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Psychometric Properties of a Caregiver Illness Perception Measure for Caries in Children Under 6 Years Old

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Abstract

Objective—Based on the Common-Sense Model of Self-Regulation (CSM), the Revised Illness Perception Questionnaire (IPQ-R) was developed to measure patients' perceptions of their chronic medical illness. Such a measure does not exist for dental conditions. This study describes psychometric properties of the IPQ-R for Dental (IPQ-RD) for parent/caregivers of children under 6 years of age.

Methods—Parent/caregivers (n=160) of children aged < 6 years attending a pediatric dental clinic completed the IPQ-RD and a questionnaire assessing their socio-demographics, dental anxiety, oral health self-efficacy, and child's preventive dental visits. Dental charts were abstracted for child's decayed, missing, filled teeth (dmft) information. The 33-item IPQ-RD was tested for internal (construct, discriminant) and external validity (concurrent, convergent, discriminant) and reliability (internal consistency).

Results—Confirmatory factor analysis demonstrated that the eight-factor model in accordance with the CSM framework (identity, consequences–child, consequences–caregiver, control–child, control–caregiver, timeline, illness coherence, emotional representations) had good construct validity based on significant factor loadings and acceptable to excellent model fit (RMSEA = 0.078, CFI = 0.951). Concurrent validity was demonstrated by significant negative correlations and higher mean factor scores for five constructs for children without dental visits indicating inaccurate caregiver perception of cavities. Discriminant validity was suggested by non-relationship with external measures (dental anxiety, self-efficacy). Internal consistency of six IPQ-RD constructs was excellent (Cronbach's alpha > 0.74).

Conclusion—The IPQ-RD is a valid and reliable measure to assess parent/caregivers' representation of young children's cavities with potential to be a valuable risk assessment tool for oral health behavioral research.

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COMPETING INTEREST STATEMENT

All authors have completed the Unified Competing Interest form at http://www.icmje.org/coi_disclosure.pdf. The authors have no competing interests to report.

Keywords

Behavioral Sciences; Caries; Dental health survey; Psychology; Reliability; Validity

INTRODUCTION

Dental caries (tooth decay, cavities) continues to be disproportionately prevalent among poor and minority children [1]. Recent national estimates in the U.S. indicate that early childhood caries (ECC) continues to be problematic with prevalence at 23% and untreated tooth decay at 10% among < 6 year olds [1]. Untreated primary tooth decay is a strong predictor of future caries indicating its chronic nature [2, 3]. Nevertheless, most low-income parent/caregivers see dental diseases as acute: only dealt with when there is pain or visible decay [4]. Such beliefs lead to poor parent/caregiver behaviors and are associated with failure to seek dental care for their children [5], leading to untreated caries [6, 7].

Illness representation, a framework of the Common-Sense Model of Self-Regulation (CSM), posits that patient's/caregiver's personal beliefs about a specific illness and its treatment and their emotional response towards it affect disease outcomes, primarily via coping responses [8, 9]. Individuals form a cognitive and emotional representation/perception based on the abstract and concrete sources of information available to them in order to self-manage their own or (if they are the caregiver) the patient's illness. These sources of information include *cultural knowledge* of the illness; *information from* doctor/dentist or parent; and *illness threat from past/current experiences* with the disease [10]. Systematic reviews have empirically demonstrated that illness perception significantly predicts a range of medical and psychological health outcomes, including medication adherence and health-related quality of life [11–15]. Behavioral interventions that have been developed to change illness perception have been instrumental in improving health outcomes, such as increased cardiac rehabilitation rates and medication adherence [16, 17].

In oral health, measures currently available assess caregivers' factual knowledge, attitude or beliefs about children's dental caries [18–20] and parent-reported young child's oral health-related quality of life [21, 22] which are mostly based on the social cognitive and health behavior theories. However, these measures have had limited utility as they are not comprehensive and focus mainly on the *consequences* of dental caries and treatments. The CSM is unique from other social cognitive and health behavior theories in three ways: (1) it requires an individual's perspective together with his/her emotional representation of the disease [23]; (2) it provides a dynamic systems framework with feedback to better understand how caregivers develop a common-sense approach to managing their children's caries threat [24]; and (3) it builds on a reasoning process by which a caregiver, who faces an oral health threat (for themselves or their child) develops a cognitive and emotional representation (personal model of oral disease) which in turn drives coping responses, oral health behaviors, and oral disease outcomes (e.g. caries, oral health quality of life). Since parent/caregivers are the gatekeepers of their children's oral health, it is important that they have an accurate representation of the disease that moves them from a disorganized (i.e. acute - disease is present only with symptoms such as pain) to an organized (i.e. chronic -

disease is present even without symptoms) model to engage in adequate self-management strategies [23]. Like any theory, the utility of the CSM model is only feasible after an accessible measurement scale has been developed [25]. Based on the CSM, the Illness Perception Questionnaire (IPQ) was developed to assess five cognitive domains (identity, cause, consequences, control, timeline) of an illness [26]. The Revised Illness Perception Questionnaire (IPQ-R) enhanced the theoretical underpinnings of the original IPQ by including two additional domains – illness coherence and emotional representations [8]. The IPQ-R has been adapted for other illnesses with good reliability [27–29] and validity [30–32]. In causal pathway analysis, illness perception has been identified as an effective mediator [33, 34].

Currently, there is lack of such a theory-based measure to understand how parent/caregivers, in response to a child's illness threat, form cognitive and emotional representations/perceptions of the child's oral disease and what guides their coping and action planning. Misconceptions about dental caries (e.g. unimportance of baby teeth, lack of understanding about its chronic nature) can impact coping and action planning. An appropriate measure is particularly important for caregivers of children under 6 years of age because it can identify targets for intervention to restructure disease beliefs and misconceptions about caries. Thus, we developed a parent/caregiver version of the Illness Perception Questionnaire Revised for Dental (IPQ-RD). The objective of this study was to assess the psychometric properties of the IPQ-RD in terms of validity and reliability for use in caregivers of children under 6 years of age with and without cavities.

