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Validity of Measures Assessing Oral Health Beliefs of American Indian Parents

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Abstract

Objectives This aimed to validate measures of constructs included in an extended Health Belief Model (EHBM) addressing oral health beliefs among American Indian (AI) parents.

Methods Questionnaire data were collected as part of a randomized controlled trial ($n = 1016$) aimed at reducing childhood caries. Participants were AI parents with a preschool-age child enrolled in the Navajo Nation Head Start program. Questionnaire items addressed five EHBM constructs: perceived susceptibility, severity, barriers, benefits, and parental self-efficacy. Subscales representing each construct underwent reliability and validity testing. Internal consistency reliability of each subscale was evaluated using Cronbach's alpha. Convergent validity was assessed using linear regression to evaluate the association of each EHBM subscale with oral health-related measures.

Results Internal consistency reliability was high for self-efficacy ($\alpha = 0.83$) and perceived benefits ($\alpha = 0.83$) compared to remaining EHBM subscales ($\alpha < 0.50$). Parents with more education ($p < 0.0001$) and income ($p = 0.0002$) perceived dental caries as more severe younger parents (ps $= 0.02$) and those with more education (ps < 0.0001) perceived greater benefits and fewer barriers to following recommended oral health behavior. Female parents ($p < 0.0001$) and those with more education ($p = 0.02$) had higher levels of self-efficacy. Parental knowledge was associated with all EHBM measures (ps < 0.0001) excluding perceived susceptibility ($p > 0.05$). Parents with increased self-efficacy had greater behavioral adherence ($p < 0.0001$), whereas lower behavioral adherence was associated with parents who reported higher perceived barriers ($p < 0.0001$). Better pediatric oral health outcomes were associated with higher levels of self-efficacy ($p < 0.0001$) and lower levels of perceived severity ($p = 0.02$) and barriers ($p = 0.05$).

Conclusions Results support the value of questionnaire items addressing the EHBM subscales, which functioned in a manner consistent with the EHBM theoretical framework in AI participants.

Keywords American Indians · Self-efficacy · Dental caries · Psychosocial factors · Child · Baseline survey

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Introduction

Oral health disparities in American Indian and Alaska Native (AI/AN) groups have become an increasing public health focus. Compared to other disadvantaged groups, the AI/AN population has the highest prevalence of dental caries [1–3] with children disproportionately affected. Traditional models aimed at improving children's oral health have focused on fluorides alone with poor predictive results [4, 5]. Health promotion interventions based on valid conceptual frameworks encompassing social determinants for the child-family unit are recommended to investigate the underlying causes of oral health disparities [5]. A range of theoretical models developed within the context of general health have been proposed and studied to address oral health disparities including the common-sense model of self-regulation [6], sense of coherence [7], and the health belief model (HBM) [8].

The HBM and related concept of self-efficacy which stems from social cognitive theory have been applied to many health conditions with modifiable behavioral components [8, 9]. Together, the constructs addressed by these models can provide a means of predicting and understanding parental health influences that may promote or impair the oral health outcomes of young children [9]. The HBM is one of the earliest and most widely used explanatory models in health promotion research [8, 10]. The HBM conceptual framework posits that health behavior is determined by an individual's perceptions of a health condition and their behaviors that may enable avoidance of the condition. The model includes four key constructs: perceived susceptibility, perceived severity, perceived benefits, and perceived barriers. The theoretical basis of the HBM [8] purports that individuals are more likely to engage in positive health behaviors when perceiving: they are susceptible to developing a given disease (higher perceived susceptibility), the disease is serious (higher perceived severity), they perceive there to be benefits to engaging in the behaviors (higher perceived benefits), and perceive few potential impediments to engaging in positive health behaviors (lower perceived barriers).

Earlier applications of the HBM were used to predict simple health behaviors, such as one-time immunizations. Eventually, the model was applied to complex health concerns requiring long-term behavioral modification. In 1988, the HBM was expanded to include the concept of self-efficacy, which represents the degree to which a person feels capable of engaging in a recommended health behavior [11]. Although this construct stems from social cognitive theory [9], it was incorporated into the HBM because of its reliability as a predictor of health behavior [12–14], theoretical connection with the HBM construct of perceived barriers [8], and relevance as a predictor of more complex behaviors, such as those required in self-management of chronic diseases.

