VALIDITY AND RELIABILITY OF THE EARLY CHILDHOOD CARIES PERCEPTIONS SCALE (ECCPS) TO ASSESS HEALTH BELIEFS RELATED TO EARLY CHILDHOOD CARIES PREVENTION AMONG PRIMARY CAREGIVERS OF CHILDREN UNDER 5 YEARS OF AGE

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Abstract. Primary caregivers' child oral health care beliefs and practices are major factors in the prevention of Early Childhood Caries (ECC). This study assessed the validity and reliability of a newly-developed scale – the Early Childhood Caries Perceptions Scale (ECCPS) – used to measure beliefs regarding ECC preventive practices among primary caregivers of young children. The ECCPS was developed based on the Health Belief Model. The construct validity and reliability of the ECCPS were examined among 254 low-socioeconomic status primary caregivers with children under five years old, recruited from 4 Bangkok Metropolitan Administration Health Centers and a kindergarten school. Exploratory factor analysis (EFA) revealed a four-factor structure. The four factors were labeled as Perceived Susceptibility, Perceived Severity, Perceived Benefits and Perceived Barriers. Internal consistency measured by the Cronbach's coefficient alpha for those four factors were 0.897, 0.971, 0.975 and 0.789, respectively. The ECCPS demonstrated satisfactory levels of reliability and validity for assessing the health beliefs related to ECC prevention among low-socioeconomic primary caregivers.

Keywords: early childhood caries, exploratory factor analysis, health belief model, oral health care, primary caregiver

INTRODUCTION

Early childhood caries (ECC) is an important oral health problem that can directly affect childhood growth or lead to infection in remote organs (Brice *et al*, 1996; Keulers *et al*, 2005; Moschos *et al*, 2005; Psoter *et al*, 2005). ECC has been found to be more prevalent in low socioeconomic groups (Villa and Guerrero, 1996; Vachirarojpisan *et al*, 2004; Ismail *et al*, 2008). ECC prevalence has decreased in Thailand but is still high and has an increasing trend in some areas (Lyn-Cook *et al*, 2007; Dental Public Health Section,

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2008). ECC can be reduced through preventive measures. Mutans Streptococci is an important cause of ECC (Olmez *et al*, 2003; Aguilera *et al*, 2005). Child oral health care behavior is an important contributing factor in ECC (Olmez *et al*, 2003; Douglass *et al*, 2004). Child oral health care behavior, feeding and cleaning behavior, are associated with ECC among children; feeding behavior includes night time bottle feeding (Hallett and O' Rourke, 2003; Slabsinskiene *et al*, 2010) and frequent consumption of cariogenic food (Gordon, 2007; Senesombath *et al*, 2010); cleaning behavior includes late commencement of child tooth brushing (Gordon, 2007) and brushing less than once a day (Peres *et al*, 2005; Senesombath *et al*, 2010; Slabsinskiene *et al*, 2010).

Better understanding of health-related behavior, such as child oral health care practices of caregivers, is enhanced by behavioral models or theories. The Health Belief Model (HBM), a cognitive-behavioral model, is one viable option. This model was developed initially in the 1950s to explain the widespread failure of people to participate in programs that would help prevent and detect disease (Hochbaum, 1958; Rosenstock, 1960). According to the HBM, an individual takes action to prevent, screen for, or control undesired health conditions if they regard themselves as susceptible to that condition, believe it would have potentially serious consequences, believe the recommended course of action would be beneficial in reducing either their susceptibility to or the severity of the condition or believe the anticipated barriers to (or cost of) taking the action are outweighed by the benefits (Rosenstock *et al*, 1988).

Four key constructs representing the perceived threats and net benefits are proposed in the HBM: a) perceived susceptibility – beliefs about the chances of getting a condition or disease; b) perceived severity – beliefs about the seriousness of the condition and its consequences; c) perceived benefits – beliefs about the benefits or effectiveness of taking action to reduce risk; and d) perceived barriers – beliefs about the material and psychological costs of taking the recommended action. The HBM has been used in previous research examining preventive health behaviors, such as oral cleaning behavior (Rayant and Sheiham, 1980; Kuhner and Raetzke, 1989; Hawe *et al*, 1998; Painter *et al*, 2010).

