Dimensional Structure of the Early Childhood Oral Health Impact Scale

Arghavan Behbahanirad¹, PhD; Hassan Joulaei², PhD; Jamshid Jamali³, PhD; Ali Golkari¹, PhD; Maryam Bakhtiar¹, PhD

¹Department of Dental Public Health, School of Dentistry, Shiraz University of Medical Sciences, Shiraz, Iran; ²Health Policy Research Center, Shiraz University of Medical Sciences, Shiraz, Iran; ³Social Determinants of Health Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

Correspondence: Arghavan Behbahanirad, PhD; Department of Dental Public Health, Shiraz Dental School, Postal code: 71956-15878, Ghasrdasht Ave., Shiraz, Iran
Tel: +98 71 36263193
Fax: +98 71 36270325
Email: behbahania@sums.ac.ir
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Abstract

Background: Detecting the latent dimensions of quality of life as affected by oral diseases is essential for promoting oral health in children. This study aimed to test the Early Childhood Oral Health Impact Scale (ECOHIS) via an appropriate method to detect its dimensions of quality of life as affected by oral diseases.

Methods: An analytical cross-sectional study was carried out in Shiraz, Iran, between 2014 and 2015. A multistage stratified design was used to select 830 parents or the guardians of primary school children aged six years. The Farsi version of the Early Childhood Oral Health Impact Scale (F-ECOHIS) was used to evaluate the children’s oral health-related quality of life. The parents were interviewed to collect data on ECOHIS. Mplus, version 7, was employed for descriptive and analytical analyses in the present study. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed to extract and verify the latent dimensions of ECOHIS.

Results: Out of the 830 invited parents or guardians, 801 participated in this study. The mean ECOHIS score was 21.95±7.45. The mean child impact score and the mean family impact score were 14.25±5.72 and 7.70±3.62, respectively. EFA yielded a 3-factor model: symptom and function, social interaction, and family impact. CFA confirmed the 3-dimensional model (root mean square error of approximation=0.045). The fit indices of the 1- and 2-dimensional models (the child and family domains) were not within the acceptable range.

Conclusion: F-ECOHIS is a 3-dimensional model rather than the hypothetical 6-dimensional model. ECOHIS appears to be a useful scale for measuring the multidimensional impact of oral diseases in children.

What’s Known

• The Early Childhood Oral Health Impact Scale (ECOHIS) questionnaire was designed to evaluate children’s oral health-related quality of life. It is a useful scale for measuring the multidimensional impact of oral diseases.
• The hypothesized six domains of this questionnaire were merely based on theory.

What’s New

• The results from exploratory and confirmatory factor analyses suggested a 3-factor structure. The Persian version of ECOHIS is a 3-dimensional model rather than the hypothetical 6-dimensional model.

Keywords • Oral health • Child • Quality of life • Factor analysis, Statistical • Parents • Early childhood oral health impact scale

Introduction

The Child Oral Health-Related Quality of Life (C-OHRQoL) questionnaire, if suitably designed, can demonstrate nearly all aspects of the psychological, social, and family domains of children.

Traditional clinical indices can only describe oral health status and, as such, disregard broader psychosocial, emotional, and functional aspects, which can be affected by oral diseases. Therefore, new oral health indices such as Oral Health-Related Quality of Life (OHRQoL) have emerged to represent not only oral health status but also emotional and psychosocial well-being.
In the literature, children’s quality of life is slightly ignored in comparison with adults.\textsuperscript{4, 5} In recent years, several C-OHRQoL questionnaires have been developed.\textsuperscript{6, 7} The Early Childhood Oral Health Impact Scale (ECOHIS) was designed to evaluate children’s OHRQoL.\textsuperscript{6} Thereafter, versions of ECOHIS were translated into several languages. Indeed, Brazilian,\textsuperscript{8} German,\textsuperscript{9} Chinese,\textsuperscript{10, 11} Turkish,\textsuperscript{12} Nigerian Pidgin English,\textsuperscript{13} and Persian\textsuperscript{14} versions were developed and validated in their respective populations.