METHODS

Development of the IPQ-RD

The Patient-Reported Outcome Measurement Information System (PROMIS®) Instrument Development and Validation Standards (Version 2.0, May 2013) served as a guideline for psychometric assessment of the IPQ-RD. The IPQ-RD measure was developed with input from three content experts (dentist, psychologist, and epidemiologist) and involved changes to the structure and organization of the IPQ-R items to make it more relevant to dental caries. It was specifically modeled after a version of the IPQ-R for individuals providing care to a relative with a chronic medical illness [35] – i.e., the control and consequences dimensions were each divided into caregiver- and child-related items.

The initial version of the IPQ-RD had 10 dimensions and 37 items at the 6th-grade Flesch-Kincaid readability level. It included the following dimensions or constructs: identity (2 items), consequences-child (8 items), consequences-caregiver (6 items), control-child (5 items), control-caregiver (4 items), timeline-acute/chronic (4 items), timeline-cyclical (2 items), illness coherence (2 items), emotional representations (4 items), and cause (1 item with multiple statements) scored on a 5-point Likert scale response format (ranging from strongly agree to strongly disagree). This initial version of the IPQ-RD was tested with 84 parents/caregivers of K-2nd grade children from an urban school district who were participating in a pilot study to develop the IPQ-RD instrument and behavioral interventions.

A mixed-methods approach was used as follows: For *qualitative*, semi-structured interviews of parent/caregivers using cognitive interviewing techniques [36] assessed the IPQ-RD's content validity. Caregivers provided detailed feedback on the IPQ-RD's readability and clarity. Caregiver interviews were transcribed and responses coded using Atlas.ti (Version 7, Berlin, Germany). The coded responses were later summarized and used to refine the IPQ-RD; for *quantitative*, confirmatory factor analysis (CFA) assessed the construct validity of the IPQ-RD constructs. The CFA confirmed a six-factor model with 31 items (consequences-child, consequences-caregiver, control-child, control-caregiver, timeline-acute/chronic, and emotional representations) that marginally fit the data (RMSEA = 0.104). Because a minimum of three items is required to estimate a factor via maximum likelihood [37], three constructs—identity, timeline-cyclical, and illness coherence—were not included in the CFA model. The marginal model fit was mainly influenced by negatively worded items (i.e. reverse-coded). For reliability, Cronbach's alpha assessing the IPQ-RD's internal consistency showed that four of the six constructs had alpha scores ≥ 0.70 . Test-retest reliability (21 participants completed the questionnaire a second time) was moderate (weighted Kappa 0.45, 95% CI: 0.42 – 0.49).

The initial testing (Appendix) indicated that the IPQ-RD had to be revised (Table 2). Reverse-coded items were unreversed by rephrasing negatively worded items (e.g. #13 “My child's tooth decay has not had much effect on my life”) into positively worded items (e.g. #10 “Cavities in my child has a big impact on my life”). In a few cases, though, negative wording was necessary to ensure that all items were stated in the same direction, e.g. item #12 (“My child's tooth decay has become easier for me to live with”) was rephrased as item #11 (“I cannot easily live with my child's cavities”). Double-barreled, vague, or unclear items were modified, e.g. item #19 (“My child's treatment will be effective in curing their tooth decay”) was rephrased as item #16 (“My child's treatment will help make his/her cavities better”). In the case of item redundancy, i.e. items that are essentially paraphrases of each other (e.g. items #4 “My child's tooth decay has had major consequences on their life” and #5 “My child's tooth decay has not had much effect on their life”), one of the items was removed (in this case, #4). The original version of the 37-item IPQ-RD was revised to the current 33-item version.

Study Design and Participants

In this study, the 33-item version of the IPQ-RD was tested in a separate sample of 160 parent/caregivers with a child < 6 years old who were part of an ongoing case-control study investigating the relationship between illness perception and early childhood caries (ECC). The caregiver participants were recruited from a pediatric dental clinic at an urban hospital in Cleveland, Ohio. The study was approved by the University Hospitals Case Medical Center Institutional Review Board and parent/caregivers signed the informed consent form. This manuscript conforms to the STROBE guidelines for observational studies.

Data Collection

Illness Perception Questionnaire-Revised for Dental (IPQ-RD: 33 items): evaluated parent/caregivers' cognitive and emotional representations of their children's dental caries. The cognitive dimensions included: *identity*, labeling of dental caries and its symptoms;

consequences (child, caregiver), belief about the impact of caries physically and socially; *cure or controllability (child, caregiver)*, belief about whether caries can be cured or kept under control; *timeline*, beliefs about caries being acute, chronic, or cyclical in nature; *illness coherence*, whether the caregiver has a clear understanding of caries and symptoms associated with caries; and *cause*, perception of the underlying cause of caries. *Emotional representation* is the caregivers' emotional response (e.g. worry, anger) to their child's dental caries. Each item was scored on a 5-point Likert scale (strongly agree to strongly disagree) with a poorer (inaccurate) perception represented by a higher score. The introduction to the IPQ-RD was stated as: "We are interested in your views about your child's cavities (tooth decay). Please indicate how much you agree or disagree with the following statements about cavities by circling one of the following responses for each question: strongly agree (1), agree (2), neither agree nor disagree (3), disagree (4), strongly disagree (5)."

Sociodemographic, Psychosocial, and Dental Factors: were assessed through a self-administered caregiver questionnaire, except for dental factors which were abstracted from the child's dental chart. They included: caregiver age (18–25 years vs. ≥ 26 years); race (Black, White, or Other); marital status (single, married); level of education (high school diploma/GED vs. > high school diploma/GED); employment status (employed vs. not employed). Child characteristics included: age (in years); decayed, missing, filled teeth (dmft); ECC, defined as dmft ≥ 1 in a child under 6 years old based on the American Academy of Pediatric Dentistry guidelines; type of dental insurance in the past month (Medicaid, private/employer, don't know type of insurance, no dental insurance); and preventive dental visit in the past 12 months (yes or no).