To examine health belief-related factors associated with child oral health care practices among caregivers, a valid, reliable instrument is needed. Unfortunately, there is no instrument examining caregiver health beliefs related to ECC and its prevention among young children. The Early Childhood Caries Perceptions Scale (ECCPS) guided by HBM concepts was developed to assess health beliefs related to ECC and its prevention among primary caregivers of children under five years of age. The ECCPS consists of four subscales: 1) perceived susceptibility – the beliefs of the primary caregiver regarding the chance of their child getting ECC, 2) perceived severity – the beliefs of the primary caregiver about the seriousness of ECC and its consequences to their child's health, including the child's social well-being and economic cost of ECC treatment (the perceived susceptibility and severity were labeled as perceived threat), 3) perceived benefits – the beliefs of the primary caregiver about the efficacy of the advised action to reduce the risk or seriousness of ECC; and 4) perceived barriers – the beliefs of the primary caregiver about the tangible and psychological costs of the advised cleaning action. The purposes of this study were to assess the construct

validity and reliability of the ECCPS in order to measure and assess the primary caregiver beliefs related to ECC and its prevention among their young child.

MATERIALS AND METHODS

Participants

A total of 254 primary caregivers were recruited from Piriya-Navin school and 4 Bangkok Metropolitan Administration (BMA) Health Centers during September to November 2009. These were comprised of 118 primary caregivers of children in kindergarten 1 (K1) at Piriya-Navin School and 127 primary caregivers of children who received routine vaccinations at BMA Health Centers. Inclusion criteria were being a primary caregiver of a child less than five years old and the ability to read Thai. Written informed consent was obtained prior to participation. No personal identifying information was solicited. The subjects were informed all their answers being anonymous and confidential and the data would only be reported at the group level. The study received ethical approval by the Institutional Review Board of Mahidol University (MU-IRB 2009/177.1108).

Scale development

Scale development included statement generation and content validity assessment and statement selection.

Statement generation. The initial pool of statements in the ECCPS was developed based on a literature review and interviews with caregivers about child oral health care. The construct definitions were guided by a literature review. The wording of the statements was developed based on the result of these interviews. Fifteen semi-structured interviews were conducted among primary caregivers of children younger than five years old at their residence. The interview data were analyzed using verbatim transcripts. Thematic analysis was applied (Aronson, 1994). The transcripts were reviewed to identify key phrases and words. Repeated words and phrases were grouped by categories, such as "risk to ECC", "tooth decay treatment", "feeding behavior", and "child mouth cleaning". Analysis of the interviews and literature review resulted in 31 statements. Pooled statements from the first draft ECCPS consisted of 4 subscales: perceived susceptibility to ECC (8 statements), perceived severity of ECC (7 statements), perceived benefits of ECC prevention (8 statements) and perceived barriers of ECC prevention (8 statements), using a five-point Likert scale consisting of: strongly disagree, disagree somewhat, neutral, agree somewhat and strongly agree.

Content validity assessment. Four experts, three in the field of behavioral science and one dentist, were asked to verify the content validity of the draft ECCPS and to add further comments they considered relevant. All the experts were asked to evaluate the relevance and the adequacy of the draft ECCPS by giving a score of 1 for a valid statement, a 0 if not sure and a -1 for an invalid statement. None of the statements were scored as invalid. Content validity was examined by item correlation (IC) for each statement to quantify expert agreement. The IC for each statement was calculated by a sum of the scores divided by the number of experts who examined that item. Statements with an IC < 0.5 were modified or discarded. No statements were discarded since none of the statements had an IC < 0.5. Additional modifications were made based on the experts' comments. Similar statements were removed. Adjustments were made due to eliminate misunder-

standings or ambiguities.

Comprehension and wording of the ECCPS were tested after content validity testing. Since the survey targeted primary caregivers of children less than five years old, five primary caregivers were asked to complete the draft ECCPS independently. After completing the ECCPS, each were debriefed individually to identify problems or ambiguities in the statements. The statements were then modified to improve comprehension. The instructions for completing the ECCPS were reported as easily understood. The draft ECCPS stood as a 31-statement scale with 5-point Likert scales.

Statement selection. Exploratory factor analysis (EFA) with rotation and item-total statistics were employed for statement selection. Statements which showed low inter-item correlations were removed if they showed low factor loadings and its corrected item-to-total correlation was smaller than others in the same factor. One statement was removed at a time. The statement removal process and rotation were carried out repeatedly to obtain the best model with a Cronbach's coefficient alpha of > 0.70. As a result of this procedure, 20 statements were included in the ECCPS.

