Community Dent Oral Epidemiol 2007; 35: 179–185

COMMUNITY DENTISTRY AND ORAL EPIDEMIOLOGY

Is the Child Perceptions Questionnaire for 11–14 year olds sensitive to clinical and self-perceived variations in orthodontic status?

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Locker D, Jokovic A, Tompson B, Prakash P. Is the Child Perceptions Questionnaire for 11–14 year olds sensitive to clinical and self-perceived variations in orthodontic status? Community Dent Oral Epidemiol 2007 35: 179–185. © 2007 The Authors. Journal compilation © 2007 Blackwell Munksgaard

Abstract – *Objectives:* To assess the association between scores on the Child Perceptions Questionnaire for 11–14 year olds (CPQ11–14) and clinical and self-perceived measures of malocclusion. *Methods:* Children were recruited from an orthodontic clinic just prior to starting orthodontic treatment. They completed a copy of the CPQ11–14 and a short questionnaire concerning their feelings about the condition of their teeth. Study models were taken and rated according to the Dental Aesthetic Index (DAI) and the Peer Assessment Rating (PAR) index by two sets of three examiners. Intra and inter-rater reliabilities for the two sets of examiners ranged from 0.80 to 0.99. CPQ11–14 scores were calculated for the full 35-item version and for 16 and 8-item short forms by summing the item response codes. The association between these scores, the DAI and PAR ratings and self-perceived measures of malocclusion were examined using appropriate parametric and nonparametric tests. *Results:* Complete data were collected for 141 children, 63 boys and 78 girls. The mean age was 12.5 (SD = 1.0). DAI scores ranged from 17.0 to 58.0 with a mean of 35.0 (SD = 8.0). The distribution of subjects across the four severity categories was minor/none – 6.6%, definite – 35.2%, severe – 15.6% and handicapping 42.6%. PAR scores ranged from 8.0 to 66.0 with a mean of 31.4 (SD = 11.1). Eight percent had scores of 50 or above indicating marked deviation from an ideal occlusion. Both the long and the short forms of the CPQ11–14 identified substantial variability in the impacts of malocclusion. Correlations between CPQ11–14 scores and the orthodontic indices ranged from 0.26 to 0.31 ($P < 0.01$). There was a clear gradient in CPQ11–14 scores across four categories of the PAR based on quartiles. The gradient across the DAI categories was less clear. There were significant associations between all CPQ11–14 scores and the children's self-ratings of oral health, ratings of the extent to which the condition of the teeth affected life overall and expressions of happiness with the appearance and arrangement of the teeth. *Conclusion:* The results provide some evidence of the validity of the CPQ11–14 when used with children needing orthodontic treatment. However, because clinical samples are biased the study needs to be repeated in different treatment settings in order to confirm the utility of the measure.

Key words: children; malocclusion; oral health-related quality of life; reliability; validity

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Submitted 11 December 2005;
accepted 2 April 2006

doi: 10.1111/j.1600-0528.2006.00324.x

The process of developing and evaluating health-related quality of life measures consists of three stages. The first is the development of the measure itself. This consists of the specification of measurement goals, identification of an appropriate conceptual framework and the use of a systematic rather than ad hoc process to select items and create sub-scales. The second stage consists of the initial evaluation of the psychometric properties of the measure. This involves assessment of internal consistency and test–retest reliability and of various forms of validity, most commonly cross-sectional construct validity. It may also involve procedures such as factor analysis to confirm the conceptual structure of the measure. The third stage is the on-going evaluation of the performance of the measure in different populations and the various contexts for which it was intended. This is particularly important with respect to generic measures which were developed to be used as outcome indicators in diverse populations and several study types including surveys and clinical trials. Such studies may lead to information on other important properties, such as longitudinal construct validity and responsiveness and/or lead to modifications that may enhance the performance of the measure. In this respect, every study in which a measure is used provides an opportunity for exploring and confirming its reliability and validity.

To date several measures designed to assess oral health-related quality of life have been developed (1). The majority is appropriate for adult and/or elderly populations but have a number of limitations when the population of interest is children. These limitations lead to the development of the Child Oral Health Quality of Life Questionnaires, a battery of measures that take into account the cognitive abilities and life styles of children. These consist of questionnaires for children aged 11–14 years (CPQ11–14) (2) and 8–10 years (CPQ8–10) (3) that assess children's perceptions of the impact of oral disorders on physical and psychosocial functioning. Also included are a questionnaire for parents that captures their perceptions of their child's oral health-related quality of life (4), and a scale to assess the effect of oral disorders on family functioning (5). Short forms of the CPQ11–14 comprised of 16 items and 8 items have also been developed (6). Preliminary studies have been undertaken that demonstrate the reliability and cross-sectional validity of all questionnaires.

