

Oral health-related quality of life for 8–10-year-old children: an assessment of a new measure

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Abstract – Objectives: The aim of the study was to assess the reliability and construct validity of the Child Oral Health-Related Quality of Life for 8-10-yearolds (COHRQoL [8-10]) using confirmatory factor analysis (CFA) and to test the measurement properties of latent variables believed to define the multidimensional construct of OHRQoL. Methods: A convenience sample of 270, year 4 children from six schools was obtained. The administered questionnaire included the 25-item COHRQoL [8-10] and the Coopersmith Self-Esteem Inventory-School Form. The analytical method was based upon CFA using maximum likelihood estimation. A second-order factoring approach was applied to determine the extent that the latent variables tapped a single overarching domain of quality of life. Results: Seven items were withdrawn for low endorsement and poor association with resultant factors. The COHRQoL [8-10] was confirmed to measure a single construct of three latent variables invariant to gender. Internal consistency of the three scales derived comprising a total of 18 retained items was acceptable. Associations with self-esteem and with a single question on the extent that the mouth was a problem were confirmed and strengthened the construct validity of the COHRQoL [8-10] measure. Conclusions: Reliability and construct validity were demonstrated for COHRQoL [8-10] and supported the scale for adoption as an epidemiological and scientific tool for group comparisons. CFA showed that the three constructs or latent variables underlying the overall COHRQoL ratings were discrete measures that can be reliably assessed in children. Further model testing with additional data will increase generalization of these findings.

The assessment of quality of life has become an integral part in the evaluation of health programmes. A number of approaches have been developed and vary from broad based instruments [such as the Short Form 36 (1)] to more specific health-related measures (2). Over the past two decades, there has been substantial development of oral health-related assessments of quality of life (3). These have been generated for adult participants. More recently, there has been an interest in the quality of life of children (4, 5) and this has included oral health (6, 7). Quality of life includes social, psychological as well as functional aspects (8). However, the development of quality of life

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measures for children are compounded with difficulties associated with the administration of the questionnaire, the children's level of maturational development and their ability to understand (9).

The development of a questionnaire to evaluate a school-based oral health promotion programme recognized the need to assess child oral health-related quality of life. In the design phase of the evaluation questionnaire, focus was restricted to discovering appropriate methods of assessing child oral health-related quality of life. Concerns were raised with regard to quantitative methods as children might have differing literacy levels. It was feared that this could impact upon the

completion rates and the reliability and validity of the children's responses. It was necessary, therefore first, to find an appropriate measure for younger children and secondly, to examine the performance of such an instrument. The Child Oral Health-Related Quality of Life Questionnaire (CO-HRQoL [8-10]) was developed at the University of Toronto (10). The COHRQoL [8-10] was specifically developed to assess oral health related quality of life in younger children and therefore fulfilled the needs of the researchers. Apart from the content validity of the COHRQoL [8-10] which was the extent to which it made intuitive sense to a group of experts in the appropriate area, no other psychometric properties had been reported for the new 8-10-year-old version. It was necessary therefore to investigate the reliability and construct validity of the COHRQoL [8-10]) (10). A procedure known as confirmatory factor analysis (CFA) was used to assess the inherent psychometric qualities of the COHRQoL [8-10] (5, 7, 11, 12). CFA's advantages lie in the ability of competing models to be empirically tested for optimal fit. Discrepancies between the proposed underlying structure of the measure and the raw data can be inspected and changes to the measurement model can be applied. Theoretical reasoning governs and limits the extent of these modifications. Likewise, the stability of the model across key groups of participants can be tested. An important categorization is gender, i.e. do girls have a markedly different approach to assessing their quality of life in relation to their mouths than their male counterparts. The aim of the study was to assess the reliability and construct validity of the COHRQoL [8-10] (10) using CFA and to test the measurement properties of latent variables believed to define the multidimensional construct of quality of life specific to oral health.

Material and methods

The sample

A convenience sample of year 4 children attending primary schools in the targeted area of Northern Ireland was obtained. Schools were selected from areas of low socioeconomic status which broadly represented the segregated school system that operates in Northern Ireland (i.e. state, or nondenominational schools, and denominational, or Catholic, schools). Consent of all children, parents/ guardians of the participating pupils was obtained. The project was given ethical approval by the Queen's University, Belfast Research Ethics Committee.