Caregiver psychosocial factors were used to check for external validity of the IPQ-RD measure. *Dental anxiety*, a five-item measure, assessed caregivers' level of anxiety in different situations at a dental visit (e.g. sitting in the waiting room, about to have a tooth drilled, about to have a local anesthetic injection in your gum) [38]. *Oral health-related self-efficacy (OHSE)*, a nine-item measure, assessed caregivers' confidence in their ability to take their child to the dentist despite personal barriers (e.g. being depressed, feeling too busy, worrying about other things in their life, their child not staying still to be examined by the dentist) [20].

Psychometric Analysis

The IPQ-RD was tested for internal validity: evaluation of the measure's hypothesized factor structure and assessment of the model's fit to the data as well as discriminant validity (i.e. inter-correlations between the IPQ-RD constructs); *external validity*: evaluation of the IPQ-RD with other measures included criterion-related (concurrent), convergent, and discriminant validity; and *reliability* (internal consistency). The IPQ-RD constructs and child dental measures (ECC, decay [the 'd' component of dmft], dental visits in the past 12 months) were used to examine concurrent validity. Caregiver's higher educational status was hypothesized to be related to the IPQ-RD constructs. Additionally some IPQ-RD constructs (emotional representations and control-caregiver, respectively) were hypothesized to be related to caregiver dental anxiety and self-efficacy (i.e. convergent validity), while

others (timeline) were not (i.e. discriminant validity). The psychometric analysis included eight illness perception constructs (32 items) except for cause. The cause construct was not included because it is considered to have its own factor structure and has been excluded [31] or analyzed apart from the other constructs [39]. Sample size estimates were based on the subjects-to-variables ratio of no lower than 5 [40, 41], and the 160 subjects in our study met this criteria. Statistical significance was established at the 0.05 alpha level.

Confirmatory factor analysis (CFA) was conducted in MPlus (Version 6.12) to assess internal validity of the IPQ-RD. Factor loadings were estimated based on polychoric correlations (accommodating the ordinal item responses) and using the weighted least squares with adjustments for the mean and variance (WLSMV) method. Internal validity was indicated by large values for factor loadings. Items with a standardized factor loading of less than 0.2 [39, 42] were considered for removal. Internal validity was also assessed through the following model fit criteria: root mean square error of approximation (RMSEA < 0.08 for acceptable fit) and comparative fit index (CFI > 0.95 for excellent fit).

The following additional validity tests were conducted based on the CFA: 1) Spearman's correlations among factors (using factor scores) were computed to assess discriminant validity; 2) Associations between factor scores and other child and caregiver variables were assessed to test external validity; Spearman's correlations were tested for count or ordinal variables (dmft, frequency of dental visits, dental anxiety, self-efficacy) while t-tests were conducted (with means, standard deviation, and correlations provided) for binary variables (caregiver age, education); 3) Residual correlation matrices were obtained to assess the local independence assumption of the CFA model; a residual correlation of greater than 0.2 was flagged as indicating a plausible violation of this assumption. To test the assumption of unidimensionality for the CFA model, we conducted exploratory factor analyses to obtain estimated eigenvalues for each factor. A standardized first eigenvalue (the eigenvalue divided by the total of all eigenvalues) of less than 0.2 indicates a possible departure from unidimensionality. Cronbach's alpha assessed the internal consistency of each construct with a value 0.70 indicating the construct's reliability.

In addition, two-parameter item response theory (IRT) models were fit to each construct. These models provide estimates of the intercept (or scale cutpoints) and slopes (or item loadings) for each item for a given construct. The fitted IRT models and a constructed chi-square statistic were used to test differential item functioning (DIF); namely, that model (intercept and/or slope) parameters are different for different subpopulations (caregiver age and race).

RESULTS

A total of 160 parent/caregiver participants with a child < 6 years old completed the IPQ-RD and the caregiver questionnaires. Table 1 shows that caregivers were predominantly female, 26 years and older, African-American, single, greater than high school education, and employed. Nearly 68% of their children had early childhood caries (ECC) and 73% had Medicaid coverage.

Internal Validity

Construct validity of the IPQ-RD instrument was assessed using confirmatory factor analysis (CFA). Following a preliminary assessment, the model was modified slightly: one questionnaire item (#25 “Cavities in my child may change from time to time”) was removed due to a low factor loading (< 0.2). In the final model, several correlation parameters were added to account for some moderate residual correlations with the goal of keeping residual correlations below 0.2 without undermining other aspects of the model fit. Table 2 indicates that all 31 items had significantly high standardized factor loadings suggesting that the eight-factor model fit the data in an acceptable (RMSEA = 0.078) to excellent (CFI = 0.951) manner. Unidimensionality estimates for all CFA factors were greater than 0.46 indicating that the set of items represented a single underlying IPQ-RD construct.

Table 3 indicates that some of the IPQ-RD constructs were recognized to be conceptually related as shown by significant correlations (e.g. consequences-child and -caregiver: $r = 0.70$). However, all IPQ-RD constructs were empirically distinct based on the threshold of correlation coefficients < 0.85 [43] indicating discriminant validity.

External Validity

Table 4 illustrates criterion-related (concurrent) validity between child-level variables (ECC, decay, dental visits) and IPQ-RD constructs based on t-tests and correlation analysis. The mean identity, consequences-child, control-child, control-caregiver, illness coherence, and overall standardized factor scores for those children without dental visits in the past 12 months were significantly higher indicating inaccurate perception of cavities. For example, the subgroup of those without dental visits (0.28) was more positively extreme on the scale of the consequences-child factor (i.e. higher score = inaccurate perception) compared to the subgroup with dental visits (-0.063 , lower score = accurate perception). The mean factor scores were not significantly different between children with and without decay or ECC, although most factor means were consistently in the positive direction trending towards inaccurate perception of caries. Correlation results were similar to the t-tests. Among caregiver characteristics, there was no significant association between education and the individual or overall factor scores. Similarly, external measures such as dental anxiety and self-efficacy scores were not related to any of the factors, thus demonstrating discriminant validity.

