. This study aimed to evaluate the validity and reliability of OHRQoL measure for use in children and preadolescents with signs and symptoms of TMD.

Methods: Five hundred and forty-seven students aged 8-14 years were recruited from public schools in Piracicaba, Brazil. Self-perceptions of QoL were measured using the Brazilian Portuguese versions of Child Perceptions Questionnaires (CPQ)₈₋₁₀ (n = 247) and CPQ₁₁₋₁₄ (n = 300). A single examiner, trained and calibrated for diagnosis according to the Axis I of the Research Diagnostic Criteria for TMD (RDC/TMD), examined the participants. A self-report questionnaire assessed subjective symptoms of TMD. Intraexaminer reliability was assessed for the RDC/TMD clinical examinations using Cohen's Kappa (κ) and intraclass correlation coefficient (ICC). Criterion validity was calculated using the Spearman's correlation, construct validity using the Spearman's correlation and the Mann-Whitney test, and the magnitude of the difference between groups using effect size (ES). Reliability was determined using Cronbach's alpha, alpha if the item was deleted and corrected item-total correlation.

Results: Intraexaminer reliability values ranged from regular ($\kappa = 0.30$) to excellent ($\kappa = 0.96$) for the categorical variables and from moderate (ICC = 0.49) to substantial (ICC = 0.74) for the continuous variables. Criterion validity was supported by significant associations between both CPQ scores and pain-related questions for the TMD groups. Mean CPQ₈₋₁₀ scores were slightly higher for TMD children than control children (ES = 0.43). Preadolescents with TMD had moderately higher scores than the control ones (ES = 0.62; $p < 0.0001$). Significant correlation between the CPQ scores and global oral health, as well as overall well-being ratings ($p < 0.001$) occurred, supporting the construct validity. The Cronbach's alphas were 0.93 for CPQ₈₋₁₀ and 0.94 for CPQ₁₁₋₁₄. For the overall CPQ₈₋₁₀ and CPQ₁₁₋₁₄ scales, the corrected item-total correlation coefficients ranged from 0.39-0.76 and from 0.28-0.73, respectively. The alpha coefficients did not increase when any of the items were deleted in either CPQ samples.

Conclusions: The questionnaires are valid and reliable for use in children and preadolescents with signs and symptoms of temporomandibular disorder.

Introduction

Over the years, different theories of etiology and different emphases on the causative factors for the various signs and symptoms of temporomandibular disorder (TMD) have been proposed in the literature [1]. The current perspective regarding TMD is now multidimensional, with

an appreciation that a combination of physical, psychological and social factors may contribute to the overall presentation of this disorder. Hence, today there is a preference for a biopsychosocial integrated approach [2]. Accordingly, TMD patients are a target population for quality of life (QoL) assessments because of the considerable psychosocial impact of orofacial pain [3]. TMD have generally been presumed to be conditions affecting only adults; however, epidemiological studies have reported signs and symptoms in children and adolescents to be as

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frequent as in adults [4] and the prevalence varies widely in the literature from 16% to 90%, due to the methodologies focusing largely on samples of patients seeking treatment or because they were conducted on convenience non-representative samples of the population. Brazilian studies have shown that in primary dentition 34% of the 99 children presented at least one sign and/or one symptom of TMD [5]. In the age of 12 years, 2.19% of the boys and 8.18% of the girls met the Research Diagnostic Criteria for TMD (RDC/TMD) when examined [6]. From 15 to 20 years-old 35.4% presented at least one symptom of TMD [7]. Signs and symptoms in childhood and adolescence have been indicating mild disorders, but these findings do not detract from the importance of early diagnosis to provide proper growth and development of the stomatognathic system [8]. Additionally the known fluctuation in signs and symptoms of musculoskeletal disorders in a time-dependent context might have been better addressed by carrying out repeated clinical recordings [4]. In addition, Dahlström and Carlsson [9], in a recent systematic review, observed a substantial negative impact on oral health-related quality of life (OHRQoL) in patients diagnosed with TMDs, being greater than other orofacial diseases/illnesses or conditions.

In this way, measuring health-related quality of life (HRQoL) in TMD patients with generic or condition-specific HRQoL instruments can complement efficacy measures, offering a complete picture of the impact of disease and treatment on overall well-being, as observed in adolescents with type 1 diabetes [10]. Jedel *et al.* [11] compared the HRQoL between children with TMD pain and a control group, using the Child health questionnaire-child form 87 (CHQ-CF87), a generic multidimensional instrument designed to assess physical and psychosocial impacts on children and adolescents aged 10-18 years. Although the results supported the use of generic instrument to measure health and to evaluate the efficacy of treatment in pediatric patients with TMD pain [11], other authors recommend the use of condition-specific instruments, which are more sensitive for detecting slight changes in specific conditions [12] and might allow a more detailed evaluation of the disability caused by TMD [13]. Accordingly, studies were conducted to evaluate the impact of TMD and associated pain on QoL in adult [3,12,14,15] and elderly [16] populations, using a condition-specific instruments, i.e., an OHRQoL measure (e.g., Oral Health Impact Profile and Geriatric Oral Health Assessment Index). The concepts in OHRQoL provide an opportunity to summarize a variety of possible psychosocial impacts in relation to specific oral diseases [14].

