

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, Ghasdasht Ave.,
Shiraz, Iran

Tel: +98 71 36263193

Fax: +98 71 36270325

Email: behbahania@sums.ac.ir

Received: 20 May 2019

Revised: 17 July 2019

Accepted: 18 September 2019

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.

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 6 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.

Please cite this article as: Behbahanirad A, Joulaei H, Jamali J, Golkari A, Bakhtiar M. Dimensional Structure of the Early Childhood Oral Health Impact Scale. Iran J Med Sci. doi: 10.30476/ijms.2019.82060.0.

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.^{1, 2} 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.^{2, 3}

In the literature, children's quality of life is slightly ignored in comparison with adults.^{4, 5} In recent years, several C-OHRQoL questionnaires have been developed.^{6, 7} The Early Childhood Oral Health Impact Scale (ECOHIS) was designed to evaluate children's OHRQoL.⁶ Thereafter, versions of ECOHIS were translated into several languages. Indeed, Brazilian,⁸ German,⁹ Chinese,^{10, 11} Turkish,¹² Nigerian Pidgin English,¹³ and Persian¹⁴ 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,⁶ who developed the ECOHIS questionnaire, used the domains introduced by Jokovic and colleagues¹⁵ 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.⁶ Nonetheless, nearly all previous studies in this field have applied the questionnaire without assessing the aforementioned domains.¹⁶⁻¹⁸ While several OHRQoL questionnaires have been previously evaluated,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.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 6-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 6-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* (1 item), the *child function domain* (4 items), the *child psychological domain* (2 items), the *child self-image/social interaction domain* (2 items), the *family function domain* (2 items), and the *parent distress domain* (2 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 (9 questions on *child impact* and 4 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.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.²⁶

The goodness-of-fit model indices consisted of the root mean square error of approximation (RMSEA), the ratio of χ^2 to degrees of freedom (χ^2/df), the Tucker–Lewis index (TLI), and the comparative fit index (CFI). A χ^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.²⁷ 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.²⁸

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 mean *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 1=3.21, eigenvalue 2=2.33, and eigenvalue

Table 1: Distribution of responses to the Early Childhood Oral Health Impact Scale questions

Impact	Never	Hardly Ever	Occasionally	Often	Very Often
	n (%)	n (%)	n (%)	n (%)	n (%)
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)
How often has your child ... because of dental problems or dental treatments?					
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 irritable or frustrated	430 (53.68)	198 (24.72)	100 (12.48)	48 (5.99)	25 (3.13)
8. avoided smiling or laughing	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					
How often have you or another family member ... because of your child's dental problems or treatments?					
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

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 ($\chi^2/df=25.98$, RMSEA=0.17, CFI=0.82, and TLI=0.79) and the 2-factor model ($\chi^2/df=5.63$, 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). As is shown in table 3, both of the hypothetical 1- and 2-stage 3-dimensional models were considered acceptable models and interestingly yielded equal accuracy indices.