The DIF analysis (possible for constructs with at least 4 items) did not exhibit differences ($p > 0.05$) between caregiver age and race categories (Table 5) indicating that IPQ-RD scores can be validly compared between these socio-demographic sub-groups.

Reliability

Internal consistency (Cronbach's alpha) for IPQ-RD factors were as follows: Identity (0.74), Consequences –child (0.91), Consequences–caregiver (0.85), Control-caregiver (0.85), Control-child (0.62), Timeline (0.58), Illness coherence (0.89), Emotional representation (0.82) indicating good to excellent reliability.

DISCUSSION

To our knowledge this study represents the first application of the Common-Sense Model of Self-Regulation (CSM) [9] in the development and psychometric testing of a revised illness perception questionnaire for dental (IPQ-RD) caries. Our findings indicate that the new IPQ-RD measure has good overall validity and reliability for use among parent/caregivers of children less than 6 years of age with and without cavities. This new measure, the IPQ-RD, could serve as a risk assessment tool for oral health researchers and dental clinicians and uniquely contribute to our understanding of caregivers' representation of young children's cavities to promote effective self-management strategies in seeking dental care. For example, researchers could use the IPQ-RD to assess changes before and after behavioral interventions that restructure disease beliefs, and as a mediator in causal pathway analysis. Similarly, clinicians could use the IPQ-RD as a tool to evaluate parent/caregivers' perception regarding their child's cavities, and restructure their beliefs to improve adoption of preventive behaviors and treatment compliance.

The new measure is unique in several ways: (1) the IPQ-RD comprehensively measures a caregiver's perception of their child's dental caries as a chronic illness with multiple dimensions compared to other caregiver oral health measures (e.g. oral health knowledge, attitude, and self-efficacy) which mainly assess the *consequences* dimension of caries [18–20]. Other caregiver-reported child's oral health-related quality of life measures (in < 6 years old) also focus mainly on the *consequences* of dental caries and subsequent treatments [21, 22]. (2) While illness perception may be linked to oral health literacy, it cannot be achieved without moving the parent from a disorganized to an organized representation of caries. Thus, an accurate representation of the disease or illness would precede oral health literacy which is the ability to obtain, process, and use oral health information; (3) The IPQ-RD was primarily modeled after an illness perception instrument for carers [35]; however, we looked to the brief version of the IPQ (Brief-IPQ) [44] to inform our development of the identity construct. Caregivers were not asked to list symptoms experienced by the child (i.e. tooth pain, tooth sensitivity to hot or cold, hole in tooth, dark or white spot on tooth, swelling in face or gums) because during the cognitive interviewing process, when caregivers were asked to provide a definition of tooth decay most described the same or similar symptoms that can affect the teeth. Thus, for the identity construct, we used two items to capture two core issues regarding dental caries as an illness – that its symptoms can be intense and that it has many symptoms rather than specific symptoms. In the psychometric analysis, the identity construct had significantly high factor loadings and correlated with all other IPQ-RD constructs and with dental visits demonstrating the importance of these two items.

The confirmatory factor analysis (CFA) validated an 8-factor structure (31 items) aligning with the theoretical constructs of the CSM framework. The factor loadings indicated that all items significantly correlated with the constructs confirming the model's appropriateness for the dental setting. A good model-data fit was also confirmed by a RMSEA < 0.08 after removal of one item in the timeline construct, and after accounting for moderate residual correlations between some item pairs. Thus, revisions to the initial 37-item version of the IPQ-RD with appropriate enhancements substantially improved the model fit and validated

the CSM's theoretical framework. Specifically, using both qualitative and quantitative data during the development phase we modified the IPQ-RD items using plain language and a reading level (Flesch-Kinkaid: 6th grade) that was applicable to the target population, including changing "tooth decay" to "cavities" as suggested by the parent/caregivers. Furthermore, some items were positively worded in the psychometrically-tested version of the IPQ-RD since negatively worded, compared to positively worded, items have been found to affect an instrument's factor structure [45]. Finally, all CSM factors formed unidimensional scales, an important finding since it validates the calculation of summative factor scores.

For concurrent validity, only child dental visits in the past year was significantly related to five of the eight IPQ-RD constructs (identity, consequences to child, control by child/caregiver, illness coherence), while ECC and decay were not. Caregivers with a better understanding of cavities, its symptoms, and control took their child to preventive dental visits. This suggests that restructuring disease perception may have more immediate influence on proximal outcomes (dental visits) rather than distal outcomes (decay and ECC). None of the caregiver characteristics were related to IPQ-RD constructs. This indicates that the IPQ-RD measure may be distinct from dental anxiety and oral health-related self-efficacy measures confirming that the new measure uniquely assesses caregiver's cognitive and emotional perception of caries. Furthermore, contrary to our hypothesis, caregiver educational status was not significantly related to any of the eight factors. This suggests that illness perception is formed by cultural knowledge of the illness, information from doctors/dentists and/or parents, and illness threat from past and current experiences with the disease [10].

The DIF analysis indicated that the IPQ-RD performed uniformly across caregiver age and racial subgroups making it potentially applicable for use with parent/caregivers greater than 18 years old and in African-American and Caucasian populations. Lastly, the reading level is suitable for low-income, low health literacy populations.

Application of CSM theory to Dental Caries

A caregiver whose child is diagnosed with cavities in their baby teeth (e.g. through a school dental screening) will analyze and interpret the meaning of their child's health threat using a cognitive process of appraisal and then initiate a coping and action plan to self-manage this threat. For example, this caregiver may interpret that her child has no tooth pain (identity), that cavities in baby teeth are not serious as they do not promote any functional limitations such as eating (consequences), be unaware that cavity-causing bacteria may be present (cause), not think that treatment for baby teeth would help (control), and believe that when baby teeth fall out (even if decayed), healthy permanent teeth will erupt in their place (timeline). Such an illness representation may lead to a caregiver's lack of concrete actions to seek dental care. The IPQ-RD has utility such that it can indicate the constructs that need intervention to restructure disease perception.