As there were no prior developed domains affected by oral health in children, Pahel and others,\textsuperscript{6} who developed the ECOHIS questionnaire, used the domains introduced by Jokovic and colleagues\textsuperscript{15} as a foundation. They suggested the following domains: the item of having oral/dental pain as the child symptoms domain; the items of having difficulty eating some foods, having difficulty drinking hot or cold beverages, having difficulty pronouncing any words, and missing preschool as the child function domain; the items of having trouble sleeping and being irritable or frustrated as the child psychological domain; the items of avoiding smiling or laughing when around other children and avoiding talking with other children as the child self-image/social interaction domain; the items of being upset and feeling guilty as the parent distress domain; and the items of taking time off from work and financial impacts as the family function domain.

These hypothetical dimensions of ECOHIS should be assessed in different populations.\textsuperscript{6} Nonetheless, nearly all previous studies in this field have applied the questionnaire without assessing the aforementioned domains.\textsuperscript{16-18} While several OHRQoL questionnaires have been previously evaluated,\textsuperscript{19-24} no study to date has assessed the domains of the ECOHIS questionnaire in a given population. Only an investigation in China assessed the dimensional structure of the Chinese version of the ECOHIS questionnaire via confirmatory factor analysis (CFA) and concluded that ECOHIS was a 3-dimensional construct.\textsuperscript{25}

Children’s oral health can be promoted by discovering the latent dimensions affected by oral health in practice, and not just by considering hypothetical domains. To the best of our knowledge, no study has assessed the factor structure of ECOHIS to explore and verify its dimensions worldwide yet.

Accordingly, in the present study, we sought to assess the ECOHIS questionnaire amongst 6-year-old primary school children of Shiraz and its suburbs via an appropriate psychometric method to detect its dimensions of quality of life as affected by oral diseases.

**Subjects and Methods**

This analytical cross-sectional study was conducted between 2014 and 2015 in Shiraz, Iran. Ethical permission was obtained from the Postgraduate School of Shiraz University of Medical Sciences (1393.126808) and the Educational Head Office of Fars province. The study objectives were fully explained to the participants’ parents or their guardians, before written informed consent was obtained.

A representative sample of six-year-old primary school children in Shiraz was selected through the application of a multistage stratified design. Shiraz was first divided into four educational districts, and then into urban and rural areas, and finally into public and private schools. Thirty-five primary schools were randomly selected (about 4% of the primary schools in each district). Inside each selected school, with the aid of the school’s records, simple random sampling was applied to select a proportionate number of children. Ultimately, the study participants consisted of 830 parents or guardians of 6-year-old first-grade primary school children.

All six-year-old first-grade children in the mentioned primary schools, except for schools for children with special needs, were included in this study. Children with mental or physical disabilities, caregivers who did not live with their child for a period of more than 6 months during the child’s life, and parents or guardians who were not willing to participate in the study were excluded.

The ECOHIS questionnaire has six conceptual domains and 13 items. It is comprised of the following dimensions: the child symptoms domain (one item), the child function domain (four items), the child psychological domain (two items), the child self-image/social interaction domain (two items), the family function domain (two items), and the parent distress domain (two items). The Farsi version of the Early Childhood Oral Health Impact Scale (F-ECOHIS) was used to evaluate C-OHRQoL. Data on the children’s OHRQoL were collected through interviews with the parents or guardians individually. Their responses to questions (nine questions on child impact and four questions on family impact) were coded: from one (never) to five (very often). All the scores were then summed to calculate a total score, within the range of 13 to 65, with higher scores reflecting worse OHRQoL. The validity of F-ECOHIS was previously confirmed by Jabarifar and colleagues.\textsuperscript{14}
They revealed that Cronbach’s alpha coefficient for the whole F-ECOHIS was 0.93 and for the child and family impact sections were 0.89 and 0.85, respectively. The concurrent validity and convergent validity (P<0.001) of the F-ECOHIS were also acceptable.