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

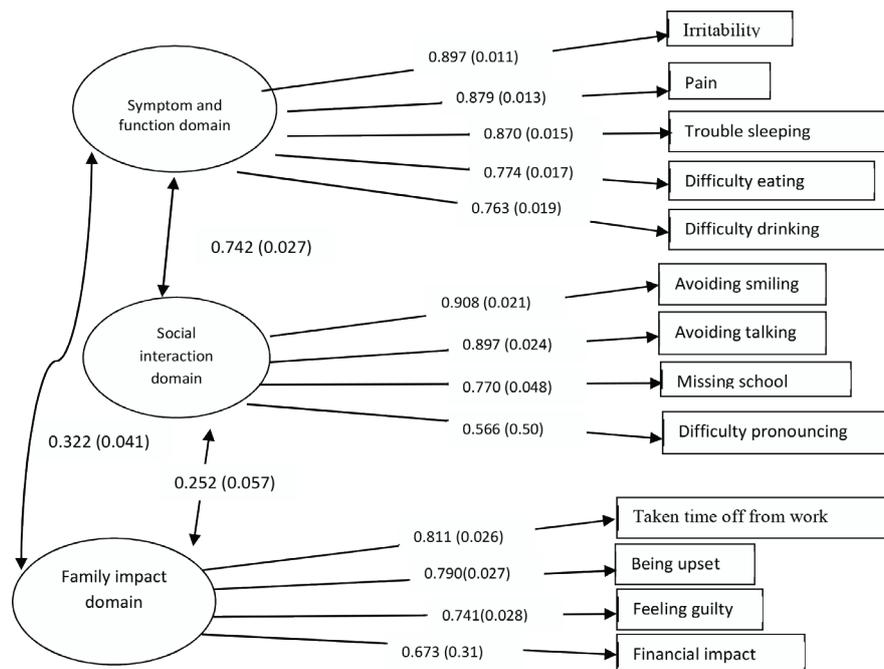


Figure 1: The figure shows the 3-factor model for the Early Childhood Oral Health Impact Scale obtained from confirmatory factor analysis, Estimate (standard error).

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*, *avoiding smiling or laughing when around other*

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
χ^2	161.475	161.475	360.374	1688.959
df	62	62	64	65
χ^2/df	2.60	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; χ^2 : Chi-square; df: Degrees of freedom; χ^2/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

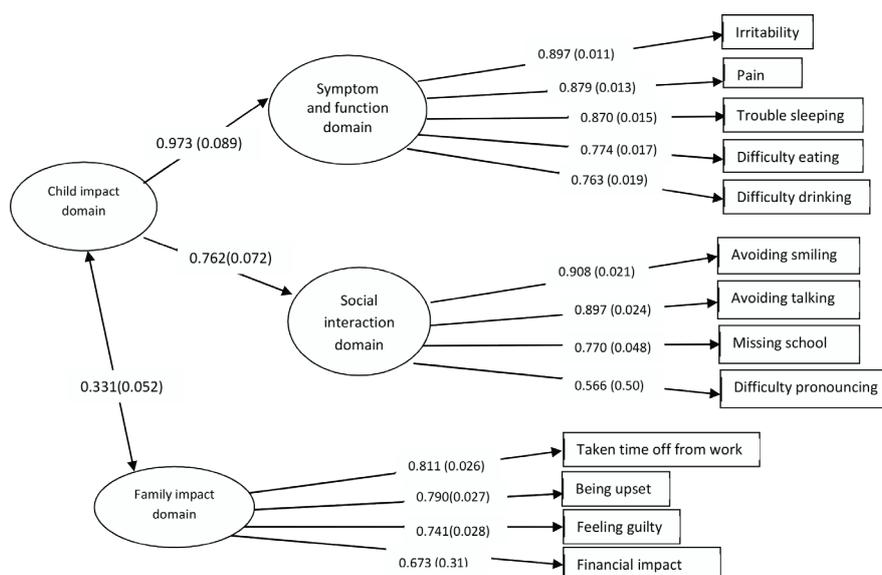


Figure 2: The figure shows the 2-stage 3-factor model for the Early Childhood Oral Health Impact Scale obtained from confirmatory factor analysis, Estimate (standard error).

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.⁶ 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.²⁹ 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.

Acknowledgment

This manuscript is based on Arghavan Behbahanirad's PhD research. The authors thank the Vice-Chancellery for Research of Shiraz University of Medical Sciences for supporting this research (Grant No. 93-7078). Many thanks are also due to Mr. H. Argasi at the Research Consultation Center (RCC) of Shiraz University of Medical Sciences for his invaluable assistance in editing this manuscript.

Conflict of Interest: None declared.