In conclusion, our study describes the psychometric properties of the new IPQ-RD measure (for caregivers of children under 6 years of age), including information on item response theory models, model-data fit, scale dimensionality, and comparability of IPQ-RD scores

across caregiver age and racial subgroups. However, since the IPQ-RD was only validated in caregivers of young children and a few racial subgroups, we recommend that it be tested in other subgroups (e.g. school-age children, Hispanics) and populations.

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REFERENCES

1. Dye, BA.; Thornton-Evans, G.; Li, X.; Iafolla, TJ. Dental caries and sealant prevalence in children and adolescents in the United States, 2011–2012. NCHS data brief, no 191. Hyattsville, MD: National Center for Health Statistics; 2015.
2. Birkeland JM, Broach L, Jorkjend L. Caries experience as predictor for caries incidence. *Community Dent Oral Epidemiol.* 1976; 4(2):66–69. [PubMed: 1062253]
3. Bader JD, Graves RC, Disney JA, Bohannon HM, Stamm JW, Abernathy JR, et al. Identifying children who will experience high caries increments. *Community Dent Oral Epidemiol.* 1986; 14(4):198–201. [PubMed: 3461904]
4. Hooley M, Skouteris H, Boganin C, Satur J, Kilpatrick N. Parental influence and the development of dental caries in children aged 0–6 years: a systematic review of the literature. *J Dent.* 2012; 40(11): 873–885. [PubMed: 22842202]
5. Lopez del Valle LM, Riedy CA, Weinstein P. Rural Puerto Rican women's views on children's oral health: a qualitative community-based study. *J Dent Child.* 2005; 72(2):61–66.
6. Brickhouse TH, Rozier RG, Slade GD. Effects of enrollment in Medicaid versus the State Children's Health Insurance Program on kindergarten children's untreated dental caries. *Am J Public Health.* 2008; 98(5):876–881. [PubMed: 18382008]
7. Edelstein BL, Chinn CH. Update on disparities in oral health and access to dental care for America's children. *Acad Pediatr.* 2009; 9(6):415–419. [PubMed: 19945076]
8. Moss-Morris R, Weinman J, Petrie KJ, Horne R, Cameron LD, Buick D. The Revised Illness Perception Questionnaire (IPQ-R). *Psychol Health.* 2002; 17(1):1–16.
9. Leventhal, H.; Brissette, I.; Leventhal, EA. The common-sense model of self-regulation of health and illness. In: Cameron, LD.; Leventhal, H., editors. *The self-regulation of health and illness behavior.* London: Routledge; 2003. p. 42–65.
10. Hagger M, Orbell S. A meta-analytic review of the common-sense model of illness representations. *Psychol Health.* 2003; 18(2):141–184.
11. French DP, Cooper A, Weinman J. Illness perceptions predict attendance at cardiac rehabilitation following acute myocardial infarction: a systematic review with meta-analysis. *J Psychosom Res.* 2006; 61(6):757–767. [PubMed: 17141663]
12. Kaptein AA, Hughes BM, Scharloo M, Fischer MJ, Snoei L, Weinman J, et al. Illness perceptions about asthma are determinants of outcome. *J Asthma.* 2008; 45:459–464. [PubMed: 18612897]
13. Kucukarslan SN. A review of published studies of patients' illness perceptions and medication adherence: lessons learned and future directions. *Res Social & Adm Pharm.* 2012; 8(5):371–382. [PubMed: 22986176]
14. Breland JY, McAndrew LM, Burns E, Leventhal EA, Leventhal H. Using the common-sense model of self-regulation to review the effects of self-monitoring of blood glucose on glycemic control for non-insulin-treated adults with type 2 diabetes. *Diabetes Educ.* 2013; 39(4):541–559. [PubMed: 23749773]