The factor structure of the ECOHIS questionnaire was extracted and evaluated by performing both exploratory factor analysis (EFA) and CFA based on the hypothesis that EFA could demonstrate the latent dimensions of ECOHIS. EFA was performed by extracting factors from principal component analysis and orthogonal rotation (varimax with the Kaiser normalization). An item loading value of 0.5 or higher on a single factor was followed by varimax rotation. CFA is most commonly used to assess the construct validity of the dimensions of questionnaires (in this study, ECOHIS). Construct validity assesses the hypothesized dimensions to demonstrate the actual domains. It was hypothesized that CFA could verify the latent dimensions obtained from EFA, the dimensions proposed by Pahel, and the 1- and 2-dimensional models (child and family domains). CFA was conducted in Mplus. According to the Kline factor, a loading value of less than 0.5 should be eliminated from the model.

The goodness-of-fit model indices consisted of the root mean square error of approximation (RMSEA), the ratio of $\chi^2$ to degrees of freedom ($\chi^2$/df), the Tucker–Lewis index (TLI), and the comparative fit index (CFI). A $\chi^2$/df of less than 2 or 3, an RMSEA of less than 0.1, and CFI and TLI of greater than 0.90 were considered within the acceptable range. Mplus, version 7, was used for the descriptive and analytical analyses in the present study. To analyze categorical data in a structural equation model, Mplus applies a robust weighted least squares estimator using a diagonal weight matrix (WLSMV). The WLSMV approach performs well when the sample size is 200 or higher.

### Results

A total of 801 out of the 830 invited parents or their guardians participated in this study. The response rate was 96.5%. The mean ECOHIS score was 21.95, with a standard deviation of 7.45. The mean child impact score and the family impact score were 14.25±5.72 and 7.70±3.62, correspondingly. Table 1 depicts the distribution of responses to the F-ECOHIS questions. The parents or the guardians reported missing school to be the least frequent item and having oral/dental pain to be the most frequent item within the child impact domain, while they reported being upset to be the most frequent item and financial impacts to be the least frequent item within the family impact domain.

#### Exploratory Factor Analysis

As is shown in Table 2, EFA with varimax rotation extracted three factors with eigenvalues of greater than 1 from ECOHIS (eigenvalue

| Impact | Never | Hardly Ever | Occasionally | Often | Very Often |
|--------|-------|-------------|--------------|-------|------------|
| Child Impact |       |             |              |       |            |
| 1. How often has your child had pain in the teeth, mouth, or jaws? | 246 (30.71) | 208 (25.97) | 181 (22.60) | 125 (15.60) | 41 (5.12) |
| 2. had difficulty drinking hot or cold beverages | 425 (53.06) | 190 (23.72) | 99 (12.36) | 66 (8.24) | 21 (2.62) |
| 3. had difficulty eating some foods | 346 (42.70) | 177 (22.20) | 135 (16.85) | 94 (11.73) | 49 (6.52) |
| 4. had difficulty pronouncing any words | 692 (86.39) | 75 (9.36) | 15 (1.88) | 12 (1.50) | 7 (0.87) |
| 5. missed preschool, daycare, or school | 737 (92.00) | 47 (5.88) | 8 (1.00) | 9 (1.12) | 0 (0) |
| 6. had trouble sleeping | 552 (68.91) | 134 (16.73) | 65 (8.12) | 29 (3.62) | 21 (2.62) |
| 7. been upset | 430 (53.68) | 198 (24.72) | 100 (12.48) | 48 (5.99) | 25 (3.13) |
| 8. felt guilty | 671 (83.77) | 75 (9.36) | 24 (3.00) | 23 (2.87) | 47 (1.00) |
| 9. avoided talking | 684 (85.39) | 70 (8.74) | 22 (2.75) | 16 (2.00) | 9 (1.12) |
| Family Impact |       |             |              |       |            |
| 10. been upset | 259 (32.34) | 223 (27.84) | 123 (15.35) | 114 (14.23) | 82 (10.24) |
| 11. felt guilty | 420 (52.43) | 156 (19.47) | 78(9.74) | 87(10.87) | 60(7.49) |
| 12. taken time off from work | 546 (68.16) | 146 (18.24) | 59(7.36) | 38(4.74) | 12(1.50) |
| 13. How often has your child had dental problems or dental treatments that had a financial impact on your family? | 503 (62.81) | 144 (17.98) | 57 (7.11) | 57 (7.11) | 40 (4.99) |