References

- 1 Sischo L, Broder HL. Oral health-related quality of life: what, why, how, and future implications. *J Dent Res*. 2011;90:1264-70. doi: 10.1177/0022034511399918. PubMed PMID: 21422477; PubMed Central PMCID: PMC3318061.
- 2 Locker D, Quinonez C. To what extent do oral disorders compromise the quality of life? *Community Dent Oral Epidemiol*. 2011;39:3-11. doi: 10.1111/j.1600-0528.2010.00597.x. PubMed PMID: 21114518.
- 3 Kramer PF, Feldens CA, Ferreira SH, Bervian J, Rodrigues PH, Peres MA. Exploring the impact of oral diseases and disorders on quality of life of preschool children. *Community Dent Oral Epidemiol*. 2013;41:327-35. doi: 10.1111/cdoe.12035. PubMed PMID: 23330729.
- 4 Abanto J, Carvalho TS, Mendes FM, Wanderley MT, Bonecker M, Raggio DP. Impact of oral diseases and disorders on oral health-related quality of life of preschool children. *Community Dent Oral Epidemiol*. 2011;39:105-14. doi: 10.1111/j.1600-0528.2010.00580.x. PubMed PMID: 21029148.
- 5 Wong HM, McGrath CP, King NM, Lo EC. Oral health-related quality of life in Hong Kong preschool children. *Caries Res*. 2011;45:370-6. doi: 10.1159/000330231. PubMed PMID: 21822015.
- 6 Pahel BT, Rozier RG, Slade GD. Parental perceptions of children's oral health: the Early Childhood Oral Health Impact Scale (ECOHIS). *Health Qual Life Outcomes*. 2007;5:6. doi: 10.1186/1477-7525-5-6. PubMed PMID: 17263880; PubMed Central PMCID: PMC1802739.
- 7 Steele MM, Steele RG, Varni JW. Reliability and validity of the PedsQL™ oral health scale: measuring the relationship between child oral health and health-related quality of life. *Children's Health Care*. 2009;38:228-44. doi: 10.1080/02739610903038818.
- 8 Martins-Junior PA, Ramos-Jorge J, Paiva SM, Marques LS, Ramos-Jorge ML. Validations of the Brazilian version of the Early Childhood Oral Health Impact Scale (ECOHIS). *Cad Saude Publica*. 2012;28:367-74. doi: 10.1590/s0102-311x2012000200015. PubMed PMID: 22331162.
- 9 Bekes K, Omara M, Safar S, Stamm T. The German version of Early Childhood Oral Health Impact Scale (ECOHIS-G): translation, reliability, and validity. *Clin Oral Investig*. 2019;23:4449-54. doi: 10.1007/s00784-019-02893-1. PubMed PMID: 30993536.
- 10 Lee GH, McGrath C, Yiu CK, King NM. Translation and validation of a Chinese language version of the Early Childhood Oral Health Impact Scale (ECOHIS). *Int J Paediatr Dent*. 2009;19:399-405. doi: 10.1111/j.1365-263X.2009.01000.x. PubMed PMID: 19811551.
- 11 Wong HM, McGrath CP, King NM. Rasch validation of the early childhood oral health impact scale. *Community Dent Oral Epidemiol*. 2011;39:449-57. doi: 10.1111/j.1600-0528.2011.00614.x. PubMed PMID: 21504439.
- 12 Peker K, Uysal O, Bermek G. Cross - cultural adaptation and preliminary validation of the Turkish version of the early childhood oral health impact scale among 5-6-year-old children. *Health Qual Life Outcomes*. 2011;9:118. doi: 10.1186/1477-7525-9-118.