The extended health belief model (EHBM) has been widely applied to a range of medical concerns in health promotion research [15–17]. Still, application in oral health research has been scant, with existing studies singularly focused on predicting oral hygiene habits in adults. Outcomes from oral health studies reflected that self-efficacy was a significant predictor of adult engagement in oral hygiene behaviors, while the predictive strength for each original HBM constructs varied among the oral hygiene studies [13, 18, 19]. The HBM measures most predictive of adult oral hygiene behaviors were perceived severity of the disease and perceived barriers to engaging in the oral health behavior [13, 18, 19]. Conclusions drawn from these studies highlight the importance of identifying specific beliefs underlying an individual's health behavior to guide development of tailored approaches for health promotion interventions.

The purpose of this study was to examine reliability and validity of measures developed to assess the EHBM constructs in relation to the influence of parents' beliefs on the oral health outcomes of their children.

Methods

Study Design This validation study is a secondary analysis of an already existing database that was generated in a community intervention randomized trial. As described in an earlier report [20], the study examined the effects of a health promotion intervention on oral health outcomes among preschool-age children enrolled in the Navajo Nation Head Start program. Randomization was conducted at the level of the Head Start Center. Thirty-nine of the 82 Head Start centers on the Navajo Nation were randomly selected. Twenty centers were randomized to the intervention arm and 19 to the control arm with 26 classrooms in each study arm. Within each Head Start Center, participants were recruited in parent-child dyads. Children were eligible for participation if they were age 3 to 5 years, enrolled in a participating Head Start Center, and had a parent/caregiver willing to participate in the study (hereafter, referred to as "parents"). Parent-child dyads were excluded if the child was allergic to any component of fluoride varnish, the child had any serious health conditions, or the parent did not speak English. No eligible parent-child dyads were excluded.

Classroom and Dyad Enrollment Occurred in the Fall of the 2011 (Cohort 1) and Fall of 2012 (Cohort 2) Enrollment reached 97.7% of the intended sample of 1040 child-parent dyads (1016 dyads). Due to the small percentage of AN children and parents, the term AI will be used henceforth in describing the study population. The intervention involved application of fluoride varnish and provision of oral health education over a 2-year period for children and oral health education for parents. Participants in the control arm did not receive study-related fluoride varnish or oral health education, instead receiving the health and educational services normally provided through the Head Start Center. In both the intervention and control arms, participants received toothbrushes and toothpaste for all family members.

Data Collection All parents completed the Basic Research Factors Questionnaire (BRFQ) at enrollment [20] with subsequent administration of the questionnaire annually. The BRFQ assessed parent and child characteristics; oral health knowledge, beliefs, behavior, and outcomes; utilization of dental services; and other constructs expected to be related to children's oral health outcomes. The BRFQ met approval criteria of review boards and at or below an eighth-grade reading level. The instrument was pilot tested in the field to assess ability of participants to complete the questionnaire and confirm the length was not burdensome. The questionnaire was administered via an audio computer-assisted self-interviewing system (ACASI), which allowed parents to simultaneously read the questions and hear the narration by a member of the Navajo Nation. The ACASI data collection methods have been found to have high acceptability ratings by AI study participants [21–23]. Baseline data (dental screening of children and caregiver surveys) were collected at the Head Start sites where children were in attendance, which provided convenient access and minimized the participation burden for families. Study personnel were present to answer questions and assist with use of the computers if needed. Parents were informed that data related to parent and family and their child's eating and dental habits would be collected to find better ways to prevent dental caries in preschool children.

Oral examination of children was completed by licensed, calibrated dental hygienists at baseline and then annually. The dental hygienists serving as study examiners were blinded to the study assignment for the classroom. After brushing the child's teeth, a knee-to-knee examination was completed by the study examiner with parental assistance, using a direct light source and mouth mirror to facilitate visualization. Prior to and annually, study examiners were calibrated to a "gold standard" dentist and required to achieve Kappa scores of at least 0.7 as described in earlier reports [24, 25]. Trained study personnel also blinded to the study condition recorded the observations, using an electronic dental research record designated as CARIN (CAries Research Instrument) specifically designed for documentation of the decayed, missing, and filled tooth surface (dmfs) measure following standardized criteria [26, 27].