1=Child symptoms domain; 2, 3, 4, and 5=Child function domain; 6 and 7=Child psychological domain; 8 and 9=Child self-image/social interaction domain; 10 and 11=Parent distress domain; and 12 and 13=Family function domain.
Dimensional structure of ECOHIS

1=3.21, eigenvalue 2=2.33, and eigenvalue 3=2.28), explaining 60.19% of the cumulative variance. The first factor comprised the items of having oral/dental pain, having difficulty drinking hot or cold beverages, having difficulty eating some foods, having trouble sleeping, and being irritable or frustrated. The second factor was composed of the items of having difficulty pronouncing any words, missing school, avoiding smiling or laughing when around other children, and avoiding talking with other children. The third factor encompassed the items of being upset, feeling guilty, taking time off from work, and financial impacts (figure 1).

Confirmatory Factor Analysis

CFA assessed the validity of the ECOHIS constructs. The proposed 6-dimensional model could not be checked using CFA since the child symptoms domain had only one item. The fit indices of the 1-factor model (χ²/df=25.98, RMSEA=0.17, CFI=0.82, and TLI=0.79) and the 2-factor model (χ²/df=5.63, RMSEA=0.07, CFI=0.97, and TLI=0.96) were not within the acceptable range. CFA confirmed a 3-factor model with 13 items that fitted the data (table 3).

Table 2: Exploratory factor loading values of the items in the Early Childhood Oral Health Impact Scale with three factors (N=801)

| Item                                      | Factor 1 | Factor 2 | Factor 3 |
|-------------------------------------------|----------|----------|----------|
| Pain in the teeth, mouth, or jaws         | 0.855    | 0.159    | 0.097    |
| Having difficulty drinking hot or cold beverages | 0.741    | 0.186    | 0.092    |
| Having difficulty eating some foods       | 0.807    | 0.125    | 0.093    |
| Having difficulty pronouncing any words   | 0.103    | 0.503    | 0.099    |
| Missing preschool                         | 0.233    | 0.542    | 0.094    |
| Having trouble sleeping                   | 0.687    | 0.404    | 0.082    |
| Being irritable or frustrated             | 0.778    | 0.335    | 0.102    |
| Avoiding smiling or laughing when around other children | 0.246    | 0.808    | 0.002    |
| Avoiding talking to other children        | 0.199    | 0.838    | -0.014   |
| Being upset                               | 0.156    | -0.001   | 0.774    |
| Feeling guilty                            | 0.097    | 0.040    | 0.746    |
| Taking time off from work                 | 0.067    | 0.144    | 0.765    |
| Financial impacts                         | 0.021    | 0.042    | 0.730    |
| Eigenvalues                               | 3.21     | 2.33     | 2.28     |
| Variance explained                        | 24.72    | 17.96    | 17.51    |
| Cumulative variance                       | 24.72    | 42.68    | 60.19    |

Values in boldface indicate loading values of 0.5 or above. Extraction method: Principal component analysis. Rotation method: Varimax with the Kaiser normalization. Rotation converged in 5 iterations.
yielded equal accuracy indices.

Figure 1 (the 1-stage model) shows that within the domain entitled “symptom and function”, the item of being irritable or frustrated was the most relevant one, followed by the items of having oral/dental pain, having trouble sleeping, having difficulty eating some foods, and finally having difficulty drinking hot or cold beverages. In the second domain, termed “social interaction”, the item of avoiding smiling or laughing when around other children was the most relevant one, followed by the items of avoiding talking with other children and missing school. The least relevant item in this domain was having difficulty pronouncing any words. In the third domain, termed “family impact”, the item of taking time off from work was the most relevant one, followed by being upset and feeling guilty, while the least relevant item was financial impacts. As is depicted in figure 1, the three domains had impacts on one another. The strongest association was between the domains of symptom and function and social interaction, whereas the weakest interaction was between the domains of family impact and social interaction. The factor loading values for the observed variables (mentioned here) are presented in figure 1.