For example, the CPQ11–14 consists of 35 items organized into four sub-scales; namely, oral symptoms, functional limitations, emotional well-being and social-well-being. Items address the frequency with which various problems have been experienced in the previous three months and have the following response options: 'Never', 'Once or twice', 'Sometimes', 'Often' and 'Everyday or almost everyday'. The instrument was initially evaluated in a study of three groups of children recruited from clinical settings (2). These were a paediatric dental group who were attending clinics for the treatment of dental caries, a group just about to begin orthodontic treatment and an oro-facial group consisting of children with cleft lip and palate or craniofacial anomalies being treated at a specialist hospital-based clinic. Internal consistency reliability and test–retest reliabilities were excellent with all Cronbach's alphas and Intra-class Correlation Coefficients (ICCs) exceeding 0.80. Discriminant validity was established by comparing scale and sub-scale scores across the three groups. As hypothesized, scores were highest in the oro-facial group, lowest in the paediatric dental group and intermediate for the orthodontic group. Construct validity was established by significant positive correlations between scale scores and children's ratings of their oral health and the extent to which the condition of the teeth and mouth affected their life overall.

However, sample sizes and limitations in the scope of the clinical data collected precluded examination of the association between scale scores and measures of clinical severity within each of the three groups included in the preliminary studies. Consequently, as the COHQoL questionnaires were intended to be generic instruments that could be used as outcome indicators in surveys, clinical trials and clinical practice, further examination of their properties and performance in different populations and different contexts are necessary.

Some evidence pertaining to the reliability and validity of the CPQ11–14 when used with general population samples has been provided by Foster Page et al. (7). They found significant positive associations between CPQ11–14 scores and DMFS scores and scores on the Dental Aesthetic Index, an indicator of malocclusion severity. Similarly, Humphris et al. (8) examined the reliability and construct validity of the CPQ8–10 among a convenience sample of schoolchildren and found acceptable internal consistency reliability (Cronbach's alpha = 0.88) and significant associations between scale scores, a measure of self-esteem and

a single question on the extent, which the mouth was a problem.

Although the results reported by Foster Page et al. (7) and Humphris et al. (8) support the use of the two age-specific versions of the CPQ in epidemiological research and provide some evidence that they perform well as generic instruments, the performance of the measures when used with specific clinical populations needs to be examined further. Consequently, we undertook a study of 11–14-year-old children with malocclusions who were about to start orthodontic therapy. The main aim was to assess the association between orthodontic indices and scores on the full CPQ11–14 and its 8 and 16 item short forms. The intention was to determine if the measure was sensitive to differences in occlusal status in a population likely to have relatively high scores on the orthodontic indices used. An additional aim was to assess the association between CPQ11–14 scores and children's perceptions of their malocclusion and its effects on their lives overall.

Methods

Participants

Participants in the study were children aged 11–14 years attending orthodontic clinics at the Faculty of Dentistry, University of Toronto. The children were recruited sequentially in the fall of 2003 and 2004 at their first visit for orthodontic treatment. At the time of enrolment in the study parents signed a consent form and all children gave their verbal assent to participation. All study procedures were approved by the Health Sciences I Committee of the Office of Research Ethics at the University of Toronto.

Measures

Prior to any treatment all children completed a copy of the CPQ11–14. Response options for the items comprising the measure were coded from 0 to 4. The questionnaire included the two global ratings of oral health and effects on life overall used in the initial assessment of construct validity (2). In addition, children recruited in 2004 also completed a short questionnaire designed to assess their perception of their orthodontic condition. This consisted of three questions: 'How happy are you with the way your teeth look?' 'How happy are you with the way your teeth come together?' and 'Do you think you need orthodontic treatment (braces)?'. Response options for the first two questions were 'Very happy', 'Happy', 'Unhappy' and 'Very Unhappy' and for the third question were 'Yes', 'No' and 'Unsure'.

Study models were taken at the initial visit to provide a record of the pre-treatment arrangement of the teeth. Using these models the severity of each child's orthodontic condition was assessed by means of two widely used orthodontic indices; the Dental Aesthetic Index (DAI) (9) and the Peer Assessment Rating Index (PAR) (10).

The DAI measures the social acceptability of a child's dental appearance. The rating is based on the measurement of ten occlusal traits each of which is multiplied by a weight. The products are summed and a constant added to give the DAI score. As the weights were derived from the judgments of a lay panel, the DAI combines clinical and aesthetic components into a single score (11). DAI scores range from 13 (the most acceptable) to 100 (the least acceptable) and can be collapsed into four malocclusion severity levels: 13 to 25 – minor/none; 26 to 31 – definite; 32 to 35 – severe, and 36 and over – handicapping (12).