Measures have been developed specifically for assessing OHRQoL of children and adolescents [17-21]. The Child Perceptions Questionnaire (CPQ) is a measure applicable to children with a wide variety of oral and

orofacial conditions, based on contemporary concepts of pediatric health and which can accommodate developmental differences among children across age ranges [17,18]. It consists of two age specific instruments for children aged 8-10 years (CPQ₈₋₁₀) [18] and 11-14 years (CPQ₁₁₋₁₄) [17]. A preliminary study has confirmed the validity and reliability of these measures for use in Brazilian children and adolescents [22]. Although these questionnaires are standardized and widely used for other oral conditions, they have not yet been tested in TMD samples.

Assessing the impact of TMD on children's QoL is important in many fronts. It provides an insight into the potential consequences of TMD to the day-to-day lives of children and thereby facilitates understanding of its importance in the provision of oral health care [23]. Moreover, identifying factors associated with the impact of TMD on children's QoL can influence management of such cases and inform best practice guidelines [24]. In this way, the present study aimed to test the validity and reliability of CPQ used in a population of Brazilian public school students aged 8-14 years to determine whether these measures are sensitive to clinical signs and subjective symptoms of TMD. An additional aim was to verify whether the presence and severity of signs and symptoms of TMD are sufficient to influence OHRQoL of this age-specific population.

Material and methods

This study was approved by the Research Ethics Committee of the Dental School of Piracicaba, State University of Campinas (protocol n°021/2006).

A cross-sectional study with students of public schools of Piracicaba, Brazil, was developed. Piracicaba city has 368.843 scholars, with 50.187 enrolled in the elementary school system <http://www.ibge.gov.br>. The sample size was calculated by Epi info version 6.0.1 software. A standard error of 2%, a 95% confidence interval level and a 5.73% prevalence of TMD [25] were used for the calculation. The minimum sample size to satisfy the requirements was estimated at 513 subjects. A total of 547 students (235 boys and 312 girls), with no systemic diseases or communication and/or neuromuscular problems, participated in the study. The subjects ranged from 8 to 14 years of age, and were from nine public schools, which were randomly selected. All students obtained parental consent.

The exclusion criteria were conditions/children with facial traumatism, neurological or psychiatric disorders, use of dental prostheses, current use of medications (e.g., antidepressive, muscle relaxant, narcotic or non-steroidal anti-inflammatory), previous or present orthodontic treatment and other orofacial pain conditions, which could interfere with TMD diagnoses.

Data collection

Oral health-related quality of life evaluation

Data were collected using the Portuguese versions of the CPQ for individuals aged 8-10 years (CPQ₈₋₁₀) and 11-14 years (CPQ₁₁₋₁₄) [22]. These formed the components of the Child Oral Health Quality of Life Questionnaire that had been designed to assess the impact of oral conditions on the QoL of children and adolescents [17,18]. They were both self-completed. Items of the CPQ used Likert-type scales with response options of "Never" = 0; "Once or twice" = 1; "Sometimes" = 2; "Often" = 3; and "Very often" = 4. For the CPQ₁₁₋₁₄, the recall period was three months, while for that of the CPQ₈₋₁₀, it was four weeks. Items were grouped into four domains: oral symptoms, functional limitations, emotional well-being and social well-being.

Children and adolescents were also asked to give overall or global assessments of their oral health and the extent to which the oral or oro-facial condition affected their overall well-being. These questions preceded the multi-item scales in the questionnaires. A four-point response format, ranging from "Very good" = 0 to "Poor" and from "Not at all" = 0 to "A lot" = 3, was offered for these ratings in CPQ₈₋₁₀. In CPQ₁₁₋₁₄, these global ratings had a five-point response format ranging from "Excellent" = 0 to "Poor" = 5 for oral health and from "Not at all" = 0 to "Very much" = 5 for well-being.

Evaluation of signs and symptoms of TMD

Intraexaminer reliability Prior to the clinical examinations, the dental examiner (TSB) participated in the calibration process, which was divided into theoretical discussions on codes and criteria for the study, as well as practical activities. Intra-examiner reliability was investigated by conducting replicated examinations on 20 individuals one week later to minimize recall bias as a result of the first test.

RDC/TMD The RDC/TMD is a classification system composed by a dual-axis approach: Axis I (physical findings) and Axis II (pain-related disability and psychosocial status).

Subjective symptom interview A self-report questionnaire was used to assess subjective symptoms according to Riolo *et al.* [26], regarding pain in the jaws when functioning (e.g., chewing), unusually frequent headaches (i.e., more than once a week and of unknown etiology), stiffness/tiredness in the jaws, difficulty opening one's mouth, grinding of the teeth and sounds from the TMJ. Each question could be answered with a "yes" or a "no."