15. Parfeni M, Nistor I, Covic A. A systematic review regarding the association of illness perception and survival among end-stage renal disease patients. *Nephrol Dial Transplant*. 2013; 28:2407–2414. [PubMed: 23737481]
16. Davies MJ, Heller S, Skinner TC, Campbell MJ, Carey ME, Cradock S, et al. Effectiveness of the diabetes education and self-management for ongoing and newly diagnosed (DESMOND) programme for people with newly diagnosed type 2 diabetes: cluster randomised controlled trial. *Br Med J*. 2008; 336:491–501. [PubMed: 18276664]
17. Mosleh SM, Bond CM, Lee AJ, Kiger A, Campbell NC. Effectiveness of theory-based invitations to improve attendance at cardiac rehabilitation: a randomized controlled trial. *Eur J Cardiovasc Nurs*. 2014; 13(3):201–210. [PubMed: 23733348]
18. Reisine S, Litt M. Social and psychological theories and their use for dental practice. *Int Dent J*. 1993; 43(3 Suppl 1):279–287. [PubMed: 8406958]
19. Adair PM, Pine CM, Burnside G, Nicoll AD, Gillett A, Anwar S, et al. Familial and cultural perceptions and beliefs of oral hygiene and dietary practices among ethnically and socio-economically diverse groups. *Community Dent Health*. 2004; 21(1 Suppl):102–111. [PubMed: 15072479]
20. Finlayson TL, Siefert K, Ismail A, Delva J, Sohn W. Reliability and validity of brief measures of oral health-related knowledge, fatalism, and self-efficacy in mothers of African-American children. *Pediatr Dent*. 2005; 27(5):422–428. [PubMed: 16435644]
21. Huntington NL, Spetter D, Jones JA, Rich SE, Garcia RI, Spiro A III. Development and validation of a measure of pediatric oral health-related quality of life: the POQL. *J Public Health Dent*. 2011; 71:185–193. [PubMed: 21972458]
22. Pahel BT, Rozier RG, Slade GD. Parental perceptions of children's oral health: the Early Childhood Oral Health Impact Scale (ECOHS). *Health Qual Life Outcomes*. 2007; 5(6):1–10. [PubMed: 17201920]
23. Edgar KA, Skinner TC. Illness representations and coping as predictors of emotional well-being in adolescents with type 1 diabetes. *J Pediatr Psychol*. 2003; 28(7):485–493. [PubMed: 12968040]
24. Breland JY, Fox AM, Horowitz CR, Leventhal H. Applying a common-sense approach to fighting obesity. *J Obes*. 2012; 2012:1–8.
25. Brewer, NT.; Rimer, BK. Perspectives on health behavior theories that focus on individuals. In: Glanz, K.; Rimer, BK.; Viswanath, K., editors. *Health Behavior and Health Education: Theory, Research, and Practice*. 4th. San Francisco: Jossey-Bass; 2008.
26. Weinman J, Petrie KJ, Moss-Morris R, Horne R. The Illness Perception Questionnaire: a new method for assessing the cognitive representation of illness. *Psychol Health*. 1996; 11(3):431–445.
27. Lobban F, Barrowclough C, Jones S. Assessing cognitive representations of mental health problems. I. The illness perception questionnaire for schizophrenia. *Br J Clin Psychol*. 2005; 44:147–162. [PubMed: 16004651]
28. Cabassa LJ, Lagomasino IT, Dwight-Johnson M, Hansen MC, Xie B. Measuring Latinos' perceptions of depression: a confirmatory factor analysis of the Illness Perception Questionnaire. *Cultur Divers Ethnic Minor Psychol*. 2008; 14:377–384. [PubMed: 18954174]
29. Hurt CS, Burns A, Brown RG, Barrowclough C. Perceptions of subjective memory complaint in older adults: the Illness Perception Questionnaire - Memory (IPQ-M). *Int Psychogeriatr*. 2010; 22:750–760. [PubMed: 20096152]
30. Chen S, Tsai J, Lee W. Psychometric validation of the Chinese version of the Illness Perception Questionnaire - Revised for patients with hypertension. *J Advanced Nurs*. 2008; 64:524–534.
31. Brink E, Alsen P, Cliffordson C. Validation of the Revised Illness Perception Questionnaire (IPQ-R) in a sample of persons recovering from myocardial infarction - the Swedish version. *Scand J Psychol*. 2011; 52:573–579. [PubMed: 21722137]
32. Abubakari AR, Jones MC, Lauder W, Kirk A, Devendra D, Anderson J. Psychometric properties of the Revised Illness Perception Questionnaire: factor structure and reliability among African-origin populations with type 2 diabetes. *Int J Nurs Stud*. 2012; 49:672–681. [PubMed: 22142936]
33. Ross S, Walker A, MacLeod MJ. Patient compliance in hypertension: role of illness perceptions and treatment beliefs. *J Hum Hypertens*. 2004; 18(9):607–613. [PubMed: 15029218]

34. Searle A, Norman P, Thompson R, Vedhara K. Illness representations among patients with type 2 diabetes and their partners: relationships with self-management behaviors. *J Psychosom Res.* 2007; 63(2):175–184. [PubMed: 17662754]
35. Barrowclough C, Lobban F, Hatton C, Quinn J. An investigation of models of illness in carers of schizophrenia patients using the Illness Perception Questionnaire. *Br J Clin Psychol.* 2001; 40:371–385. [PubMed: 11760614]
36. Willis, GB. Cognitive interviewing: a tool for improving questionnaire design. Thousand Oaks, CA: Sage; 2005.
37. Bollen, KA. Structural equations with latent variables. New York: Wiley; 1989.
38. Humphris GM, Morrison T, Lindsay SJ. The Modified Dental Anxiety Scale: validation and United Kingdom norms. *Community Dent Health.* 1995; 12(3):143–150. [PubMed: 7584581]
39. Hagger MS, Orbell S. A confirmatory factor analysis of the revised illness perception questionnaire (IPQ-R) in a cervical screening context. *Psychol Health.* 2005; 20:161–173.
40. MacCallum RC, Widaman KF, Zhang S, Hong S. Sample size in factor analysis. *Psychol Methods.* 1999; 4:84–99.
41. Gorsuch, RL. Factor analysis. 2nd. Hillsdale, NJ: Erlbaum; 1983.
42. Brown, T. Confirmatory factor analysis for applied research. New York: Guilford Press; 2006.
43. Kline, RB. Principles and practice of structural equation modeling. 2nd. New York: Guilford Press; 2005.
44. Broadbent E, Petrie KJ, Main J, Weinman J. The Brief Illness Perception Questionnaire. *J Psychosom Res.* 2006; 60:631–637. [PubMed: 16731240]
45. Peterson NA, Lowe JB, Hughey J, Reid RJ, Zimmerman MA, Speer PW. Measuring the intrapersonal component of psychological empowerment: confirmatory factor analysis of the sociopolitical control scale. *Am J Community Psychol.* 2006; 38:287–297. [PubMed: 16977501]

APPENDIX: Confirmatory factor analysis of initial IPQ-RD† (6 factors: 31 items)

Factors & items	Standardized factor loading	Standard error	Caregiver input
<i>Consequences – child (8 items)</i>			
<i>My child's tooth decay ...</i>			
3: ...is a serious condition	0.36*	0.11	Terminology; redundant
4: ...has had major consequences on their life	0.65*	0.08	Redundant
5: ...has become easier for them to live with (R)	0.16	0.12	Redundant
6: ...has not had much effect on their life (R)	0.34*	0.11	Delete
7: ...has strongly affected the way others see them	0.58*	0.08	Delete
8: ...has had strong economic and financial consequences for them	0.63*	0.08	Reword; delete
9: ...is disabling	0.61*	0.08	Terminology; reword; delete
10: ...has strongly affected the way they see themselves as a person	0.72*	0.07	Specify age; delete
<i>Consequences – caregiver (6 items)</i>			
<i>My child's tooth decay ...</i>			
11: ...has had major consequences on my life	0.85*	0.04	Irrelevant; delete