The PAR Index is based on the scoring of six occlusal traits each of which is weighted. The sum of the weighted scores indicates the extent to which the dentition deviates from what is considered ideal occlusion and alignment (13). An ideal occlusion would have a score of 5 or less while a score of 50 indicates an occlusion that deviates substantially from the ideal (13). As no system exists for classifying scores into severity categories, four groups were created by dividing the scores into quartiles.

The DAI ratings were undertaken by three trained and calibrated examiners and the PAR ratings by three PAR-certified examiners. In order to assess intra- and inter-examiner reliability both groups of raters independently assessed a random 10% sample of the models and then reassessed the models after a 1 week interval. Intra-examiner reliability for the DAI raters was high with intra-class correlation coefficients of 0.98, 0.91 and 0.98 respectively. The ICC for inter-examiner reliability was 0.80. For the PAR raters ICCs for intra-examiner reliability were all 0.99 and for inter-examiner reliability the ICC was 0.95.

Data analysis

Additive scale and sub-scale scores for the CPQ11–14 were calculated by summing the Likert response codes to the items comprising the measure. Scores

were calculated for the full 35-item version and the 16 and 8-item versions. As scores were skewed nonparametric tests were used to assess the significance of differences between groups. The distributions of the DAI and PAR ratings were approximately normal and statistical analysis including these indices used parametric methods when appropriate. For example, Pearson coefficients were used to examine the correlation between CPQ 11–14 scores and the DAI and PAR scores. When the DAI and PAR scores were reduced to four categories, Kruskal–Wallis tests were used to assess differences in CPQ 11–14 scores across groups. Similarly, associations between CPQ 11–14 scores and children's self-ratings of oral health and perceptions of their teeth were examined using the same tests. Statistical significance was set at $P < 0.05$. All data were analysed using SPSS for Windows Version 13.0 (SPSS Inc., Chicago, IL, USA).

These tests were used to assess the discriminative and construct validity of each of the three versions of the questionnaire (35-item, 16-item and 8-item). For each version six null hypotheses were tested; that is, there is no association between scores on the CPQ 11–14 and the clinical and self-report indicators used. If the tests were independent the probability of at least one false positive is 0.235. As the tests are not independent the probability of at least one false positive will be less than 0.235 but by an unknown amount (14). Consequently, following the individual tests of the null hypotheses the Bonferroni method was used to test the composite hypothesis that all null hypotheses are true. Following Bland and Altman (15), the individual *P*-values were multiplied by the number of tests ($n = 6$). Then 'if any is significant ($P < 0.05$) the test of the composite null hypothesis is significant at the 0.05 level, and the smallest modified *P*-value gives the *P*-value for the composite null hypothesis' (15).

Results

Data collection were completed for 141 children; 63 boys and 78 girls. The distribution of ages was 11 years – 18.6%; 12 years – 33.6%; 13 years – 26.4%, and 14 years – 21.4%. The mean age was 12.5 (SD = 1.0).

Internal consistency reliability for the 35-item CPQ11–14 was indicated by a Cronbach's alpha of 0.94. Alphas for the four sub-scales were oral symptoms – 0.68; functional limitations – 0.76; emotional well-being – 0.92, and social well-being – 0.86. The alphas for the 16 and 8-item short forms were 0.87 and 0.74 respectively.

CPQ11–14 scores for the full 35-item version ranged from 1 to 75 with a mean of 21.1 (SD = 16.6). Scores for the 16-item version ranged from 1 to 41 (mean = 12.8; SD = 8.9) and for the 8-item version ranged from 0 to 19 (mean = 8.9; SD = 4.3). Spearman's rank correlations between scores from the long and the two short versions were 0.97 ($P < 0.001$) and 0.91 ($P < 0.001$) respectively.

Dental Aesthetic Index scores ranged from 17.0 to 58.0 with a mean of 35.0 (SD = 8.0). The distribution of subjects across the four severity categories was minor/none – 6.6%, definite – 35.2%, severe – 15.6% and handicapping – 42.6%. PAR scores ranged from 8.0 to 66.0 with a mean of 31.4 (SD = 11.1). Eight percent had scores of 50 or above indicating marked deviation from an ideal occlusion. The Pearson correlation between the DAI and the PAR was moderate at 0.40 ($P < 0.001$), suggesting that they are measuring different components of malocclusion.