Moreover, three specific questions (yes/no) of the RDC/TMD Axis II were considered for further TMD diagnosis [27,28]: (1) *Have you had pain in the face, jaw, temple, in front of the ear or in the ear in the past month?*; (2) *Have you ever had your jaw lock or catch so*

that it won't open all the way?; (3) *Was this limitation in jaw opening severe enough to interfere with your ability to eat?* The other questions of Axis II were not included due to difficulty to understand or inappropriate for children.

Clinical signs evaluation The clinical signs of TMD were assessed using the RDC/TMD criteria (Axis I) described as follows [28,29]:

Pain Site. To determine whether the present pain was ipsilateral to the pain provoked by the clinical examination of the masticatory muscles and during jaw function.

Mandibular Range of Motion (mm) and Associated Pain. Jaw-opening patterns. Corrected and uncorrected deviations in jaw excursions during vertical jaw opening. Vertical range of motion of the mandible. Extent of unassisted opening without pain, maximum unassisted opening and maximum assisted opening. Mandibular excursive movements. Extent of lateral and protrusive jaw excursions.

Temporomandibular Joint Sounds. Palpation of the TMJ for clicking, grating, and crepitus sounds during vertical, lateral and protrusive jaw excursions.

Muscle and Joint Palpation for Tenderness. Bilateral palpation of extraoral and intraoral masticatory and related muscles (n = 20 sites) and bilateral palpation of the TMJ (n = 4 joint sites).

The clinical evaluation selected individuals with at least one sign and one symptom of TMD [30], who were referred to as the TMD group in this present study. Subjects meeting the criteria for myofascial pain with or without limited opening (Axis I, Group 1a or 1b disorders) and/or for disc displacement with reduction, without reduction with limited opening or without reduction without limited opening (Axis I, Group 2a, 2b or 2c) or for arthralgia or arthritis (Axis I, Group 3a or 3b) were considered to have an RDC/TMD diagnosis (RDC/TMD diagnosis group) [28]. The control group consisted of individuals with no current signs or symptoms of TMD (supercontrols) or those without signs or symptoms of TMD (control group) [14,28]. This recruitment strategy was based on the principle that subjects belonging to different groups will almost certainly respond differently to the questionnaire [31]. If the questionnaire is valid, it must be sensitive to such differences.

Data analysis

Statistical analyses were performed using SPSS 9.0 (SPSS, Chicago, IL, USA) with a 5% significance level and normality was assessed using the Kolmogorov-Smirnov test. Since score distributions were asymmetrical, non-parametrical tests were used in the performed analyses.

Overall scores for each participant were calculated by summing the item codes, whereas the subscale scores

were obtained by summing the codes for questions within the four health domains. Descriptive statistics were followed by bivariate analyses, which used (where appropriate) Chi-squared and Fisher's exact tests for a comparison of proportions and Mann-Whitney test for a comparison of the means of the continuous variables.

Intraexaminer reliability

Intraexaminer reliability calculations were performed on 20 individuals who participated in the Axis I assessment and the Axis II diagnosis interview. Only three questions (3, 14a, 14b) from the latter were used as required determinants for the Axis I diagnoses.

The two most commonly accepted methods for assessing the intraexaminer reliability were used [32]. When the clinical examination variable could be measured on a continuous scale, reliability was assessed by computing the intraclass correlation coefficient (ICC), using the one-way analysis of variance random effect parallel model [33]. The strength of the intra-examiner agreement was based on the following standards for ICC: < 0.2, poor; 0.21-0.40, fair; 0.41-0.60, moderate; 0.61-0.80, substantial and 0.81-1.0, excellent to perfect [34]. The Kappa statistic (Cohen's Kappa, κ) was computed to assess the reliability when variables were measured with a categorical rating scale (e.g., yes/no). Kappa values above 0.8 were considered excellent, from 0.61 to 0.8 good, 0.41 to 0.6 acceptable, 0.21 to 0.40 regular and below 0.20 fair [35].

Validity

The validity of a questionnaire represents the degree to which it measures what it is meant to measure. Criterion validity was calculated by comparing the correlations between CPQ scores and pain scores (obtained from Question 3 of the RDC/TMD Axis II), using the Spearman's correlation coefficient. As pain was considered a variable only in the TMD patients, the relevant correlation coefficients were calculated only for the TMD groups.

Discriminant construct validity was evaluated by comparing the mean scale scores between TMD and control groups using the Mann-Whitney test. The magnitude of the difference between groups was assessed using the effect size (ES). This was derived from the mean difference in scores between the groups divided by the pooled SD of scores: a value of 0.2 was taken to be small, 0.5 to be moderate and 0.8 to be large [36]. Discriminant construct validity was also assessed by verifying the difference between RDC/TMD diagnosis (individuals in Group I, II or III diagnosis) and "supercontrol" groups (individuals with no current sign and symptom of TMD). Correlational construct validity was assessed by comparing the mean scores and global ratings of oral health and overall well-being using Spearman's correlation coefficient.