Measures Analyses used baseline BRFQ and oral exam data to assess validity of items designed to measure the five main constructs addressed by EHBM (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, and self-efficacy).

Extended Health Belief Model Sixteen items measured four main constructs from the original HBM: perceived susceptibility, perceived severity, perceived benefits, and perceived barriers [8–10]. Items were adapted from four sources to capture beliefs toward specific behaviors recommended as part of the intervention [3, 28–30]. Responses to all items ranged from 1 ("Strongly Disagree") to 5 (Strongly Agree"). The average of items associated with each construct was computed, with larger numbers reflecting a greater degree of each construct.

The BRFQ encompassed 12 items designed to measure parental oral health self-efficacy [31, 32]. Items were adapted from Reisine's Dental Confidence Questionnaire [33] or newly developed and used a scale of 1–5, where 1 indicated a parent was "not at all sure" he/she could engage in a given behavior and 5 indicated he/she was "extremely sure." For analysis, the average of the self-efficacy items was computed.

Oral Health Knowledge Parents answered 14 questions assessing knowledge of oral health and recommended parental oral health behaviors. Validity of these items was described in an earlier report [34]. Responses were coded as correct or incorrect ("don't know" responses were identified as incorrect). Oral health knowledge was measured as the percentage of questions answered correctly.

Adherence to Recommended Oral Health Behavior Twelve questions, which were previously validated [34], assessed parental oral health behavior. For each item, responses were coded as adherent or non-adherent with current recommendations for good oral health care. A behavioral adherence score was computed representing the percentage of behaviors for which parents were adherent.

Indicators of Oral Health Three measures of children's oral health and one measure of parental oral health were assessed. Using baseline oral examination data, a score for dmfs was computed for each child. In addition, one survey item, adapted from the National Survey of Children's Health [35], asked parents to rate their child's oral health status (OHS) as excellent = 1, very good = 2, good = 3, fair = 4, and poor = 5. A parallel item asked parents to rate their own OHS, using the same response scale that parents used to rate their child's OHS. Pediatric oral health quality of life (POQL) was assessed using a measure previously validated in AI [36, 37] and other populations [38]. In evaluating POQL, parents reported the frequency with which their children's oral health affected their daily functioning and how bothered their children were by these experiences. The POQL scores had a potential range from 0 to 100, with lower scores representing better POQL.

Participant Characteristics Participant characteristics included parent and child age and gender, parent's employment status, educational attainment, household income, and relationship to child. In analyses, employment was computed as a dichotomous variable indicating whether a parent was employed at least part time. Education was coded using a four-point scale ($1 \leq$ high school graduate, 4 = college degree or more). Income was measured as the total pre-tax income of all household members for the prior year and coded using a five-point scale, ranging from < \$10,000 = 1 to ≥ \$40,000 = 5. Because a high percentage of participants declined to provide income information, the categorical variable representing income included a category identifying missing income data.

Sample Size and Data Analysis The sample size for the study was calculated to meet the objectives of the intervention randomized trial. The target sample size was 1040 parent-child dyads randomized equally between the intervention and control groups to detect a 40% reduction in the dmfs measure with 80% power and a 70% retention rate. Descriptive analyses were conducted to examine participant characteristics and baseline performance on all measures. To assess internal consistency reliability, the item-total correlation of items with their respective subscales and Cronbach's alpha for each subscale were computed. Item-total correlations of 0.30 or higher were considered to reflect an acceptable degree of association between an item and the total score for its subscale. Cronbach's alpha of 0.70 or higher was deemed to reflect an acceptable degree of consistency among items in a subscale.

ANOVA was used to examine the association of the EHBM subscales with sociodemographic characteristics (age, gender, educational attainment, income). Ordinary least squares regression was used to assess the relationship of the subscales with convergent measures (knowledge, behavioral adherence, oral health outcomes). These latter analyses controlled for age, gender, education, and income. Analyses were conducted using all available data; missing values were not imputed. For all variables, the percent missing was very low (1% or less for most variables and 3% for dmfs) excluding income at 16%. Analyses were performed using SAS version 9.4. (SAS Institute, Cary, North Carolina).