The Pearson correlation between the DAI and the full CPQ11–14 scores was 0.30 ($P < 0.001$) and between the PAR and the CPQ11–14 was 0.31 ($P < 0.001$). Significant correlations were also observed between the two orthodontic indices and three of the CPQ11–14 sub-scales; namely, functional limitations, emotional well-being and social well-being. The *r* values ranged from 0.20 to 0.37 (Table 1). Pearson correlations between the 16-item version and the DAI and PAR were both 0.30 ($P < 0.001$) and between the 8-item version and the two orthodontic indices were 0.26 ($P = 0.002$) and 0.30 ($P < 0.001$) respectively.

Table 2 shows that there were no significant differences in overall CPQ11–14 scores or sub-scale

Table 1. Pearson correlation coefficients between CPQ11–14 scores and the two orthodontic indices

CPQ11–14	DAI	PAR
Scale:	0.30 ($P < 0.001$)	0.31 ($P < 0.001$)
Sub-scales:		
Oral symptoms	0.09 ($P = 0.310$)	0.06 ($P = 0.505$)
Functional limitations	0.30 ($P < 0.001$)	0.20 ($P = 0.036$)
Emotional well-being	0.28 ($P = 0.001$)	0.37 ($P = < 0.001$)
Social well-being	0.24 ($P = 0.004$)	0.25 ($P = 0.005$)

DAI, Dental Aesthetic Index; PAR, Peer Assessment Rating.

Table 2. Mean CPQ11–14 scores by DAI and PAR categories

	CPQ11–14 total score	Oral symptoms	Functional limitations	Emotional well-being	Social well-being
DAI category					
Minor/none	16.1	5.6	3.9	4.6	2.4
Definite	19.6	6.0	3.2	5.4	4.9
Severe	17.7	5.5	2.7	4.2	4.7
Handicapping	24.5	6.4	4.9	7.0	5.9
P-value[a]	0.158	0.412	0.572	0.112	0.307
PAR category[b]					
1	14.2	5.2	2.5	3.5	3.1
2	19.7	6.3	4.1	4.6	4.8
3	21.9	6.2	3.6	6.1	5.9
4	28.6	6.1	5.0	8.3	7.1
P-value[a]	0.006	0.574	0.150	0.004	0.044

DAI, Dental Aesthetic Index; PAR, Peer Assessment Rating.
[a]*P*-values derived from Kruskal–Wallis tests.
[b]Scores divided into quartiles.

scores across DAI categories, even though those in the 'handicapping' category consistently had the highest scores. However, there was a distinct gradient in CPQ11–14 scores across the four PAR categories with those in lowest quartile having the lowest overall scores and those in the highest quartile having the highest overall scores ($P < 0.01$). The same pattern was also observed for the emotional well-being and social well-being sub-scales. There were also significant differences in functional limitations scores but the gradient was less clear. When the analyses were repeated using the scores for the 16 and 8-item short forms there were no significant differences across the DAI categories ($P = 0.121$ and $P = 0.213$, respectively) but significant differences across the PAR categories ($P = 0.008$ and $P = 0.015$, respectively).

When asked to rate their oral health 22.7% of subjects reported that it was excellent or very good, 43.3% that it was good and 34.0% that is was only fair or poor. One-fifth, 18.4% said that the condition of their teeth or mouth had no impact on their life overall, 43.3% that it had only a little impact, 28.4% that it had some impact and 9.9% that it affected their lives a lot or very much. As in the initial assessments of construct validity, Kruskal–Wallis tests indicated that all three versions of the questionnaire showed significant associations with these self-ratings of oral health ($P = 0.016$ for the 35-item version; $P = 0.032$ for the 16-item version and $P = 0.019$ for the 8-item version) and ratings of the effect of oral health on life overall ($P < 0.001$ for all three versions) in the expected directions.

Among the sub-sample of 92 subjects recruited in 2004, 72% were very unhappy or unhappy with the way their teeth look and 65.5% were very unhappy or unhappy with the way their teeth came together. Kruskal–Wallis tests indicated significant associations, in the expected direction, between children's feelings regarding the appearance of their teeth and scores from all three versions of the CPQ11–14 ($P = 0.01$, $P = 0.006$ and $P = 0.004$, respectively). There were also significant associations between the children's feelings about the way their teeth fit together and scores from the questionnaires ($P = 0.048$, $P = 0.039$ and $P = 0.013$, respectively). As only one child said that he/she did not need orthodontic treatment no further analysis using this variable was possible.

When the Bonferonni correction was applied to the *P*-values obtained from the three sets of tests of discriminative and construct validity, three of the six had *P*-values < 0.05 for the 35-item version of the questionnaire, with four having *P*-values < 0.05 for both the 16 and 8-item versions. For each version, the smallest *P*-value observed was $P = 0.006$, giving the *P*-value for the composite null hypothesis.