Internal reliability

Reliability can be defined as a measure of the internal consistency or homogeneity of the items. Two measures were used for the analysis of internal reliability; the corrected item total correlation and the Cronbach's alpha coefficient [37]. Values above 0.2 for the former and 0.7 for the latter can be acceptable [38]. Alphas were also calculated with each item deleted.

Results

Descriptive statistics

A sample distribution of the evaluated characteristics (e.g., age, gender, TMD groups and CPQ scores) is shown in Additional file 1. Female children and preadolescents were more prevalent in TMD groups. Muscle tenderness and headaches were the most frequent signs and symptoms of TMD found in children and preadolescents, being observed more significantly in girls than in boys (Chi-squared test).

Intraexaminer reliability

Among the 20 subjects for the reliability study, there were 14 girls and 6 boys with an average age of 10.30 ± 1.78 years. Fourteen of the subjects complained of symptoms suggestive of TMD, while six were asymptomatic. In almost all subjects ($n = 19$), at least one sign of TMD was observed. The frequency of individuals with RDC/TMD diagnosis was 10% for muscle tenderness and 5% for disc displacements, respectively.

Table 1 shows the intraexaminer reliability for the clinical examinations and diagnostic questions of RDC/TMD. The ICC and Kappa values for the former ranged from 0.49 to 0.74, indicating a moderate to substantial agreement and from 0.30 to 0.96, indicating a regular to excellent agreement, respectively. High levels of reliability were found for all three questions of the Axis II, with kappa values ranging from 0.70 to 0.81.

Criterion validity

Table 2 shows the correlations between the scores of the different subscales and variable pain, which was the sum of the positive responses to question number 3 of the RDC/TMD Axis II, "Have you had pain in the face, jaw, temple, in front of the ear or in the ear in the past month?" There were positive correlations between the CPQ₁₁₋₁₄ total scores and variable pain ($r = 0.32$, $p < 0.0001$). Positive correlations were also observed between all of the domains of CPQ₁₁₋₁₄ and pain scores. There were no significant correlations observed between the scale and subscale CPQ₈₋₁₀ scores and variable pain, with the exception of the functional limitation subscale ($r = 0.18$, $p < 0.05$).

Table 1 Intraexaminer reliability of diagnostic questions and clinical examinations of the RDC/TMD criteria (n = 20)

RDC/TMD criteria	Reliability	
	Statistical tests	Interpretation
<i>Sign of TMD - Axis I</i>		
<i>Muscle tenderness</i>		
Extraoral myofascial sites (4-category variable) [†]	0.74	Substantial agreement
Intraoral myofascial sites (4-category variable) [†]	0.53	Moderate agreement
Jaw movements*	0.46	Acceptable agreement
<i>Joint pain</i>		
Palpation (4-category variable) [†]	0.67	Substantial agreement
Jaw movements*	0.96	Excellent agreement
<i>Range of motion</i>		
Vertical dimension (mm) [†]	0.68	Substantial agreement
Jaw excursions (mm) [†]	0.49	Moderate agreement
Jaw-opening pattern*	0.30	Regular agreement
<i>Joint sounds</i>		
Sound on jaw movement*	0.84	Excellent agreement
(Question) Symptom of TMD - Axis II*		
(3) Pain in facial area, the jaws or the jaw joint	0.81	Excellent agreement
(14a) Limitation in jaw opening	0.70	Good agreement
(14b) Diet restriction due to limitation in jaw opening	0.80	Good agreement

RDC/TMD, research diagnostic criteria for temporomandibular disorder

* Cohen's Kappa

† Intraclass correlation coefficient

Discriminant construct validity

Children with signs and symptoms of TMD reported, on average, worse OHRQoL than the control group, as indicated by the mean overall scores of 20.6 versus 13.5, respectively (Table 3). The effect size of 0.43 indicated that the difference between the groups was moderate ($p < 0.0001$). The CPQ₈₋₁₀ scores for the TMD group were

Table 2 Criterion validity: correlations between the CPQ scores and variable pain (Question 3, RDC/TMD Axis II) for TMD groups

TMD groups		Pain variable	
		r ^a	P
CPQ ₈₋₁₀ n = 141	Total scale	0.14	0.089
	<i>Subscales</i>		
	Oral symptoms	0.13	0.106
	Functional limitations	0.18	0.024
	Emotional well-being	0.06	0.476
	Social well-being	0.09	0.278
CPQ ₁₁₋₁₄ n = 176	Total scale	0.32	< 0.0001
	<i>Subscales</i>		
	Oral symptoms	0.33	< 0.0001
	Functional limitations	0.26	0.000
	Emotional well-being	0.24	0.001
	Social well-being	0.27	0.000

TMD, temporomandibular disorder; CPQ, child perceptions questionnaire

^a Spearman's correlation coefficient

also higher than in all subscales. When expressed as effect size, the magnitude of the mean differences was small to moderate. The mean score in the RDC/TMD diagnosis group (25.6 ± 22.3) was moderately higher than in the "supercontrol" group (7.5 ± 7.8) (Table 4). There were also significant differences between the groups for all the domains, with effect sizes ranging from moderate for functional (ES = 0.58), emotional (ES = 0.50) and social (ES = 0.54) domains to large for the oral symptom subscale (ES = 0.87).