Test of validity and reliability

Construct validity. EFA was conducted to assess the construct validity of the ECCPS. Respondents were invited to complete the revised ECCPS by teachers and BMA Health Center staff. Following data cleaning and checking, missing values were excluded pairwise. Factorability of the questionnaire was investigated by item-total correlations, the Kaiser-Meyer-Olkin measure for sampling adequacy (KMO), the Bartlett's test for sphericity, and the measures for sampling adequacy (MSAs) (Hair *et al*, 2006). A principal axis factor (PAF) was determined since the assumption of multivariate normality was not achieved (Costello and Osborne, 2005). The optimal number of factors was determined by the scree test (Hair *et al*, 2006). Since the number of predicted factors in the HBM is four and the scree test suggested four factors, the four factors were retained (Costello and Osborne, 2005). The factor loading tables were compared after rotation. The one with the cleanest factor structure had the best fit for the data. The best fit for the data was assumed if the factor loading was > 0.30, there were no or few cross-loadings and none of the factors had fewer than three statements (Costello and Osborne, 2005). An oblique rotation was employed since the constructs of the HBM were related (Janz *et al*, 2002; Hair *et al*, 2006).

Reliability

The reliability of the scale was assessed by the internal consistency. Internal consistency was assessed by three conditions: 1) an inter-item correlation > 0.30; 2) a corrected item-to-total correlation > 0.50; and 3) a Cronbach's coefficient alpha > 0.70 (Hair *et al*, 2006). Statements were deleted to achieve those conditions.

RESULTS

Participant characteristics and descriptive results

We achieved a 90% response rate. The socio-demographic characteristics of participants are shown in Table 1. Most participants (78.4%) were female. The mean age of the participants was 32.4 years with a standard deviation of 8.7 years. The participants were comprised of mothers (66.9%), fathers (18.4%), grandparents (8.2%) and aunts or uncles (6.5%). The majority (86.9%) were married, employed

(61.2%) and claimed child rearing experience (76.3%). Thirteen point one percent of participants had a less than sixth grade education, 17.1% reached Grade 6, 53.1% graduated from high school or vocational school, and 16.7% had a bachelor's degree or higher. Most participants (82.9%) had a monthly family income < 15,000 Baht and 43.3% had a monthly family income < 10,000 Baht.

The means and standard deviations for each statement and each construct are listed in Table 2. The statements were grouped according to their related constructs. Higher mean scores indicated greater agreement with the statement and higher standard deviations indicated more variability in the responses. Statements in the perceived susceptibility construct generally had higher mean scores with more moderate variability than other constructs. Statements in the perceived barriers construct had generally lower mean scores with the lowest variability. (Table 2).

Construct validity

The 20 remaining statements were used to assess the construct validity of the ECCPS. The correlation matrix indicated a simple correlation among the 20 statements whose values exceeded 0.30. The correlation matrix, Kaiser-Meyer-Olkin measure for sampling adequacy (KMO) (0.917), Bartlett's test of sphericity (χ^2 = 5477.257, df =190 and p-value < 0.0001) and the measures of sampling adequacy (MSAs) (ranged from 0.810 to 0.963) indicated the data were able to be grouped. The results revealed communality values, the amount of variance in the variable shared with all other variables, ranged from 0.317-0.937 (Table 3). The optimal number of factors suggested by the scree test was a four-factor-model as it showed

Table 1
Demographic characteristics (N=245).

Sociodemographic characteristics	Frequency (%)
Age	
Mean (SD) = 32.3 (8.7)	
Minimum = 15, Maximum = 60	
15-29	99 (40.4)
30-39	93 (38.0)
40-49	42 (17.1)
50-60	11 (4.5)
Caregiver's gender	
Male	53 (21.6)
Female	192 (78.4)
Caregiver's occupation	
Government employee	41 (16.7)
Employee	96 (39.2)
Business owner	13 (5.3)
Unemployed	24 (9.8)
Stay at home for child rearing	53 (21.6)
Others	18 (7.4)
Caregiver's marital status	
Single	25 (10.2)
Married	213 (86.9)
Divorced	7 (2.9)
Caregiver's highest education	
Lower than grade 6	32 (13.1)
Grade 6	42 (17.1)
High/vocational school	130 (53.1)
Bachelor degree or higher	41 (16.7)
Family income per month[a]	
Less than 10,000 Baht	106 (43.3)
10,000-15,000 Baht	97 (39.6)
15,001-30,000 Baht	38 (15.5)
More than 30,000 Baht	4 (1.6)
Caregiver's relationship with child	
Mother	164 (66.9)
Father	45 (18.4)
Grandparents	20 (8.2)
Aunt/uncle	16 (6.5)
Having experience in child rearing	
Yes	187 (76.3)
No	58 (23.7)