Procedure

A member of the research team (KS) made preliminary contact with the targeted schools. The schools were issued with a sample of the questionnaire, the parent and child consent forms and offered the opportunity to express any concerns in relation to their content. KS met key 'stakeholders' in each school (including the Principal, the Senior Management Team and class teachers). Teachers were reassured and encouraged to stress the 'fun' aspect of the whole process of the questionnaire administration with the children. A standardized protocol was employed when administering the questionnaire which required that the researcher be present in the classroom to provide assistance and ensure independent and confidential responding, to read out the instructions and items verbatim to the children, and to give advice to them, explaining the answering scheme if necessary. The researcher collected the consent forms and questionnaires.

The Questionnaire

The questionnaire consisted of three parts. The first inquired of the children's age, and gender. A third question asked the children if their teeth or mouth had bothered them. This question was assessed on a four-point Likert scale ranging from 'not at all' (score 4) to 'a lot' (score 1).

The second part was the 25-item COHRQoL [8–10] questionnaire designed by Jokovic (10) at the University of Toronto. The questions were related to the teeth and mouth and whether in the last 4 weeks children experienced pain, sore spots, pain when drinking or eating cold drinks or foods, food packing or bad breath. The remaining questions assessed, whether in the last 4 weeks the children had, as a result of their teeth or mouth, difficulty in eating, sleeping, talking, smiling, laughing, socializing, concentrating or speaking out in class or had felt shy, worried or had been teased or questioned by other children about their teeth or mouth. Responses to the questions were assessed on a five-point Likert scale. The responses ranged from 5, 'Never'; 4, 'Once or twice'; 3, 'Sometimes'; 2, 'Often'; to 1, 'Everyday or almost everyday'.

The third part of the questionnaire was the Coopersmith Self-Esteem Inventory-School Form (Coopersmith SEI-SF), for 8–15-year olds (13). The Coopersmith SEI-SF was developed as a measure to assess children's attitudes towards themselves in

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general, and within particular social contexts – with regard to their relationships with peers and parents; their self-esteem in school-based situations and the extent to which their self-esteem impacts upon their personal interests. The Coopersmith SEI-SF has high reliability and validity (13). The respondents stated whether a set of 8 favourable or unfavourable aspects of an individual were 'like me' or 'not like me'. A score of 1 was awarded to a positive response. The summation of the individual scores provided a total score for self-esteem. Total scores range from a maximum of 8 (very high selfesteem), to a minimum of 0 (indicating very low self-esteem).

Data analysis

Descriptive and exploratory factor analysis was conducted by SPSSTM Version 11. Confirmatory factor analyses was performed by AMOSTM Version 4 (14). An explorative principal components analysis of all questionnaire ratings, followed by Direct Oblimin rotation with Kaiser normalization (15) was used to demonstrate simple structure of the latent variables. This initial computational run was conducted as the first analytical step as recommended to ensure the factorial integrity for formal testing (16). The second step, CFA was then applied to test the adequacy of the measurement model derived (17). Each latent construct (estimate of concept free from measurement error) was specified by the first indicator pre-set to a loading of 1.0 in the structural equation model describing the scale. Conventional incremental and absolute fit indices were employed in the CFA and structural equation modelling analyses as recommended by Hu and Bentler (18). Models with comparative fit index (CFI) >0.90, and root mean square error of approximation (RMSEA) <0.06 were regarded as acceptable. The chi-square/df ratio <2 was also employed as a measure of how well the observed data matched the specified model. Values <2 are indicative of excellent fit (19). Modification indices (Langrange multiplier) supplied by AMOS were inspected to assist in this process (20).

Results

All children and parents gave their consent to participate. Within the sample, there were 138 boys, and 132 girls (Table 1). There were 38 (20 boys; 18 girls) 7-year olds, and 232 (118 boys;

Table 1.	Frequency	of	participants'	gender,	age	group
and scho	ol attended					

	п	%
Gender		
Boys	138	51
Girls	132	49
Age		
7 years	38	14
8 years	232	86
School		
А	49	18
В	49	18
С	49	18
D	38	14
Е	37	14
F	48	18
Total	270	100

114 girls) 8-year olds. There were no statistically significant correlations between the age of the respondents and total COHRQoL [8–10] or self-esteem scale scores. Neither were there differences in these self-report measures between the boys and girls.