Preadolescents in the TMD group had, on average, higher overall scores than in the control group (27.6 vs. 16.3; $p < 0.0001$) (Table 3). The same difference was observed in all domains, with the mean functional and social well-being score being two times higher in the former than in the latter patient group: 6.5 vs. 3.6 ($p < 0.0001$) and 5.9 vs. 2.9 ($p < 0.0001$). The magnitude of the differences between the clinical groups was moderate, ranging from 0.46 in the oral symptoms domain to 0.62 in the functional limitations domain. When the scores for the RDC/TMD diagnosis groups were examined, preadolescents diagnosed with TMD had significantly higher scores than the "supercontrol" group for all total and subscale CPQ₁₁₋₁₄ scores (Mann-Whitney *U* test) (Table 4).

Correlational construct validity

As an index of construct validity, Spearman's correlation was highly significant at the 0.0001 level in both global

Table 3 Discriminant construct validity: a comparison between the CPQ mean scores of the TMD and control groups

		TMD group (n = 141)		Control group (n = 106)		P*	ES [†]
		Mean (SD)		Mean (SD)			
CPQ ₈₋₁₀	Overall scale [0-100]	20.6 (17.7)		13.5 (15.4)		< 0.0001	0.43
	Subscales						
		Oral symptoms [0-20]		5.2 (3.9)		< 0.0001	0.55
		Functional limitations [0-20]		2.6 (3.8)		0.001	0.36
		Emotional well-being [0-20]		2.6 (4.1)		< 0.0001	0.52
	Social well-being [0-40]		3.1 (5.9)		0.009	0.39	
		TMD group (n = 176)		Control group (n = 124)		P*	ES [†]
		Mean (SD)		Mean (SD)			
CPQ ₁₁₋₁₄	Overall scale [0-148]	27.6 (20.7)		16.3 (14.8)		< 0.0001	0.62
	Subscales						
		Oral symptoms [0-24]		5.2 (3.5)		< 0.0001	0.46
		Functional limitations [0-26]		3.6 (4.2)		< 0.0001	0.62
		Emotional well-being [0-36]		4.5 (5.6)		< 0.0001	0.53
	Social well-being [0-52]		2.9 (4.0)		< 0.0001	0.56	

TMD, temporomandibular disorder; CPQ, child perceptions questionnaire

Values in square brackets indicate range of possible scores

* P-values obtained from Mann-Whitney test

† ES = Effect sizes, difference in group means/pooled SD

ratings for CPQ₈₋₁₀ total scales in the TMD group (Table 5). Positive correlations were also observed between all the CPQ₈₋₁₀ subscale scores and global oral health ratings, as well as overall well-being.

The TMD group showed significant correlations between overall CPQ₁₁₋₁₄ scores and global oral health ratings (p < 0.0001) and overall well-being (p < 0.0001). Significant correlations were also observed between the

scores for all CPQ₁₁₋₁₄ subscale scores and both global ratings (Table 5).

Reliability

Internal consistency reliability was assessed for the TMD samples using Cronbach's alpha (Table 6). This was 0.93 for the total CPQ₈₋₁₀ and ranged from 0.68 to 0.90 for the subscales, indicating an acceptable to good

Table 4 Discriminant construct validity: CPQ overall and domain scores by the RDC/TMD diagnosis and "supercontrol" groups

		RDC/TMD Diagnosis Group (n = 32)		Supercontrol Group (n = 28)		P*	ES [†]
		Mean (SD)		Mean (SD)			
CPQ ₈₋₁₀	Overall scale [0-100]	25.6 (22.3)		7.5 (7.8)		< 0.0001	0.61
	Subscales						
		Oral symptoms [0-20]		3.5 (3.4)		< 0.0001	0.87
		Functional limitations [0-20]		1.3 (1.9)		< 0.0001	0.58
		Emotional well-being [0-20]		1.1 (1.7)		0.000	0.50
	Social well-being [0-40]		1.7 (3.1)		0.006	0.54	
		RDC/TMD Diagnosis Group (n = 69)		Supercontrol Group (n = 29)		P*	ES [†]
		Mean (SD)		Mean (SD)			
CPQ ₁₁₋₁₄	Overall scale [0-148]	35.0 (24.1)		11.7 (9.6)		< 0.0001	0.88
	Subscales						
		Oral symptoms [0-24]		4.2 (2.1)		< 0.0001	0.74
		Functional limitations [0-26]		2.2 (2.9)		< 0.0001	0.89
		Emotional well-being [0-36]		3.1 (4.1)		< 0.0001	0.73
	Social well-being [0-52]		2.1 (3.4)		< 0.0001	0.82	

TMD, temporomandibular disorder; CPQ, child perceptions questionnaire

Values in square brackets indicate range of possible scores

* P-values obtained from Mann-Whitney test

† ES = Effect sizes, difference in group means/pooled SD

Table 5 Correlational construct validity: correlations between CPQ scores and global ratings of oral health and overall well-being (TMD groups)

