

An Epistemic Look at Parental Conceptual Knowledge and Oral Health Outcomes in Children

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Abstract

Objective. This study explores the impact of parental oral health knowledge on children's oral health, investigating if limited knowledge contributes to poor outcomes. The CAMBRA caries risk assessment and the World Health Organization dmft/DMFT index measure oral health. **Methods.** Over 23 months, the Knowledge Related to Oral Health Literacy (KROHL) questionnaire assesses parental knowledge in 4 domains and 5 oral health conditions. Pearson Correlation Coefficient analyzes the association between KROHL scores and CAMBRA outcomes. **Results.** Positive correlation emerges between parental oral health knowledge levels and children's dental caries risk, indicating the KROHL questionnaire's utility in identifying knowledge gaps. No standardized method for measuring oral health knowledge exists, although various tools claim to address aspects of the issue. This study pioneers the correlation between oral health knowledge and CAMBRA outcomes. **Conclusion.** The KROHL questionnaire proves a practical, disease-specific tool for research, emphasizing parental oral health knowledge's pivotal role in children's oral health. It serves as a valuable means to identify knowledge gaps and potential areas for intervention and education in oral health.

Keywords

oral, risk, pediatric, health, knowledge

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Introduction

Health knowledge, defined as context-specific knowledge about health and health care which is distinguishable from general knowledge in both definition and application, is related to increased health literacy and improved health outcomes.¹ Health literacy has been demonstrated to be associated with health knowledge.^{2–4} Conceptual knowledge is a construct of health literacy.⁵ Studies have examined the relationship between parental oral health knowledge (POHK) and pediatric oral health outcomes. Mostly preventable, untreated dental caries in children is a prevalent outcome for parents with deficiencies in oral health knowledge.⁶ While it is recognized that knowledge does not always predict behavior change, health behavior theories generally include basic knowledge as a necessary element of health behavior change and outcomes.^{7,8}

A heightened risk of caries development in a child is strongly associated with the oral health behavior of their

parent.^{9–11} The objective of the analysis was to compare the Knowledge Related to Oral Health Literacy (KROHL) questionnaire with 2 established population-based measures of pediatric oral health outcomes, CAMBRA (Caries Management By Risk Assessment), and dmft/DMFT. Providing a wide-ranging analysis of the associated risk factors, this investigation hopes to clarify whether limitations in POHK lead to poor oral health outcomes in children. KROHL assesses knowledge in place of literacy because knowledge is a basic and necessary element for better oral health outcomes.

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Knowledge, as an epistemic tool,¹²⁻¹⁶ offers an alternative perspective for understanding the specific information clinicians need to tailor care to individual patient needs, moving beyond a narrow focus on objective facts of oral disease.

Materials & Methods

This 23-month cross-sectional investigation measures parental oral health knowledge (POHK) using the KROHL questionnaire and describes the features of a hospital pediatric dental patient population in terms of caries experience and risk. KROHL evaluates oral health knowledge at the individual level in the context of OHL.¹⁷ KROHL incorporates elements from the Basic Health Literacy Screening (BHLS), the Comprehensive Measure of Oral Health Knowledge (CMOHK), and 5 open-ended questions regarding various oral disease states.¹⁸

The BHLS consists of the following 3 screening questions effective in detecting inadequate health literacy: How often does the individual have someone help read hospital materials; How confident is the individual at filling out medical forms independently; How often does the individual have problems learning about his or her medical condition because of difficulty understanding written information?¹⁹ The CMOHK includes 23 sets of multiple-choice questions and responses read aloud to participants, measuring knowledge related to general oral health and specific oral conditions such as caries, periodontal disease, and cancer.¹² KROHL evaluates the conceptualization of OHK.²⁰ Allowing the respondent to elaborate in their own words on their understanding of an oral condition, KROHL identifies specific domains of knowledge related to cause, prevention and treatment within each oral condition.

Hypothesis

We hypothesized a linear relationship between parent KROHL index and child CAMBRA score. The null hypothesis (H0) posited no correlation (equivalent to $r=0$), while the alternative hypothesis (H1) suggested a correlation (equivalent to $r \neq 0$), allowing for any significant correlation (positive or negative) in a 2-tailed test. We used the Pearson correlation coefficient to test these hypotheses, measuring the strength and direction of a linear relationship. If the null hypothesis is rejected, it implies evidence for a correlation; if not, there isn't enough evidence to conclude a correlation.

Sample Size

Ninety parent-child paired participants of both genders, children aged 1 to 17 years were selected using a

convenience sampling method. Parents were sampled without replacement and surveyed using KROHL when their child presented for initial or recall examination. The population size was 929 and the sample size was 90, a ratio of approximately 10%. The sample size was larger than 5% of the total population. A Finite Population Correction Factor (FPC) was applied using the following formula: $FPC = \sqrt{(N-n)/(N-1)}$. A confidence level of 90% needed an adjusted sample size of 89; thereby, the real value was within $\pm 4.99\%$ of the measured value. (Figure 1) A total of 90 KROHL-parent questionnaires were administered consisting of 30 observations in the 3 language categories (English, Mandarin, and Spanish).