Study Approvals The protocol was approved by the Navajo Nation Human Research Review Board and the Colorado Multiple Institutional Review Board at the University of Colorado as well as governing bodies at the Tribal and local levels, the Tribal departments of Head Start and Education, and Head Start parent councils. Participating parents or caregivers provided written informed consent and Health Insurance Portability and Accountability Act authorization prior to study participation.

Results

Sample Characteristics Table 1 presents characteristics of the study sample. Participating parents were on average 32 years old, with an age range of 19 to 88 years. The majority of adult participants were female with more than three-quarters being the participating child's mother. Study participants experienced significant economic distress, with nearly 60% reporting household incomes below $20,000 per year and 28% employed full or part time. Among participants, 84% had at least a high school education. Participating children were 3 to 5 years in age, with an average of 3.6 years. The sample size differs for subsequent Tables 2, 3, and 4 due to six parents not completing the BRFQ but having demographic and children's dmfs data.

Table 1 Descriptive characteristics of the sample ($N = 1016$)

Parent characteristics	Mean (SD) or %
Age	31.9 (9.3)
Gender: female	83.8%
Highest grade completed	
< High school graduate	15.8%
High school grad/GED	37.1%
Some college/vocational	35.2%
College degree or more	11.9%
Income	
< $10 K	41.5%
$10 K to < $20 K	17.3%
$20 K to < $30 K	9.3%
$30 K to < $40 K	6.8%
≥ $40 K	9.0%
Income Missing	16.1%
Employment status	
Employed full or part time	28.4%
Full- or part-time student	10.6%
Homemaker	23.5%
Unemployed	34.8%
Other	2.7%
Relationship to child	
Mother	77.0%
Father	15.0%
Grandmother	4.9%
Other	3.1%
Child characteristics	
Age	3.6 (0.5)
Gender: female	50.9%

Baseline Item Performance Table 2 presents baseline performance on all subscale items. Mean item scores for the perceived susceptibility subscale hovered around 3 on the five-point scale, suggesting that parents did not perceive children to be at especially high risk for developing dental caries. Item-total correlations under 0.30 and Cronbach's alpha of 0.39 suggest that the susceptibility questionnaire items were not well correlated with each other. Importantly, parents considered children in general to be at greater risk for dental caries than their own children. Although parents somewhat agreed most children have dental caries and dental caries can occur as soon as teeth are present, on average, parents neither agreed nor disagreed their own children would develop dental caries.

Table 2 Mean values and item-total correlations for each question in the extended health belief model scale and the subscales ($N = 1010$)