The 2-stage model for the ECOHIS questionnaire is demonstrated in figure 2. In this model, the child impact and the family impact were considered to be latent variables. The factor loading values for the observed variables are shown in figure 2.

### Discussion

In this study, the results from EFA and CFA suggested a 3-factor structure for F-ECOHIS: symptom and function, social interaction, and family impact. The factor loading values of the items indicated that all the items were significantly correlated with their underlying constructs. The first domain consisted of the items of having oral/dental pain, having difficulty drinking hot or cold beverages, having difficulty eating some foods, having trouble sleeping, and being irritable or frustrated. The second domain was comprised of the items of having difficulty pronouncing any words, missing school,

| Table 3: Goodness-of-fit indices for the 1-, 2-, and 3-dimensional CFA models (N=801) |
|---------------------|---------------------|---------------------|---------------------|
| CFA with 3 Dimensions (2-stage model) | CFA with 3 dimensions | CFA with 2 dimensions | CFA with 1 dimension |
| χ²  | 161.475 | 161.475 | 360.374 | 1688.959 |
| df   | 62   | 64   | 65   | |
| χ²/df | 2.60 | 5.63 | 25.98 | |
| CFI  | 0.989 | 0.989 | 0.968 | 0.825 |
| TLI  | 0.987 | 0.987 | 0.961 | 0.790 |
| RMSEA | 0.045 | 0.045 | 0.076 | 0.177 |
| WRMR | 0.926 | 0.926 | 1.512 | 3.459 |

CFA: Confirmatory factor analysis; χ²: Chi-square; df: Degrees of freedom; χ²/df, Normed chi-square; CFI: Comparative fit index; TLI: Tucker–Lewis index; RMSEA: Root mean square error of approximation; WRMR: Weighted root mean square residual

| Child impact domain | Symptom and function domain | Social interaction domain | Family impact domain |
|---------------------|-----------------------------|---------------------------|----------------------|
| 0.973 (0.089)       |                             |                           |                      |
| 0.762 (0.072)       |                             |                           |                      |
| 0.331 (0.052)       |                             |                           |                      |

| Irritability        | Pain                        | Difficulty eating         | Difficulty drinking   |
|---------------------|-----------------------------|---------------------------|-----------------------|
| 0.897 (0.011)       | 0.879 (0.013)               | 0.774 (0.017)             | 0.763 (0.019)         |
| Avoiding smiling    |                            |                           |                       |
| 0.908 (0.021)       | 0.897 (0.024)               | 0.770 (0.046)             | 0.566 (0.50)          |
| Avoiding talking    |                            |                           |                       |
| 0.811 (0.026)       | 0.796 (0.027)               | 0.743 (0.028)             | 0.673 (0.31)          |
| Taking time off from work | Being upset | Feeling guilty | Financial impact |
| 0.811 (0.026)       | 0.796 (0.027)               | 0.743 (0.028)             | 0.673 (0.31)          |

Figure 2: The figure shows the 2-stage 3-factor model for the Early Childhood Oral Health Impact Scale obtained from confirmatory factor analysis, Estimate (standard error).
avoiding smiling or laughing when around other children, and avoiding talking with other children. The third domain comprised the items of being upset, feeling guilty, taking time off from work, and financial impacts.

To the best of our knowledge, no investigators have extracted and evaluated the factor structure of the ECOHIS questionnaire yet, except for Yongmei and colleagues,25 who only evaluated the Chinese version of ECOHIS using a CFA model.25 While several studies have been conducted on other OHRQoL questionnaires,19-22, 24 there is no similar study on ECOHIS worldwide. Therefore, debating the findings is to some extent difficult and limited.