A principal components analysis of the 25-item COHRQoL [8-10] scale was conducted. On an initial run, the communalities of five items were <0.2. Lack of significant correlations between these items and others in the scale were responsible for these low values and were excluded from further analysis (items 21-25). Items 19 and 20 loaded equally on more than one factor and were also eliminated. Eighteen items remained. The initial analysis indicated five factors with eigenvalues >1. The fourth and fifth factors possessed eigenvalues marginally >1.0, i.e. 1.07 and 1.04, respectively, and were uninterpretable. Hence the analysis was repeated, specifying three factors. This additional run produced a clear solution and all communalities attained a value of ≥ 0.5 . The KMO measure of sampling adequacy was high (0.85) and Barlett's test of sphericity was significant: $\chi^2 = 1386$, df = 153, P < 0.001 demonstrating a high level of relatedness between the question responses. The three factors explained 46% of the total variance of the covariance matrix (15). To assess whether this three-factor structure was robust, three separate random samples of approximately 50% of the original sample were drawn and the same analysis on the 18 items was repeated. Very similar solutions were found, i.e. 13-16 items of the possible 18 in these three solutions loaded on the same factors as described in the analysis of the full sample.

These three factors were then labelled as separate subscales within the overall total COHRQoL [8–10] 18-item measure and subjected to confirmatory factor analysis to test for goodness-of-fit of the observed data to the proposed model suggested by the exploratory factor analysis.

Confirmatory factor analysis

The initial run of CFA was fitted to the three-factor model with an over-riding quality of life latent construct (i.e. second-order factor analysis with each of the subscales regressed onto the single overall quality-of-life latent variable). Such a procedure assumed that there was equivalence and sufficient overlap (i.e. nonorthogonal) in the three latent variables to describe an overall quality-of-life construct. This model produced a reasonable fit (see Table 2). A significant improvement was found when three pairs of error terms were allowed to correlate (determined by high Lagrange indices). Figure 1 presents the diagrammatic representation of the model with standardised parameters. To test the possibility that a simpler two-factor secondorder model could describe the 18 items, the exploratory factor analysis solution was modelled and goodness of fit statistics generated. A relatively poor fit was found which was not improved sufficiently with relaxing four correlated errors. Hence the three-factor solution was accepted. Interpretation of the subscales for the three factors appeared straightforward. The label 'Oral health status awareness' was given to the three-item subscale that comprised of being asked questions about their oral health by other children, experiencing toothache and mouth soreness. 'Oral and social self image' was adopted as the label for the eight-item subscale as these items appeared to describe oral (physical) and social problems

Table 2. Fit indices for second-order CFA models

Model	χ^2	df	χ^2/df	CFI	RMSEA
Two factor					
Uncorrelated errors	359.67	134	2.68	0.822	0.079
Four correlated errors	240.24	130	1.85	0.913	0.056
Three factors					
Uncorrelated errors	298.77	132	2.26	0.868	0.069
Three correlated errors	217.62	129	1.69	0.930	0.051

RMSEA, root mean square error of approximation; CFI, comparative fit index.



Fig. 1. Completely standardized solution to secondorder CFA showing loadings for the 18 items, three underlying factors and a single factor. Error variances of latent factors included, whereas those for individual items have been omitted. Three correlated errors shown by double-arrowed loops on right-hand-side connecting pairs of items.

associated when eating and drinking in the company of others. The child with a high 'Oral and social self image' (high score on this scale) would be at ease with peers when consuming food and drink or when participating in sports and club activities. 'Social confidence and well-being' was chosen as a suitable descriptor for the seven-item subscale that described the social discomfort and lack of well-being children experience when performing their essential social activities associated with school and school work.

To test that the relationships between the firstorder factor, i.e. the three latent variables being described by the respective subscale items and the second-order overall quality-of-life latent variable is invariant across gender, two further models were compared. The first was the model displayed in Fig. 1, allowing the correlations between the latent subscale and overall quality-of-life constructs to be unconstrained across the two groups defining gender. This was tested against a constrained model where the parameters were fixed across gender; i.e. for example, the parameter estimate between the overall quality-of-life latent variable

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and 'Social confidence and well-being' was presumed to be identical across boys and girls. It was similar for the other two subscales and the overall quality of life construct. The result of this test was insignificant ($\Delta \chi^2 = 2.71$, df = 3, P = 0.44) demonstrating that the key relationships between the constructs that define overall quality of life are essentially identical across boys and girls at this age.

Internal consistency

The overall internal consistency for the COHRQoL [8–10] scale, assessed using Cronbach's alpha was 0.88. The individual subscales were then also tested for reliability: 'Social confidence and well-being', $\alpha = 0.77$; 'Oral and social self-image', $\alpha = 0.80$; and 'Oral health status awareness' $\alpha = 0.70$.