Extended health belief model	Mean (SD)	Item-total correlation[a]
Perceived susceptibility		
Most children get cavities.	3.6 (1.2)	0.28
My child will probably get cavities in the next few years.	2.9 (1.2)	0.25
Children can get cavities as soon as their first tooth comes in.	3.7 (1.4)	0.17
Perceived severity		
Dental problems can be serious for a child.	4.6 (0.9)	0.19
Having bad teeth affects a child's everyday life.[b]	4.0 (1.4)	0.30
Dental problems are as important as other health problems.[b]	4.3 (1.1)	0.35
Perceived benefits		
My child is unlikely to get cavities…		
If his/her teeth are brushed with fluoride toothpaste twice a day	4.2 (1.1)	0.63
If he/she goes to the dentist for regular check-ups	4.3 (1.1)	0.67
If I keep him/her from eating a lot of sugary foods and drinks	4.3 (1.0)	0.57
If an adult helps brush his/her teeth until at least age 6	4.3 (1.1)	0.62
If a dentist or other care provider puts fluoride varnish on his/her teeth	4.1 (1.1)	0.62
Perceived barriers		
It's not easy to make sure that my child's teeth are brushed with fluoride toothpaste twice a day.[b]	1.6 (0.9)	0.19
It would be hard to take my child to the dentist for regular check-ups.	2.2 (1.3)	0.34
It's hard to keep my child from eating sweet foods and drinks.	2.9 (1.3)	0.22
I have trouble making sure that my child's teeth are brushed the last thing before bed.[b]	2.0 (1.2)	0.22
It's inconvenient to have fluoride varnish put on my child's teeth.	2.4 (1.5)	0.16
Self-efficacy		
How sure are you that you can…		
Carefully check your child's teeth and gums every month for spots and problems?	4.3 (1.0)	0.53
Take your child to the dentist for regular check-ups?	4.7 (0.7)	0.44
Always use fluoride toothpaste when brushing your child's teeth?	4.5 (0.9)	0.40
Make sure that your child does not eat or drink anything other than water after his/her gums and teeth are cleaned at bedtime?	4.3 (1.0)	0.55
Keep your child from eating frequent sweets (cake, candy)?	4.1 (1.1)	0.58
Keep your child from putting anything in his/her mouth that has been in someone else's mouth?	4.4 (1.0)	0.51
Have fluoride varnish put on your child's teeth by a dentist or other health care provider?	4.5 (0.9)	0.40
Keep your child from drinking sugary drinks like soda, pop, or Kool-Aid?	4.0 (1.1)	0.57
Avoid putting your child to bed with a bottle or sippy cup with anything other than water in it?	4.5 (1.0)	0.44
Make sure your child's teeth are brushed twice a day?	4.7 (0.7)	0.59
Make sure your child's teeth are brushed before going to bed?	4.7 (0.7)	0.60
Help your child brush his/her teeth until he/she is at least 6 years old?	4.4 (1.0)	0.34
Summary scores	Mean (SD)	Cronbach's alpha
HBM—susceptibility	3.4 (0.9)	0.39
HBM—severity	4.3 (0.8)	0.45
HBM—benefits	4.3 (0.8)	0.83
HBM—barriers	2.2 (0.7)	0.43
Self-efficacy	4.4 (0.5)	0.83

[a] Standardized value

[b] The wording of these items has been revised from what is in the original survey to reflect that the items were reverse coded for analysis

As shown in Table 2, responses to the perceived severity items suggesting that parents perceived dental caries as a fairly serious problem (average scores ranged from 4.0 to 4.6 on the five-point scale). Two of the items had item-total corrections of 0.30 or greater, and one fell short of the threshold (0.19), suggesting that the latter item was not

Table 3 Association between parent demographic variables and the EHBM subscales($N = 1010$)

Demographic variable	HBM susceptibility mean (SD) or correlation	HBM severity mean (SD) or correlation	HBM benefits mean (SD) or correlation	HBM barriers mean (SD) or correlation	Self-efficacy mean (SD) or correlation
Gender					
Male	3.4 (0.9)	4.4 (0.7)	4.2 (0.8)	2.3 (0.7)	4.3 (0.6)
Female	3.4 (0.9)	4.3 (0.8)	4.3 (0.8)	2.2 (0.7)	4.5 (0.5)
p value	0.61	0.06	0.95	0.26	< 0.0001
Highest grade completed					
< High school graduate	3.5 (0.8)	4.2 (0.9)	4.1 (0.9)	2.4 (0.8)	4.4 (0.6)
High school grad/GED	3.4 (0.9)	4.1 (0.9)	4.2 (0.9)	2.3 (0.7)	4.4 (0.6)
Some college/vocational	3.4 (0.9)	4.5 (0.7)	4.4 (0.8)	2.1 (0.6)	4.5 (0.5)
College degree or more	3.4 (0.8)	4.5 (0.7)	4.5 (0.7)	2.0 (0.6)	4.5 (0.4)
p value	0.38	< 0.0001	< 0.0001	< 0.0001	0.02
Income					
< $10 K	3.5 (0.9)	4.2 (0.8)	4.2 (0.9)	2.3 (0.7)	4.4 (0.6)
$10 K to < $20 K	3.4 (0.9)	4.4 (0.7)	4.2 (0.8)	2.2 (0.7)	4.4 (0.6)
$20 K to < $30 K	3.2 (0.9)	4.5 (0.7)	4.4 (0.7)	2.0 (0.6)	4.5 (0.5)
$30 K to < $40 K	3.4 (0.8)	4.5 (0.6)	4.4 (0.7)	2.1 (0.7)	4.4 (0.5)
≥ $40 K	3.4 (0.8)	4.4 (0.8)	4.3 (0.8)	2.0 (0.7)	4.5 (0.4)
Income missing	3.4 (0.9)	4.2 (0.9)	4.1 (0.9)	2.3 (0.7)	4.3 (0.6)
p value	0.09	0.0002	0.11	0.0002	0.39
Age	− 0.007	− 0.04	− 0.07	0.07	− 0.003
p value	0.83	0.16	0.02	0.02	0.92