TMD groups	CPQ ₈₋₁₀ (n = 141)				CPQ ₁₁₋₁₄ (n = 176)			
	Oral Health		Overall Well-being		Oral Health		Overall Well-being	
	R ^a	P ^b	R ^a	P ^b	R ^a	P ^b	R ^a	P ^b
Total scale	0.36	< 0.0001	0.41	< 0.0001	0.37	< 0.0001	0.62	< 0.0001
<i>Subscales</i>								
Oral symptoms	0.37	< 0.0001	0.39	< 0.0001	0.36	< 0.0001	0.42	< 0.0001
Functional limitations	0.25	0.002	0.41	< 0.0001	0.28	0.000	0.48	< 0.0001
Emotional well-being	0.44	< 0.0001	0.38	< 0.0001	0.34	< 0.0001	0.57	< 0.0001
Social well-being	0.28	0.000	0.36	< 0.0001	0.26	0.000	0.53	< 0.0001

TMD, temporomandibular disorder; CPQ, child perceptions questionnaire

level of internal consistency. For the overall CPQ₈₋₁₀ scale, the corrected item-total correlation coefficients were from 0.39 to 0.76 and for the domains the same coefficients ranged from 0.37 to 0.77. The alpha coefficients did not increase when any of the items were deleted.

A total of 176 TMD individuals were used to test the internal reliability of the CPQ₁₁₋₁₄ (Table 6). Cronbach's alpha for CPQ₁₁₋₁₄, as a whole, was excellent (0.94). For the domains of the CPQ₁₁₋₁₄, the coefficients ranged from 0.69 for oral symptoms to 0.90 for emotional well-being, indicating an acceptable to good levels of internal consistency reliability. The corrected item-total correlations for the total CPQ₁₁₋₁₄ scale ranged from 0.28 to 0.73. For the CPQ₁₁₋₁₄ subscales, the corrected item-total correlation coefficients ranged from 0.28, which represented the lower coefficient for the social well-being domain, to 0.76 for emotional well-being. The alpha was not higher when any item was deleted.

Discussion

This study was undertaken to provide evidence of the reliability and validity of the CPQ₈₋₁₀ and CPQ₁₁₋₁₄ in children and preadolescents with signs and symptoms of TMD. Our previous study had indicated that these measures were able to discriminate between children and preadolescents with different levels of severity of dental caries, malocclusion, fluorosis and gingivitis [22]. According to Locker *et al.* [39], the process of evaluating HRQoL measures consists of two stages; the first involves an assessment of the reliability and validity and the second consists of on-going evaluations of the performance in different populations and the various contexts for which it was intended. Furthermore, the linguistic and cultural context in which a measure is used can have a bearing on the validity, as can the intended purpose of the measure; thus prior validity and reliability tests, the instruments must be translated, back-translated, and cross culturally adapted in order to

Table 6 Internal consistency reliability: Cronbach's alpha, Alpha if item deleted and Corrected item-total correlation (TMD groups)

TMD groups		Number of items	Cronbach's alpha	Range of α 's if items deleted	Range of corrected item total correlations	
CPQ ₈₋₁₀ n = 141	Total scale	25	0.93	(0.93-0.93)	(0.39-0.76)	
	<i>Subscales</i>					
	Oral symptoms	5	0.68	(0.61-0.66)	(0.37-0.48)	
	Functional limitations	5	0.78	(0.70-0.75)	(0.51-0.67)	
	Emotional well-being	5	0.85	(0.81-0.83)	(0.60-0.71)	
Social well-being	10	0.90	(0.88-0.90)	(0.52-0.77)		
CPQ ₁₁₋₁₄ n = 176	Total scale	37	0.94	(0.93-0.94)	(0.28-0.73)	
	<i>Subscales</i>					
	Oral symptoms	6	0.69	(0.62-0.68)	(0.33-0.51)	
	Functional limitations	9	0.79	(0.76-0.78)	(0.40-0.57)	
	Emotional well-being	9	0.90	(0.88-0.89)	(0.59-0.76)	
Social well-being	13	0.87	(0.85-0.87)	(0.28-0.67)		

TMD, temporomandibular disorder; CPQ, child perceptions questionnaire

ensure their conceptual and functional equivalences [22,27,31].

The RDC/TMD had been the best and most used classification system to date for epidemiological studies that sought to understand TMD etiology and mechanisms [40]. Together, Axis I and Axis II assessments constitute a comprehensive evaluation consistent with the biopsychosocial health model [2]. In this study, only three specific items for the latter were included, since they were more appropriate for the age sample. Accordingly, a questionnaire containing items regarding self-reported pain and associated symptoms of TMD [26] was used to replace the pain-related disability approach of RDC/TMD Axis II [41].