[a]1 USD = 30 THB

Table 2
Means, standard deviations and Cronbach's coefficient alpha and other statistics.

Statements	Mean	Standard deviation	Corrected item-total correlation
Perceived susceptibility Cronbach's coefficient alpha = 0.897	3.303	0.823	
1. It is likely that my child will get tooth decay.	3.286	0.984	0.799
2. My child's chances of getting cavities in the next few years are great.	3.286	0.923	0.783
3. Developing cavities is currently a possibility for my child.	3.355	0.924	0.795
4. I am concerned about my child's likelihood of developing cavities in the near future.	3.286	0.932	0.713
Perceived severity Cronbach's coefficient alpha = 0.971	2.996	1.121	
5. Toothache can keep a child from sleeping through the night.	2.971	1.236	0.908
6. Children with cavities have bad breath.	2.996	1.276	0.915
7. Children with cavities are likely to be teased by his/her friends.	2.959	1.097	0.898
8. Children with missing teeth are likely to be teased by his/her friends.	2.967	1.134	0.918
9. Children with cavities require parents to spend money for dental treatment costs.	3.078	1.204	0.897
10. Children with cavities require parents to spend time for dental treatments.	3.004	1.233	0.912
Perceived benefits Cronbach's coefficient alpha = 0.975	2.705	1.086	
11. Habitual child oral health cleaning will help my child avoid cavities.	2.727	1.128	0.860
12. Wiping my child's gum/tongue will help him/her avoid tooth decay.	2.645	1.094	0.946
13. Sipping water after every milk feeding will help my child avoid cavities.	2.698	1.093	0.937
14. Caries prevention will keep my child from having dental pain.	2.767	1.224	0.953
15. Caries prevention will help my child sleep through the night.	2.686	1.147	0.951
Perceived barriers Cronbach's coefficient alpha = 0.789	2.545	0.681	
16. A child's toothbrush is too expensive.	2.576	0.958	0.615
17. Brushing my child's teeth with a toothbrush is difficult.	2.596	0.899	0.655
18. Practicing child oral cleaning is painful for my child.	2.616	0.878	0.578
19. I do not know how frequently to clean my child's mouth.	2.625	0.909	0.486
20. My family members do not agree with forcing my child to have his/her teeth cleaned.	2.314	0.977	0.511

n=245, total scale mean (SD) = 2.872 (0.605)

Table 3
Factor loadings and communalities of exploratory factor analysis of the ECCPS.

Statements	Factor				Communalities
	1	2	3	4	
1. It is likely that my child will get tooth decay.		**0.865**			0.746
2. My child's chances of getting cavities in the next few years are great.		**0.824**			0.711
3. Developing cavities is currently a possibility for my child.		**0.879**			0.726
4. I am concerned about my child's likelihood of developing cavities in the near future.		**0.721**			0.598
5. Toothache can keep a child from sleeping through the night.				**0.849**	0.852
6. Children with cavities have bad breath.				**0.812**	0.878
7. Children with cavities are likely to be teased by his/her friends.				**0.952**	0.845
8. Children with missing teeth are likely to be teased by his/her friends.				**0.950**	0.887
9. Children with cavities require parents to spend money for dental treatment costs.				**0.670**	0.854
10. Children with cavities require parents to spend time for dental treatments.				**0.776**	0.861
11. Habitual child oral health cleaning will help my child avoid cavities.	**0.608**				0.814
12. Wiping my child's gum/tongue will help him/her avoid tooth decay.	**0.953**				0.927
13. Sipping water after every milk feeding will help my child avoid cavities.	**0.989**				0.916
14. Caries prevention will keep my child from having dental pain.	**0.933**				0.937
15. Caries prevention will help my child sleep through the night.	**0.906**				0.930
16. A child's toothbrush is too expensive.			**0.640**		0.560
17. Brushing my child's teeth with a toothbrush is difficult.			**0.743**		0.602
18. Practicing child oral cleaning is painful for my child.			**0.674**		0.447
19. I do not know how frequently to clean my child's mouth.			**0.579**		0.317
20. My family members do not agree with forcing my child to have his/her teeth cleaned.			**0.576**		0.344

Extraction and rotation method: Principal Axis Factoring, Oblimin with Kaiser Normalization.