Note: The "income missing" category was excluded for *p* value calculations involving income

well correlated with this subscale. Overall, the Cronbach's alpha of 0.45 indicated poor internal consistency among the questionnaire items related to perceived severity.

Mean scores related to the EHBM subscales of perceived barriers and benefits suggest that parents perceived relatively few barriers and significant benefits to engaging in recommended parental oral health behavior (Table 2). Strong item correlations for the benefits items (0.57 and higher) and a strong Cronbach's alpha (0.83) indicate strong internal consistency of the items in this subscale. Conversely, item-total correlations were lower for the barriers items (with only one item having an item-total correlation of 0.30 or higher). Likewise, Cronbach's alpha was low for this subscale (0.43).

Table 2 also presents item performance for the self-efficacy subscale. Mean scores for the self-efficacy items ranged from 4.0 to 4.7 on the 5-point scale, suggesting that participants were quite confident they could engage in recommended parental oral health behavior. Item-total correlations ranged from

Table 4 Association between convergent measures and each of the EHBM subscales ($N = 1010$)

Convergent measures	HBM susceptibility	HBM severity	HBM benefits	HBM barriers	Self-efficacy
Parental oral health knowledge and behavior					
Oral health knowledge score	− 0.003 (0.17)	0.02 (< 0.0001)	0.01 (< 0.0001)	− 0.01 (< 0.0001)	0.01 (< 0.0001)
Behavioral adherence score	− 3.66 (<0.0001)	1.70 (0.06)	0.79 (0.36)	− 10.73 (< 0.0001)	12.32 (< 0.0001)
Pediatric oral health					
dmfs	1.99 (0.01)	0.20 (0.81)	0.05 (0.95)	2.04 (0.03)	− 1.39 (0.24)
Pediatric oral health status	0.17 (< 0.0001)	− 0.02 (0.70)	− 0.09 (0.04)	0.30 (< 0.0001)	− 0.32 (<0.0001)
Pediatric oral health-related quality of life	0.40 (0.27)	− 0.41 (0.30)	− 0.83 (0.03)	2.04 (< 0.0001)	− 2.48 (< 0.0001)
Parental oral health					
Parental oral health status	0.06 (0.08)	0.09 (0.02)	− 0.05 (0.17)	0.09 (0.05)	− 0.25 (< 0.0001)

Note: Table presents regression coefficients and *p* values from ordinary least squares regression analyses that assessed the relationship of the independent variables (EHBM subscales) with dependent variables (convergent measures). For the oral health knowledge score, knowledge was the independent variable and the EHBM subscales were the dependent variables. All analyses controlled for age, gender, education, and income

0.34 to 0.60, suggesting that the self-efficacy items were well correlated with the full self-efficacy subscale. The Cronbach's alpha of 0.83 also reflected a strong degree of internal consistency reliability among the self-efficacy items.

Association of EHBM Constructs with Sociodemographic Factors Table 3 presents outcomes of the ANOVAs examining the link between parents' sociodemographic characteristics and their oral health-related beliefs. Perceived severity was significantly related to educational attainment and income, such that parents with higher levels of education and income perceived dental caries as more serious compared to parents with lower educational and income levels ($p \leq 0.0001$). Parents with higher levels of education and younger parents perceived greater benefits of and fewer barriers to adherence with recommended oral health behaviors. Parents with higher income levels perceived fewer barriers to adherence with recommended oral health behaviors. Self-efficacy was associated with parents' characteristics, with female parents ($p < 0.0001$) and parents with higher educational attainment ($p = 0.02$) being more confident they could successfully engage in recommended parental oral health behaviors. Perceived susceptibility was not associated with any sociodemographic characteristics ($p > 0.05$).