Reliability and validity are the basic underpinnings of any scientific measure. The reliability of a diagnostic instrument sets the upper limit for its validity [42]. Several studies evaluating the reliability of clinical findings have shown that the experiences and calibration of the examiners are crucial for accuracy of the results [32,43,44], as done in the present study. Individuals with most common TMD conditions as well as asymptomatic controls were included in the reliability assessment ($n = 20$) to ensure that a broad spectrum, ranging from none to severe findings, was present [32,45]. It provided a more realistically simulated actual clinical and research conditions, wherein patients and subjects who were both symptomatic and asymptomatic for TMD might actually appear to undergo RDC/TMD diagnostic examinations [46]. Other influencing factors included the feasibility of conducting such examinations in an acceptable time frame [46-48].

Considering the minimum acceptable level for agreement at 0.40 (kappa) for categorical measures and at 0.70 (ICC) for continuous variables [49], inconsistency was found in some RDC/TMD measurements, mainly in the pain scores and in the ranges of motion. However, the overall reliability results were still good. The poor intraoral muscle reliability found in the present study and by others [43,47] could be explained by the low specificity of muscle palpation [50,51]. Moreover, a low reproducibility for the pain scores is not unusual because pain intensities do vary over even short periods of time [52] partly due to poor memory recall for pain [53]. Only a moderate level of reproducibility was found for jaw excursions, compared with other studies where more agreement was observed [43,47]. In addition, differences in reliability findings may reflect variations in the methodology, such as differences in subject samples, numbers of examiners, study designs, statistical analyses, as well as prevalence and sampling variability [43,46,54].

Muscle tenderness was the most frequent clinical sign, found in 77.3% of children and 67% of preadolescents, agreeing with Tuerlings and Limme [55]. However,

these results must be carefully considered given the low specificity of muscle palpation [50,51]. The prevalence of joint pain was substantial, being the second most frequent sign observed in 48.9% of the children and 44.9% of the preadolescents, higher than values observed in adolescents by Bonjardim *et al.* [41] (7.83%-10.6%). The less prevalent sign of TMD were TMJ sounds, found in just 5% of the children and 8% of the preadolescents and even lower than those observed in previous studies [41,56,57]. The difference in findings may reflect variations in the tools being used. The high sensitivity of RDC/TMD classification for TMJ sounds, which is based on reproducible clicks on two of three trials, contributes to the elimination of indistinct or temporary clicking sounds [32], decreasing the probability of false positive results.

In TMD groups, the presence of headaches was higher in children than in preadolescents, as previously observed [41,56,58]. There was no gender difference in the symptomatic children, but among preadolescents, the prevalence of headaches associated with TMD was higher in girls than in boys. In line with these findings, previous studies found an increasing of this association with age among adolescents, especially in females [59,60]. Similarly, the higher prevalence of the clinical signs of TMD, mainly painful signs among females, was consistent with some previous findings [57,58,61], whereas others found no gender-linked relationships [41,62]. The difference between genders could probably be explained by the fact that girls may be more sensitive to tenderness and pain on palpation of the TMJ and adjacent muscles [63] mainly in older age due to hormonal changes [56,61].

Ideally, criterion validity would be measured relative to a "gold standard." As no such standard exists for oral health status measures, criterion validity was evaluated by correlating the CPQ scores with a score corresponding to the sum of the answers to the item investigating pain (Question 3, RDC/TMD Axis II). This approach is consistent with literature reports that suggest the use of external criteria to test criterion validity [31]. Subjects with pain-associated conditions presented higher impacts on daily function in this study and in others performed in adult [3,12] and elderly [10] populations. Accordingly, the patients' well-being decreased as a function of pain duration and increased in pain intensity, frequency and number of pain sites [12,31]. In the only study to address this issue in youth patients, Jedel *et al.* [11] found that children and adolescents with TMD pain more than once a week were associated with higher impacts on physical functioning, emotional roles and behavioral roles, resulting in limitations on physical activities, school work and activities with friends. Similarly, positive correlations were observed between all the

domains of CPQ₁₁₋₁₄ and pain scores for preadolescents. Although a substantial prevalence of pain symptoms existed in the CPQ₈₋₁₀ sample (36.2%), only the functional domain was associated with this variable. It is likely that reporting symptoms of minor severity or of fleeting nature resulted in such a high prevalence. Less severe pain and sensations may be responsible for less impaired OHRQoL in children reporting TMD. In fact, patients with TMD initially display functional limitations. These are followed by psychological discomfort, social disability and handicap and finally chronic pain [31]. This progression can also explain the different discriminant construct validity results, which compared the controls with both TMD groups and with the advanced cases.

The discriminant construct validity of the questionnaires was supported by their ability to detect differences in the impact on QoL, evidenced by the highest scores being seen in children and preadolescents with signs and symptoms of TMD. However, although the difference in scores supported the validity of the measures, the magnitude of these differences was only low to moderate. According to Reissmann *et al.* [14], the magnitude of TMD impact depends on the definition of the comparison group without TMD diagnoses. Although patients in the general population are the most plausible choice for comparison (which was chosen in the present study), they may have some signs and symptoms of TMD; these are insufficient to warrant an RDC/TMD diagnosis but sufficient to influence QoL. This is consistent with the findings by Reissmann *et al.* [14], where subjects without diagnosis had a more than 50% higher OHRQoL impact levels compared to subjects without any TMD sign or symptom. Other authors suggest that differences in scores of QoL measures can be properly interpreted only after minimally important differences have been recognized [64]. The minimum important difference is defined as the smallest difference in scores that patients perceive as being important, which would suggest a change in the patient's management [65]. This score can be determined only following longitudinal studies in which some individuals changed and some did not, either as the result of therapy or natural fluctuations in the disorder. This evaluation has yet to be undertaken with respect to the measures used in this study.