Table 4
Factor correlation matrix.

Factor	Perceived benefits	Perceived susceptibility	Perceived barriers	Perceived severity
Perceived benefits	1			
Perceived susceptibility	0.254	1		
Perceived barriers	-0.356	-0.114	1	
Perceived severity	0.726	0.381	-0.379	1

a noticeable difference in slope after the first two and five components (Fig 1). Principal axis factors (PAF) with several rotations were carried out. The final four factors explained 73.8% of the variance. The factor loading tables were compared after rotation. A principal axis factor (PAF) with oblique rotation (oblimin) gave the best fit model. The pattern matrix was examined for factor loadings (Costello and Osborne, 2005). Within each factor, every statement had positive factor loadings; they ranged from 0.576 to 0.989 (Table 3). Each statement loaded with its respective construct. The correlations between factors are shown in Table 4.

The final instrument had 4 factors: Factor 1 with 5 statements addressing the beneficial outcomes of caries preventive behavior; Factor 2 with 4 statements addressing the susceptibility of the child to having ECC; Factor 3 with 5 statements addressing the barriers to performing child oral health care; and Factor 4 with 6 statements addressing the perceived effects of having ECC.

Reliability

The calculation revealed the internal consistency, indicated by Cronbach's coefficient for each factor, ranged between 0.77 and 0.90, which is acceptable. The Cronbach's coefficient alpha results for Factors 1, 2, 3, and 4 were 0.975, 0.897, 0.789 and 0.971, respectively. The corrected item-total correlations ranged from 0.486 to 0.953 (Table 2). Since the Cronbach's alpha coefficient for each construct was > 0.80 (except Factor 4, slightly less than 0.80), the results indicate strong correlations with the ECCPS (Hair *et al*, 2006) indicating the ECCPS is a reliable instrument for assessing perceptions related to ECC.

DISCUSSION

This study describes the development and assessment of the ECCPS measuring primary caregiver health beliefs related to ECC prevention. The construct validity and reliability of the ECCPS were assessed for measuring those health beliefs. The results of this study show the ECCPS has good construct validity and good internal consistency with an adequate sample size (254 subjects answering 20 statements) (Costello and Osborne, 2005; Hair *et al*, 2006). Good validity was indicated since the EFA revealed the four factors corresponded closely to the draft ECCPS. The type and character of the draft ECCPS statements were specified by HBM constructs. Factor analysis indicated correspondence between content validity and expert opinion (Hair *et al*, 2006). The expert agreement shows good theoretical

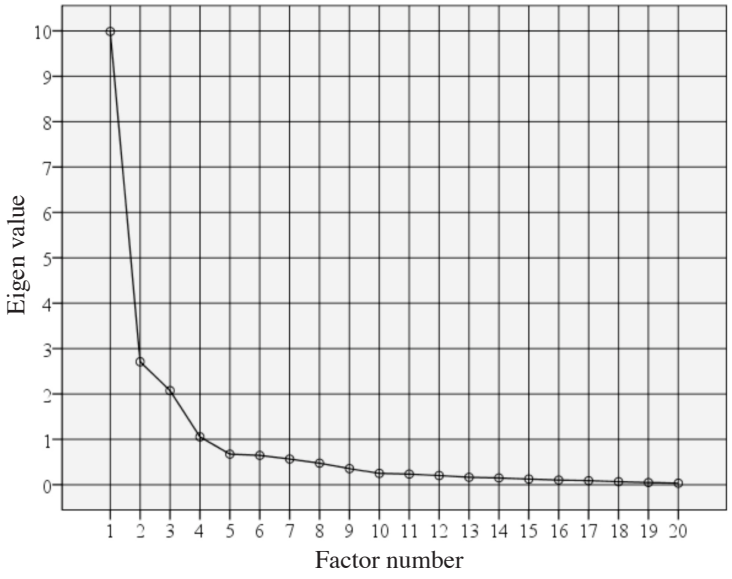

Fig 1–The scree test.

and practical properties of the ECCPS. The ECCPS appears valid in measuring perceptions related to ECC prevention among primary caregivers of children under five years old.