Factors & items	Standardized factor loading	Standard error	Caregiver input
12: ...has become easier for me to live with (R)	0.31 *	0.11	Redundant
13: ...has not had much effect on my life (R)	0.41 *	0.10	No input
14: ...has strongly affected the way others see me	0.69 *	0.07	Delete
15: ...has had strong economic and financial consequences for me	0.63 *	0.08	Terminology; not applicable; redundant
16: ...has strongly affected the way I see myself as a person	0.76 *	0.06	Didn't like
Control – child (5 items)			
17: There is a lot my child can do to control his/her symptoms	0.17	0.13	Specify age; redundant; delete
18: There is very little that can be done to improve my child's tooth decay (R)	0.68 *	0.10	No input
19: My child's treatment will be effective in curing their tooth decay	0.36 *	0.12	Terminology; don't know
20: Recovery from my child's tooth decay is largely dependent on chance or fate (R)	-0.53 *	0.11	Terminology; delete
21: What my child does determines whether his/her tooth decay gets better or worse	0.17	0.13	Didn't understand; delete
Control – caregiver (4 items)			
22: There is a lot I can do to control my child's symptoms	0.73 *	0.08	Redundant; don't know
23: What I do determines whether my child's tooth decay gets better or worse	0.50 *	0.10	No input
24: There is very little I can do to stop my child's tooth decay once it starts (R)	0.40 *	0.11	Redundant
25: There is nothing I can do to prevent tooth decay in my child (R)	0.77 *	0.07	Redundant
Timeline – acute/chronic (4 items)			
<i>My child's tooth decay ...</i>			
26: ...will last a short time (R)	0.31 *	0.12	Confusing; delete
27: ...will improve in time (R)	0.29 *	0.13	Confusing; delete
28: ...is likely to be permanent rather than temporary	0.57 *	0.11	Delete
29: ...will last for a long time	0.84 *	0.12	Delete
Emotional representations (4 items)			
34: I get depressed when I think about my child suffering from tooth decay	0.72 *	0.08	Terminology; delete
35: Seeing my child with tooth decay does not worry me (R)	0.35 *	0.12	No input
36: Seeing my child with tooth decay makes me feel angry	0.61 *	0.09	Delete
37: Seeing my child with tooth decay can affect me emotionally (e.g. can make me feel helpless or distressed)	0.77 *	0.07	Delete

* p < .05

(R) Item was reverse scored on initial version of IPQ-RD but will be unreversed on revised IPQ-RD

[†] Constructs removed from CFA model: Identity (items 1, 2), Timeline cyclical (items 30, 31), Illness coherence (items 32, 33)

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Highlights

- IPQ-RD: New measure to assess caregivers' perception of early childhood caries (ECC)
- Eight-factor model of illness perception, based on common-sense model, fit the data
- 5 IPQ-RD constructs significantly related to preventive dental visits (child <6 yrs.)
- New measure will inform interventions to restructure perception of ECC

Table 1

Socio-demographic and clinical characteristics of participants (N = 160)

Caregiver characteristics	
Gender (N = 160)	
Female	154 (96%)
Male	6 (4%)
Age (N = 158)	
18 – 25 years	47 (30%)
26 years	111 (70%)
Race/ethnicity (N = 157)	
Black	105 (67%)
White	33 (21%)
Other	19 (12%)
Marital status (N = 158)	
Single	108 (68%)
Married	50 (32%)
Level of education (N = 158)	
High school diploma / GED	59 (37%)
> High school diploma	99 (63%)
Employment status (N = 149)	
Employed	102 (68%)
Not employed	47 (32%)
Child characteristics	
Gender (N = 160)	
Female	69 (43%)
Male	91 (57%)
Age (N = 160)	
Years, M ± SD	3.34 ± 1.26
dmft (N = 160)	
M ± SD	4.52 ± 4.49
Early childhood caries (ECC) status (N = 160)	
ECC (dmft ≥ 1)	109 (68%)
No ECC	51 (32%)
Frequency of preventive dental visits in past 12 months (N = 155)	
None	28 (18%)
1 or more visits	127 (82%)

Caregiver characteristics

Type of dental insurance during the last month (N = 158)

Medicaid	115 (73%)
Private/from employer	18 (11%)
Don't know type of insurance	9 (6%)
No dental insurance	16 (10%)

Note: Percentage totals for categories may not add up to 100% because of rounding.

Table 2

Confirmatory Factor Analysis of IPQ-RD (8 factors)

Factors (illness perception constructs) & items	Standardized factor loading*	Standard error	Unidimensionality
Identity (2 items)			0.83
1: Cavities (tooth decay) is an illness with symptoms generally of an intense nature.	0.86	0.06	
2: Cavities is an illness with many symptoms.	0.77	0.06	
Consequences – child (7 items)			0.71
<i>Cavities in my child ...</i>			
3: is a serious illness.	0.54	0.06	
4: has had a big effect on his/her life.	0.83	0.03	
5: has had a big effect on he/she smiles.	0.85	0.02	
6: has had a big effect on his/her behavior at home.	0.90	0.02	
7: has had a big effect on his/her school work.	0.97	0.01	
8: has had a big effect on his/her self-worth.	0.89	0.02	
9: is disabling.	0.82	0.03	
Consequences – caregiver (5 items)			0.69
10: Cavities in my child has a big impact on my life.	0.86	0.03	
11: I cannot easily live with my child's cavities.	0.76	0.04	
12: Cavities in my child has a big effect on how others see me.	0.84	0.03	
13: Cavities in my child has caused money problems for me.	0.73	0.04	
14: Cavities in my child has a big effect on my self-worth.	0.84	0.03	
Control – child (4 items)			0.54
15: There is a lot that can be done to improve the cavities in my child.	0.88	0.05	
16: My child's treatment will help make his/her cavities better.	0.79	0.05	
17: Improve in my child's cavities is not due to chance or fate.	0.55	0.07	
18: What my child does decides if his/her cavities get better or worse.	0.27	0.07	
Control – caregiver (4 items)			0.79
19: There is a lot I can do to control my child's cavity symptoms.	0.85	0.03	
20: What I do decides if my child's cavities get better or worse.	0.90	0.03	
21: There is a lot I can do to stop my child's cavities once they start.	0.80	0.04	
22: There is a lot I can do to prevent cavities in my child.	0.84	0.03	
Timeline (3 items)			0.46
23: My child's cavities will not get better over time.	0.64	0.07	
24: Cavities in my child are likely to be long-lasting rather than short-term.	0.99	0.07	
26: There will be times when my child's cavity symptoms get worse and times when they get better.	0.39	0.09	
Illness coherence (2 items)			0.94
27: I have a clear understanding of my child's cavities.	0.98	0.03	
28: My child's cavity symptoms are not confusing to me.	0.90	0.03	