Convergent Validity Analyses Table 4 presents the adjusted ordinarily least squares regression analyses examining the association between the EHBM constructs and convergent measures addressing oral health knowledge, behavior, and outcomes. Perceived susceptibility was negatively associated with behavioral adherence ($p < 0.0001$) as well as two pediatric outcome measures. Contrary to the expected direction of the model, parents who perceived their children to be more susceptible to dental caries were less likely to adhere to recommended parental oral health behaviors ($p < 0.0001$) and had children with worse dmfs ($p = 0.01$) and OHS ($p < 0.0001$). Perceived severity was positively associated with oral health knowledge and negatively associated with parental oral health outcomes. Parents with greater knowledge of oral health perceived dental caries as a more serious problem ($p < 0.0001$). Conversely, parents who perceived dental caries as a more severe outcome reported worse parental OHS ($p = 0.02$).

Perceived benefits and barriers were associated with the convergent measures as expected. Parents with greater knowledge of oral health perceived greater benefits to and fewer barriers of engaging in recommended parental oral health behavior ($ps < 0.0001$). Although perceived benefits were not associated with behavior ($p > 0.05$), parents who perceived greater barriers to recommended behavior were far less likely to adhere to good parental oral health behavior ($p < 0.0001$). Also, parents who perceived more barriers to recommended behavior had worse parental OHS ($p = 0.05$) and had children with worse dmfs ($p = 0.03$) as well as worse OHS and POQL ($p < 0.0001$).

As expected, self-efficacy was associated with the convergent measures. Parents with greater knowledge related to oral health reported being more confident they could manage their children's oral health ($p < 0.0001$). Parents with higher levels of self-efficacy were vastly more adherent to recommended oral health behavior ($p < 0.0001$), had children with better OHS and POQL ($p < 0.0001$), and reported their own OHS to be significantly better ($p < 0.0001$).

Discussion

Application of the EHBM in relation to parents' influences on children's' oral health offered insight for existing disparities in the AI population. As depicted in Fig. 1, the EHBM constructs were expected to be related to oral health knowledge, behavior, and health outcomes. Accordingly, parental knowledge was expected to influence health beliefs and self-efficacy, which collectively serve as predictors of parental health behavior and children's health outcomes. As a precursor, health knowledge is considered necessary, although not sufficient for behavior change. Study findings followed theoretical expectations with knowledge being associated with all EHBM constructs excluding perceived susceptibility (Table 4). As expected, parents with greater oral health knowledge perceived greater benefits to and fewer barriers in adherence with recommended parental oral health behavior, perceived dental caries as a serious problem, and had greater confidence in their ability to manage their children's oral health. Outcomes for behavior were consistent with expectations for perceived barriers and self-efficacy. Although perceived severity and benefits were not associated with behavior, parents perceiving fewer barriers and feeling more confident were more adherent to recommended parental oral health behavior. Additionally, parents who reported increased barriers to adherence with good oral health behavior had significantly worse oral health outcomes as did their children. Overall, each of the EHBM constructs was related to at least one of the four oral health outcome measures for the child or parent.

Contradictory findings relative to the theoretical basis of the EHBM and the expected outcome for behavior in regard to perceived severity and benefits may be explained by the concept of inverse care law. The concept implies that in areas of socioeconomic deprivation, efforts to prevent disease complications and reverse risks will achieve less [39]. Comparatively, groups with lower health needs experience greater benefits from healthcare