The ECCPS revealed a strong conceptual foundation to support an existing theoretical structure. The optimal number of factors determined by the scree test corresponded to the HBM construct. The results of EFA supported the construct validity of the ECCPS with significant factor loadings (Hair *et al*, 2006). The significant loading on oblimin rotation with Kaizer normalization for each variable without cross-loading indicates the unidimensionality of the ECCPS. The high factor loadings show high correlation between statements and constructs in the ECCPS. The factor solution of the ECCPS can provide a meaningful interpretation. Squared factor loadings, which can be compared to the R-Square in regression analysis, indicate the percentage of variance of an original variable explained by a factor. Each statement in the ECCPS had a high factor loading of > 0.576, indicating at least 33% of the variance in the statement was explained or shared with the construct. No cross-loading indicates the statement was specific for its construct. Thus, the ECCPS with a four-factor scale had adequate validity. Since the best fit model was obtained by an oblique rotation, it reveals the relationships between constructs. The HBM states people perform a preventive behavior if they perceive a threat (of high risk or severe outcome) with that disease (Becker, 1974). This could imply a positive association between a perceived susceptibility to disease and perceived severity of disease. If the benefits of performing ECC prevention tasks outweigh the barriers to performing them, this motivates people to practice the suggested behavior. This is evidenced by the negative relationship between perceived benefits of and perceived barriers to preventive behavior. The EFA results indicated a relationship between the construct and the theory.

Internal consistency of the ECCPS was determined to ensure ECCPS content was homogeneous. The ECCPS had a high correlation among statements; the instrument included 20 statements. The results show adequate internal consistency of the ECCPS with the high Cronbach's coefficient alpha and its optimal number of statements. We can infer the ECCPS statements were measuring the same issues and were highly intercorrelated (Hair *et al*, 2006).

The ECCPS proved to be valid, reliable and appropriate for assessing health beliefs related to ECC prevention among primary caregivers of children under 5 years of age. It is a useful instrument since it has a short length, a low respondent burden and has comprehensibility. The participants spent five to ten minutes to complete the ECCPS. There was no questions asked during their self-administered ECCPS. The ECCPS demonstrated its advantage as a rapid assessment instrument that can be used to provide tailored educational messages focused on improving primary caregiver's health beliefs about ECC prevention. This rapid assessment of the health beliefs of people indicates which health beliefs need to be addressed as part of an oral health education campaign.

The ECCPS could be used as an instrument for providing individually tailored educational materials for respondents. An oral health education program, which puts emphasis on decreasing perceived barriers and increasing perceived benefits, for encouraging the primary caregiver to perform the suggested ECC preventive behavior represents a practical progression in helping dentists and researchers influence primary caregivers to adopt appropriate ECC prevention practices. Future research should test whether an oral health educational program employing tailored-made activities based on the results of the ECCPS produces a positive outcome for influencing the adoption of the ECC prevention practices among primary caregivers. The activities should emphasize increasing perceived susceptibility to ECC, perceived severity of ECC, perceived benefits of ECC prevention and decreasing perceived barriers to ECC prevention. The change in perceptions after participating in an oral health education program may be measured by repeated evaluation with the ECCPS and examining how these relate to self-reported ECC prevention behavior and clinically relevant outcome variables, such as reduced ECC.

Several limitations of this study should be noted. The ECCPS cannot yet be used in a diverse population, since it was initially tested among a particular group of low socioeconomic primary caregivers. Use of the ECCPS in other populations might reveal different findings for the instrument's accuracy. To strengthen the generalizability of the findings, the ECCPS should be tested among a diverse population.

There may be response bias since the data in this study was based upon self-assessments and self-reports. The ECCPS was a self-administered questionnaire; there may be measurement errors. ECC is not a life-threatening disease and may be perceived by some as a normal condition in children. The ECCPS may not show perceived severity.

Since our study sample for the development of ECCPS was low socioeconomic primary caregivers, the ECCPS should be used in this population. The HBM is a cognitive-behavioral model that attempts to explain and predict health behavior. The ECCPS may be suitable for evaluating improvement in health beliefs after implementing an oral health education program for ECC prevention among low socioeconomic primary caregivers.

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