Factors (illness perception constructs) & items	Standardized factor loading [*]	Standard error	Unidimensionality
<i>Emotional representations (4 items)</i>			0.71
29: I get really sad and upset when I think about my child suffering from cavities.	0.85	0.03	
30: Seeing my child with cavities worries me.	0.86	0.03	
31: Seeing my child with cavities makes me feel angry.	0.81	0.04	
32: Seeing my child with cavities can make me feel helpless.	0.68	0.05	

* All factor loadings were significant at $p < 0.05$

Unidimensionality is the magnitude of the largest eigenvalue divided by the total of all the eigenvalues for the factor, and is interpreted as the proportion of total item variance explained by the single factor. A value > 0.2 is considered support for unidimensionality (adequacy of a single factor for the items).

The CFA model included correlations for item pairs (1, 3), (2, 3), (10, 13), (15, 26), (16, 32), (17, 26), (17, 32), (18, 26).

Table 3

Spearman's Correlations between Illness Perception Constructs

Illness perception constructs (8 factor model)								
	Identity	Conseq – child	Conseq – caregiver	Control – child	Control – caregiver	Timeline	Illness coherence	Emotional represent.
Identity	1							
Consequences – child	0.50* [<.001]	1.00						
Consequences – caregiver	0.26* [<.001]	0.70* [<.001]	1.00					
Control – child	0.35* [<.001]	0.25* [.001]	0.30* [<.001]	1.00				
Control – caregiver	0.16* [.03]	0.13 [.09]	0.23* [.003]	0.79* [<.001]	1.00			
Timeline	0.17* [.03]	0.48* [<.001]	0.35* [<.001]	–0.10 [.20]	–0.13 [.10]	1.00		
Illness coherence	0.35* [<.001]	–0.11 [.17]	0.07 [.39]	0.61* [<.001]	0.55* [<.001]	–0.32* [<.001]	1.00	
Emotional representation	0.41* [<.001]	0.41* [<.001]	0.74* [<.001]	0.49* [<.001]	0.28* [<.001]	0.21* [.007]	0.28* [<.001]	1.00

* p < 0.05

p values are in brackets

Table 4

Correlations between Illness Perception Constructs and Child/Caregiver Variables

Child	n	Identity	Conseq- child	Conseq- caregiver	Control- child	Control- caregiver	Time- line	Illness coherence	Emotional represent	Average Fac Score
Decay										
yes (mean)	46	0.055	0.044	0.049	0.055	0.068	0.024	0.13	0.077	0.063
no (mean)	97	-0.050	-0.011	-0.037	0.011	-0.019	-0.079	-0.010	-0.062	-0.032
correlation		0.055	0.026	0.042	0.023	0.045	0.066	0.075	0.068	0.12
Early Childhood Caries (ECC)										
yes (mean)	49	0.12	0.037	0.088	0.17	0.18	-0.075	0.17	0.14	0.10
no (mean)	94	-0.087	-0.009	-0.061	-0.049	-0.079	-0.031	-0.036	-0.097	-0.056
correlation		-0.11	-0.022	-0.073	-0.12	-0.13	0.029	-0.11	-0.12	-0.11
Dental visit										
Yes (mean)	112	0.13 *	-0.063 *	-0.056	-0.039 *	-0.074 *	-0.046	-0.055 *	-0.053	-0.065 *
no (mean)	26	0.42	0.28	0.20	0.34	0.31	-0.089	0.43	0.22	0.26
correlation		-0.24 *	-0.17 *	-0.11	-0.17 *	-0.17 *	0.023	-0.21 *	-0.11	-0.21 *
Caregiver										
Education										
high school (mean)	53	0.15	0.14	-0.021	0.16	0.093	0.003	0.061	0.058	0.081
> high school (mean)	88	-0.10	-0.047	0.030	-0.051	-0.051	-0.065	0.014	-0.037	-0.039
correlation		-0.14	-0.094	0.026	-0.12	-0.077	-0.045	-0.026	-0.049	-0.074
Dental anxiety score										
correlation		-0.143	0.011	-0.069	-0.107	-0.031	0.059	-0.007	-0.174	-0.080
Self-efficacy score										
correlation		0.049	0.091	0.045	-0.131	-0.123	-0.008	0.078	-0.056	-0.026

*
p < 0.05

T-tests were used to test for mean differences, and a Z-test based on the Spearman correlation was used to test for non-zero correlations.

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Table 5

Differential Item Functioning (DIF) of Illness Perception Constructs with Age and Race

	Age N (18–25 yrs. = 111; 26 yrs. = 47)			Race/ethnicity N (Black = 105; Non-Black = 52)		
	chi square	df	p value	chi square	df	p value
Conseq – child	7.26	7	0.40	7.75	7	0.36
Conseq – caregiver	8.93	5	0.11	5.86	5	0.32
Control – child	7.25	4	0.12	3.53	4	0.47
Control – caregiver	5.01	4	0.29	1.15	4	0.89
Emotional representations	1.76	4	0.78	9.10	4	0.059

p > 0.05 indicates lack of evidence for a difference in any IPQ-RD item parameter (loadings or intercepts) between the compared groups (by age or race/ethnicity).