Construct validity

The extent that the COHRQoL [8-10] measure uncovered relationships that was in keeping with the theory underlying the construct is referred to as construct validity. Evidence of construct validity in this study was demonstrated by the correlations between the subscale scores of the COHRQoL [8–10] and the scores of the Coopersmith SEI-SF. Both the 'Social confidence and well-being' and the 'Oral and social self-image' subscales were correlated significantly with self-esteem, whereas the 'Oral health status awareness' subscale was very weakly related to self-esteem, as shown in Table 3. The raw correlations of the three COHRQoL [8–10] scales were similar to each other: 'Social confidence and well-being' and 'Oral social self-image' r = 0.48; 'Social confidence and well-being' and 'Oral health status awareness' r = 0.49, and finally, 'Oral social self-image' and 'Oral health status awareness' r = 0.50.

A further check on construct validity was made through the plotting of the summed subscale scores for each construct against the single rating made by every child to the question 'How much are you

Table 3. Correlations of self-esteem with the three latent constructs derived from confirmatory factor analysis

Quality of life scale	Number of items	Coopersmith SEI-SF	<i>P</i> -value
1. Social confidence and well-being	7	0.28	<0.001
2. Oral and social self-image	8	0.45	< 0.001
3. Oral health status awareness	3	0.03	0.61

bothered by your mouth?' The four-category ordinal scale ranged from 'not at all' to 'a lot'. To enable sufficient participants for analysis the two top categories, 'some' or 'a lot' were collapsed; i.e. the categories were combined. Gender was retained as an important comparator. Results of these plots are displayed in the three graphs of Fig. 2. All graphs show an ordered relationship between increased 'bother' and reduced COHRQoL [8–10] as reported by the child. This was confirmed by analysis of variance with category of 'bother' and gender as independent fixed factors. All F-values describing the comparison across the three-level bother ratings were strongly significant, although gender was not implicated independently or as an interaction with the bothersome categorization.

Discussion

This is the first study to report psychometric details of an oral health-related quality-of-life measure developed specifically for children aged 8–10 years. The positive acceptance and response from parents and children to the invitation to take part was due to the extensive preparation expended with the principal teachers, class teachers and parents. The questionnaire was accepted by teachers and completed with ease by children as reflected in the complete lack of missing data.

The CFA analyses provide reassurance that the three constructs underlying the overall quality of life ratings collected via the questionnaire are discrete measures that can be reliably assessed in this age group of children. The measures describe constructs that are invariant to gender. The measure can be reported with some justification as a total score as the subscale constructs all load heavily on the overall COHRQoL [8–10] construct. Evidence of construct validity was demonstrated by the correlations between the subscales scores of the COHRQoL [8–10] and the scores of the Coopersmith SEI-SF. However, separate subscale scores appear to have unique meaning as shown by the differential in correlation between these constructs and self-esteem and supported the scale for adoption as an epidemiological and scientific tool for group comparisons.

Controversy exists in the use of exploratory and confirmatory factor analyses on an identical data set (21). Our approach was to obtain a testable model using EFA and then determine through CFA whether the number of factors obtained could be



Fig. 2. The three subscale scores of oral health-related QoL and the child's self-reported 'bother' of their mouth. Mean scores and 95% confidence intervals broken down by gender.

justified and if the measurement model held across gender. It is acknowledged that a more programmatic approach would provide a stronger basis for our findings, that is to perform EFA on one set of data and test the model on a second set. It is

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interesting that exploratory factor analyses conducted on a number of random samples from the original data set produced a close approximation to the solution using all of the data. It seemed justifiable on this basis to continue with testing how well this solution held for both boys and girls and whether the data might fit a simpler two factor solution. Researchers are urged, however, to obtain further information on this measure to ensure that the results reported are not based upon the 'capitalization of chance' (21).

Some specific limitations should be noted. First, the data were collected from convenience samples of schools that were selected due to their initial expressed interest in the study. The authors were keen to select purposively from deprived urban areas. Additional study of children from a wider and more representative sampling frame would assist generalisation, i.e. external validity and furthermore support the argument immediately above of testing whether newly drawn samples approximate the population. Secondly, not all possible models were fitted. For example, no models where question items were able to load on more than one factor were allowed. Hence the fitted model was highly constrained. This limited the number of models to a manageable level. Further data sets and samples are required to refine our understanding of child self-reported ratings of their oral health-related quality of life.

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