Discussion

This study was undertaken in order to provide further evidence of the reliability and validity of the Child Perceptions Questionnaire for children aged 11–14 years. Our previous study had indicated that the measure was able to discriminate between groups of children with different clinical

conditions. However, it was not able to determine whether or not the instrument discriminated between children with difference levels of severity of the same clinical condition. The data presented here examined this issue for children just about to begin orthodontic treatment. In order to assess discriminative validity associations between two orthodontic indices and scores derived from a long 35-item version of the CPQ11–14 and short forms consisting of 16 and 8 items were examined. Construct validity was assessed by associations between CPQ11–14 scores and four self-report measures of oral health.

The results indicated that all three versions of the CPQ11–14 detected substantial variability in the oral health-related quality of life of children with malocclusions sufficiently severe to have lead to demand and selection for orthodontic treatment. The internal consistency reliability of the three versions was confirmed along with the criterion validity of the short forms when used in this disease-specific population.

Scores from the long and short forms of the questionnaire showed significant positive correlations with the DAI and PAR ratings suggesting that the CPQ11–14 was sensitive to variations in the severity of the malocclusion. In addition, there was a distinct and significant gradient in scores across the four categories of the PAR, also suggesting the ability of the measure to discriminate according to malocclusion severity.

Although CPQ11–14 scores tended to be lowest for the 'minor' category of the DAI and highest for the 'handicapping category', a clear gradient was not observed across the four categories and differences in scores were not significant. In this respect our study differs from the population-based study undertaken by Foster Page et al. (7). In the latter study a clear gradient was observed with the differences in mean scores across the categories being significant. This reason for this difference in results is not immediately apparent given that mean CPQ11–14 scores within each of the four DAI categories were similar for the two. It may be due to differences in the overall sample size, and the distribution of subjects and sample sizes across the four treatment need categories. For example in the population-based study 39.5% were classified as 'minor/one' and 17.0% as 'handicapping'. In the study here, the corresponding figures were 6.6% and 42.6%. Foster Page et al. (7) did not use the PAR index so no comparisons can be made with respect to this rating scale.

There were, however, significant associations between CPQ11–14 scores and the four self-report measures used. Two of these were global ratings and two assessed subjects' feelings about their dentition. These indicate the construct validity of the measures when used in a population of children undergoing orthodontic treatment.

These findings were confirmed when the Bonferonni correction was applied to the individual *P*-values in order to control for the probability of false positives associated with multiple statistical tests. The three composite hypotheses tested were all rejected ($P = 0.006$) indicating an association between CPQ11–14 scores and the variables used to assess discriminative and construct validity. However, it should be noted that the Bonferroni correction assumes that the tests are independent. When they are not, as is the case here, the *P*-value is larger than it should be, and the power of the study is reduced. This increases the risk of a type II error by an unknown amount, a common criticism of the Bonferonni approach (16).

The correlations between CPQ11–14 scores and the DAI and PAR indexes deserved comment. These appear to be weak at 0.30. However, this is to be expected for two reasons. First, all contemporary models of disease and its consequences, such as that of Wilson and Cleary (17), indicate that the relationships between biological variables, as measured by the DAI and PAR, and health-related quality of life outcomes, as measured by the CPQ11–14, are not direct but mediated by a variety or personal, social and environmental variables. Variables such as socioeconomic status and psychosocial factors such as self-esteem and resilience will attenuate the correlations between the two types of measure (18). Further, in clinical samples all scores are likely to be clustered towards the top end of the range so that high correlations are unlikely to be achieved. Consequently, correlations of 0.3 to 0.5 are sufficient for establishing construct validity (19).

A further issue concerns the sample included in the study. Clinical samples, particularly when recruited from one clinical facility, are more often than not convenience samples, highly selected and likely to be subject to various biases. Consequently, the results reported here should not be generalized to all children with malocclusions or all children selected for orthodontic treatment. This means that the study needs to be repeated on different samples recruited from different clinical locations in order to confirm the psychometric properties of the

CPQ11–14 when used with this disease-specific population. A further limitation is that this is a cross-sectional study that cannot assess the evaluative properties of the questionnaires. Accordingly all children recruited for the study are being followed-up and will be reassessed at the completion of orthodontic treatment. Changes in DAI and PAR ratings and their associations with CPQ11–14 change scores will be used to determine the responsiveness of the measure and its longitudinal construct validity. This will provide a preliminary indication of whether or not the long and short versions of the instrument can be used as additional outcome measures in clinical oral health research involving children.

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