Pahel and colleagues suggested six domains of symptoms, function, psychological, self-image/social interaction, parent distress, and family function for ECOHIS.6 Nevertheless, the hypothesized six domains of ECOHIS were merely based on theory. The prior hypothetical domains placed the items of having difficulty eating some foods and having difficulty drinking hot or cold beverages in the function domain and the items of having trouble sleeping and being irritable or frustrated in the psychological domain.6 In contrast, in the present study, we considered all the mentioned factors in one domain, the symptom and function domain. Since having trouble eating, drinking, and sleeping, as well as being irritable, are common following tooth pain, accommodating these factors in one domain appears more logical.

In the current study, we included the items of avoiding smiling or laughing when around other children, avoiding talking with other children, missing school, and having difficulty pronouncing any words in the social interaction dimension (the second domain) insofar as they may occur due to oral diseases. The items of avoiding smiling or laughing when around other children and avoiding talking with other children were also included in the social interaction dimension in the previous hypothetical domain.6 In the hypothetical model, the items of missing school and having difficulty pronouncing any words were incorporated in the child function domain.5 Thus, according to our results, the parents or the guardians considered that the items of missing school and having difficulty pronouncing any words only affected the social rather than the function domain.

Our third domain was the family impact, which was comprised of two previous hypothetical domains, i.e. parent distress domain and family function domain. As was confirmed in this study, the parent distress domain and the family function domain were inseparable. As a result, the items of being upset, feeling guilty, taking time off from work, and financial impacts appear to be interdependent.

Yongmei and colleagues only assessed the Chinese version of the ECOHIS questionnaire using CFA. Their results showed a 3-dimensional model. They suggested the first domain as pain, having difficulty eating some foods, having difficulty drinking hot or cold beverages, having trouble sleeping, and having difficulty pronouncing any words. The second domain consisted of being irritable or frustrated, avoiding smiling or laughing when around other children, avoiding talking with other children, being upset, and feeling guilty. The third domain was missing school, taking time off from work, and financial impacts. Still, the dimensions and items in each domain did not appear to be logical.25 In contrast to our results, Yongmei and others did not apply EFA prior to CFA, precluding a comparison between their results and ours. While CFA merely assesses the hypothesized model, EFA suggests the best model to fit the data. In the current study, EFA and CFA showed that the 3-dimensional model was the best.

We attempted to include both urban and rural areas of Shiraz; accordingly, our multi-stage sampling with a relatively large sample size has the potential to demonstrate OHRQoL among 6-year-old children in Shiraz. The present study has a unique advantage in that it applies both EFA and CFA, which are superior to traditional techniques. By identifying the underlying factor structure of a set of observed variables without considering a preconceived model, EFA can discover a model that best fits the data. CFA tests the model to assess whether or not it fits the data appropriately.

Caution should be exercised in the interpretation of the results of the previous studies that considered ECOHIS to be a multidimensional tool with six domains.8, 17, 18 Indeed, it is advisable that other nations evaluate their own translated version of ECOHIS using EFA and CFA and compare the results with those obtained in the current study. We eliminated factor loading values of less than 0.5 from the model; however, our application of a cutoff value of 0.4 yielded findings similar to the greater cutoff value.

The findings of the present study have several implications for policymakers, researchers, and clinicians. Policymakers should consider the domains of quality of life most affected by oral diseases to promote oral health status in children. Through the application of ECOHIS with three dimensions, the impact of dental treatments or oral diseases on children's daily
life can be measured easily. Moreover, clinicians can assess the cost-effectiveness of oral treatments in children via ECOHIS.

A salient weak point of the ECOHIS questionnaire is the prevalence of recall bias on the part of parents or the guardians, who might not be good representatives for their 6-year-old child. Child self-reported OHRQoL questionnaires have provided little evidence in the literature, which mandates further research. Moreover, due to a lack of socioeconomic indices in our county, we could not confidently select a sample of all socioeconomic gradients.

Conclusion

Our findings suggest that F-ECOHIS is a 3-dimensional model that is entirely different from the original hypothetical 6-dimensional model. Therefore, future clinical or epidemiological researchers and policymakers should take into account the 3-dimensional model of ECOHIS to assess children’s OHRQoL in Iran. Additional studies are essential to study the dimensions of ECOHIS in other populations.

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Dimensional structure of ECOHIS

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