Evidence that the higher scores of the TMD individuals may be important was found in the responses of the advanced cases when compared to the "supercontrol" reports. Analyses of the scores derived from both questionnaires indicated that the QoL of children and preadolescents diagnosed with TMD was markedly worse than that of individuals with no current signs or symptoms of TMD. These results were consistent with

the higher impact found in adults diagnosed with TMD when compared with control groups in the study by Rener-Sitar *et al.* [15], which suggested that diagnoses associated with pain (e.g., myofascial pain, arthralgia) have a higher impact than non-pain-related diagnoses (e.g., disc displacement with reduction). Considering that muscle tenderness was the most frequent diagnosis observed among the evaluated TMD sample, greater impact on QoL was expected for these subjects.

The construct validity was further supported when the CPQ scores were assessed for the TMD groups against the global questions, as high correlations between them suggest that they are measuring the same construct. Moreover, these associations showed that the reported issues and concerns of the TMD groups extend beyond oral health and are of sufficient magnitude to have some effect on their life as a whole. It means that the questionnaires actually measured as originally intended [38].

Accepted minimal standards for internal reliability coefficients are 0.70 for group comparisons and 0.90-0.95 for individual comparisons [66]. Accordingly, the reliability coefficients for both CPQ total and subscales exceeded standards for group and individual level comparisons [67], except for oral symptoms domains, which were slightly lower at 0.68 for CPQ₈₋₁₀ and at 0.69 for CPQ₁₁₋₁₄. However, these values can be acceptable, as they are far greater than 0.50, an indicative level for non-homogeneous scales [68]. According to Gherunpong *et al.* [59], alpha is not a perfect indicator of reliability, as it tends to underestimate the reliability of multidimensional scales and because lower values can be expected from health-related measures. All item-total correlations were above the minimum recommended level of 0.20 [19] and alpha did not increase when an item was deleted.

The greatest strength of this study is the use of the standardized OHRQoL questionnaires and also the standardized assessment of the level of impairment of different anatomical structures that constitute a stomatognathic system according to the RDC/TMD protocol [15]. Besides that, the recruitment strategy of sample allowed for a spectrum of participants, which provided a valid estimation of the differences between individuals with variety levels of severity of the same clinical condition, so that a judgement could safely be made concerning the generalisation of the results to that population [31]. On the other hand, it is also important to recognize the limitations of the work performed in terms of the methodology and analytic strategies used [69]. Given the cross-sectional nature of the data study, the observed finding could address only the descriptive and discriminative potential of OHRQoL measures in relation to TMD condition. Further research is required to determine whether or not these

instruments discriminated between groups of children and adolescents with different clinical conditions. Studies should also include the measurement of factors that may account for the variation in OHRQoL observed in TMD patients, as well as, for other oral conditions. Finally, longitudinal studies are required to demonstrate OHRQoL responsiveness to change prior to using it in a context where change is expected, desired or possible [70].

Conclusions

The results of this study emphasize the importance of perceived health status and QoL assessment for evaluating TMD patients, since signs and symptoms of TMD can have a substantial functional, emotional and psychologic impact, negatively affecting the QoL of children and preadolescents. Comparisons between individuals with different levels of the same condition clearly indicated the progressive aspects of the pathology that appear in advanced cases. Sufficient descriptive and discriminative psychometric properties of CPQ in TMD populations make these instruments suitable for assessing OHRQoL in cross-sectional studies. Finally, further studies are required to confirm the evaluative potential of these measures in this clinical and age-specific population.

Abbreviations

(CPQ): Child Perceptions Questionnaire; (CPQ₈₋₁₀): Child Perceptions Questionnaire 8-10 years; (CPQ₁₁₋₁₄): Child Perceptions Questionnaire 11-14 years; (κ): Cohen's Kappa; (ES): Effect size; (HRQoL): Health-related quality of life; (ICC): Intraclass correlation coefficient; (OHRQoL): Oral health-related quality of life; (QoL): Quality of life; (RDC/TMD): Research Diagnostic Criteria for temporomandibular disorder; (TMD): Temporomandibular disorder

Additional material

Additional file 1: Sample distribution in accordance with the evaluated characteristics - number of children (%). The data provided represent the distribution of the age-specific samples according to clinical groups, signs and symptoms of TMD and perception of oral health.

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Authors' contributions

TSB participated in conception and design of the study, data analysis and interpretation, acquisition of data and drafting the manuscript. MS contributed to the data collection. PMC made critical comments on the manuscript. MBDG participated in the conception and design of the study and critical revision of manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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