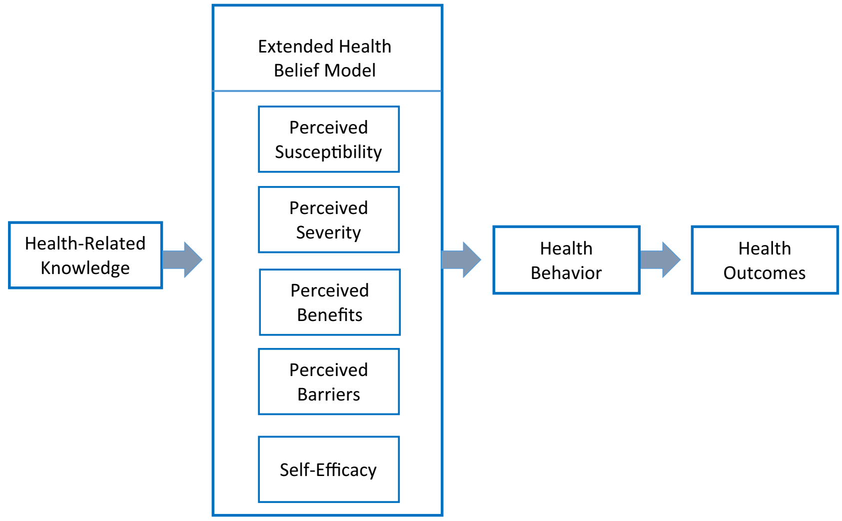

Fig. 1 Extended health belief model. Source: Wilson AR, Mulvahill MJ, Tiwari T. The impact of maternal self-efficacy and oral health beliefs on early childhood caries in Latino children. Front Public Health. 2017;5:8–16

[40]. As a consequence of deprivation, higher needs and social and health comorbidities reduce an individual's ability to manage multiple challenges and may lead to a selective focus where compared to other concerns, dental caries is viewed as less severe [39].

The EHBM construct of perceived susceptibility did not perform as hypothesized. Contrary to the expected directional basis of the model, parents who perceived their children to be more susceptible to developing dental caries were less likely to adhere to recommended oral health behavior and their children experienced worse oral health outcomes. Prior research shows that AI parents who are not adherent to recommended oral health behavior have children with negative oral health outcomes [34]. It is possible, these parents then perceive their children are particularly susceptible to dental caries. Because these analyses were based on cross-sectional data, it was not possible to examine the causal direction of these relationships to determine whether perceptions influence behavior and outcomes or whether behavior and outcomes influence perceptions.

Consistent with previous studies, not all of the four original HBM constructs proved to be significant predictors of health behavior [13, 18, 19]. Overall, perceived benefits and self-efficacy had high internal consistency, while the other subscales had low internal consistency. Subscales with low internal consistency were based upon only a few items (3 to 5), and this may have influenced the magnitude of the Cronbach alpha. Self-efficacy was a particularly strong predictor of parents' engagement in recommended health behavior and oral health outcomes. Parents with higher self-efficacy were significantly more adherent to recommended oral health behavior and experienced better oral health outcomes and reported the same for their children.

Findings were similar to existing oral health research [13, 18, 19], in which sociodemographic factors influenced performance on the EHBM measures. Income and education were strong predictors of oral health beliefs, with age and gender showing significant associations with selected EHBM constructs. As predicted, parents with higher educational attainment and income viewed dental caries as more serious and reported greater benefits and fewer barriers to recommended oral health behavior. Younger parents also reported greater benefits and fewer barriers to recommended oral health behavior. Female parents and those with higher educational attainment were more confident in their ability to engage in recommended oral health behavior. Positive findings for female parents may be attributable to AI women's identities being strongly tied to their role as mothers and caregivers [41].

A limitation of this study included use of one type of reliability (internal consistency) and validity (convergent validity) assessment. There are other types of reliability (test-retest reliability) and validity (divergent validity, predictive validity) that can be used for validation studies. Surveillance using self-reported data is a potential limitation as participants may provide socially accepted responses. To address potential concerns, distractor questions were included among survey questions to evaluate accuracy in self-reported information. Additionally, data collection via an ACASI system has been found to result to improve reliability of reported health-related behaviors and result in more honest answers [21–23].

As the first study exploring the EHBM constructs and oral health measures in relation to knowledge, behavior, and outcomes, results suggest that the questionnaire items assessing the EHBM theoretical constructs are reliable and valid as measures of key parental beliefs influencing children's oral health outcomes in an AI population. Testing of these measures among a range of tribal groups as well as other low socioeconomic status and indigenous and ethnic groups will lend additional support to these measures.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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