- PubMed PMID: 22192577; PubMed Central PMCID: PMCPMC3310831.
- 13 Nzomiwu CL, Sote EO, Oredugba FA. Translation and Validation of the Nigerian Pidgin English Version of the Early Childhood Oral Health Impact Scale (NAIJA ECOHIS). *West Afr J Med.* 2018;35:102-8. PubMed PMID: 30027995.
 - 14 Jabarifar SE, Golkari A, Ijadi MH, Jafarzadeh M, Khadem P. Validation of a Farsi version of the early childhood oral health impact scale (F-ECOHIS). *BMC Oral Health.* 2010;10:4. doi: 10.1186/1472-6831-10-4. PubMed PMID: 20367888; PubMed Central PMCID: PMCPMC2858088.
 - 15 Jokovic A, Locker D, Stephens M, Kenny D, Tompson B, Guyatt G. Validity and reliability of a questionnaire for measuring child oral-health-related quality of life. *J Dent Res.* 2002;81:459-63. doi: 10.1177/154405910208100705. PubMed PMID: 12161456.
 - 16 Behbahanirad A, Joulaei H, Jamali J, Vosoughi M, Golkari A. A model for oral health gradients in children: using structural equation modeling. *Community Dent Health.* 2017;34:50-5. doi: 10.1922/CDH_3978Behbahanirad06. PubMed PMID: 28561559.
 - 17 Hashim NA, Yusof ZYM, Saub R. Responsiveness to change of the Malay-ECOHIS following treatment of early childhood caries under general anaesthesia. *Community Dent Oral Epidemiol.* 2019;47:24-31. doi: 10.1111/cdoe.12417. PubMed PMID: 30187941.
 - 18 Farsi DJ, Farsi NJ, El-Housseiny AA, Damanhoury WH, Farsi NM. Responsiveness of the Arabic version of the ECOHIS to dental rehabilitation under general anaesthesia. *Int J Paediatr Dent.* 2018;28:52-61. doi: 10.1111/ipd.12307. PubMed PMID: 28514525.
 - 19 Santos CM, Oliveira BH, Nadanovsky P, Hilgert JB, Celeste RK, Hugo FN. The Oral Health Impact Profile-14: a unidimensional scale? *Cad Saude Publica.* 2013;29:749-57. doi: 10.1590/s0102-311x2013000800012. PubMed PMID: 23568304.
 - 20 Goursand D, Ferreira MC, Pordeus IA, Mingoti SA, Veiga RT, Paiva SM. Development of a short form of the Brazilian Parental-Caregiver Perceptions Questionnaire using exploratory and confirmatory factor analysis. *Qual Life Res.* 2013;22:393-402. doi: 10.1007/s11136-012-0145-3. PubMed PMID: 22396181.
 - 21 Possebon A, Faot F, Machado RMM, Nascimento GG, Leite FRM. Exploratory and confirmatory factorial analysis of the OHIP-Edent instrument. *Braz Oral Res.* 2018;32:e111. doi: 10.1590/1807-3107bor-2018.vol32.0111. PubMed PMID: 30379235.
 - 22 Kavaliauskiene A, Sidlauskas A, Zaborskis A. Modification and psychometric evaluation of the child perceptions questionnaire (CPQ11-14) in assessing oral health related quality of life among Lithuanian children. *BMC Oral Health.* 2019;19:1. doi: 10.1186/s12903-018-0701-5. PubMed PMID: 30611272; PubMed Central PMCID: PMCPMC6320629.
 - 23 Liu H, Hays R, Wang Y, Marcus M, Maida C, Shen J, et al. Short form development for oral health patient-reported outcome evaluation in children and adolescents. *Qual Life Res.* 2018;27:1599-611. doi: 10.1007/s11136-018-1820-9. PubMed PMID: 29508207.
 - 24 Pilotto LM, Scalco GP, Abegg C, Celeste RK. Factor analysis of two versions of the Oral Impacts on Daily Performance scale. *Eur J Oral Sci.* 2016;124:272-8. doi: 10.1111/eos.12260. PubMed PMID: 26935779.
 - 25 Deng Y, He S, Li X. Application and dimensional structure of the early childhood oral health impact scale. *Hua Xi Kou Qiang Yi Xue Za Zhi.* 2013;31:38-41. PubMed PMID: 23484299.
 - 26 Kline RB. Principles and practice of structural equation modeling. New York: Guilford publications; 2015.
 - 27 Marôco J. Análise de equações estruturais: Fundamentos teóricos, software & aplicações. Pêro Pinheiro: Report Number, Lda; 2010.
 - 28 Rhemtulla M, Brosseau-Liard PE, Savalei V. When can categorical variables be treated as continuous? A comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. *Psychol Methods.* 2012;17:354-73. doi: 10.1037/a0029315. PubMed PMID: 22799625.
 - 29 Tsakos G, Blair YI, Yusuf H, Wright W, Watt RG, Macpherson LM. Developing a new self-reported scale of oral health outcomes for 5-year-old children (SOHO-5). *Health Qual Life Outcomes.* 2012;10:62. doi: 10.1186/1477-7525-10-62. PubMed PMID: 22676710; PubMed Central PMCID: PMCPMC3413607.