Inclusion and Exclusion Criteria

The inclusion criteria for study participants were parents of immigrant children aged less than 17 years of age treated in a hospital dental medicine clinic. These families live below federal poverty guidelines and have limited English proficiency. Participants were primarily of Asian, Hispanic, White, and African ethnicity. Parent volunteers were able to read and write in one of the following languages: English, Spanish, and Mandarin Chinese were eligible. Language categories were based on the most common original language spoken among the patient population. Race, ethnicity, and preferred language were documented during the registration at the most recent visit. Parents self-reported as having no previous participation in formal oral health education prevention programs. However, parents and children who participated in prior oral health knowledge research were excluded.

KROHL

The 40-item KROHL questionnaire was administered by calibrated fourth-year dental students in one-to-one interviews with the parent. The co-investigator performed dental student training sessions in OHL, which focused on the KROHL content, survey methods, and skills. Instructions and other related information were scripted to minimize variation across interviews. Questionnaires were printed in a reader-friendly font so the respondent could see the questions and response categories. The interviewer read the questions to the parent. The interviewer reminded the respondent before the interview began that "I don't know" (IDK) was an acceptable answer to a question if they were unsure of a response.

Measures of parental OHK were of the following 5 specific oral conditions: caries, periodontal disease, oral cancer, edentulism, and malocclusion. These oral conditions were assessed in 4 knowledge domains general

The standard deviation is based on the proportion is: $\sqrt{p(1-p)} = 0.300000$.
 Calculates the sample size to get the following confidence interval: 0.1 ± 0.05 .
 $\alpha = 1 - 0.90 = 0.10$.
 $Z_{(1-\alpha/2)} = Z_{(1-0.10/2)} = Z_{0.950} = 1.644854$.

The required sample size is:
 $n = Z_{0.950}^2 * p(1-p) / MOE^2 = 1.644854^2 * 0.1(1-0.1) / 0.05^2 = 98$.
 Rounded up from: 97.399564.

Since the population size is finite: $N=929$, the corrected sample size is:
 $n * N / (n + N - 1) = 89$.
 Rounded up from: 88.242865.

Figure 1. Power analysis.

knowledge, etiology, prevention, and treatment.¹⁷ Although there were 40 items consisting of different types of questions, KROHL focuses on the 4 open-ended. Open-ended questions allowed the respondent to elaborate in their own words on their understanding of an oral condition, giving more insight into the OHK level for the individual parent. Responses to open-ended questions were coded using the following system: 2 for a correct answer, 1 for a partial, and 0 for an incorrect or IDK.²¹ A total POHK score from 0 to 38 was created from the summation of the answers to the open-ended KROHL questions.

Parental oral health knowledge scores were categorized as “high” for scores greater than 25 and “low” for less than or equal to 12. To establish the scoring validity, the level of agreement was determined using the scores from the 3 unique raters trained by an OHL expert. The rater training was a 3-step process consisting of the following: (1) familiarization of raters with the correct answer criteria for each question; (2) evaluation and scoring of KROHL parent responses independently and then as a group; (3) Group discussion of the results. The mean scores for all 5 specific oral health conditions within 4 domains of knowledge were used in the final analysis.^{22,23}

CAMBRA

For this investigation, we used January 2019 updated CAMBRA form created by the University of California,

San Francisco, and the California Dental Association.²⁴ The CAMBRA system is highly predictive of future caries for groups aged 6 years through adult and 0 to 5 years.²⁵⁻²⁷ Caries risk was determined at the initial and periodic visits. Radiographs were taken as indicated based on AAPD guidelines. All child participants’ dental caries disease indicators, risk factors, and protective factors were determined. However, bacterial testing was not part of the CRA due to the lack of funding. Each child was assigned a caries risk category from 0 to 3 based on the presence of caries protective factors, caries risk factors, and disease indicators recorded in the CRA forms.

dmft/DMFT

The DMFT index for permanent teeth and the dmft index for primary teeth, including data on decayed (D/d), missing (M/m), and filled (F/f) conditions such as caries, fluorosis, enamel defects, dental trauma, and malocclusion, were recorded based on the World Health Organization’s (WHO) World Health Organization version), considering the child’s chronological age and dental development.²⁸ A pediatric dental faculty conducted the oral examination in the dental chair using a headlight and dental mirror. The result of the examination and dmft indexes were recorded by a calibrated dental student. Using the WHO odontogram for caries assessment, the calibrated dental student recorded a surface as decayed if it presented with a detectably softened floor,

undermined enamel, or softened walls. Individual child caries experience was determined from the sum of dmft. Since the dmft score does not indicate the number of teeth at risk or sound teeth, the total number of teeth present in the child's mouth was recorded. The dmft ranged from 0 to 20, for children in mixed dentition from 0 to 24, and for adults from 0 to 28.²⁹

Data Analysis

The primary outcome was the association between KROHL (CMOHK plus BHLS) and CAMBRA, quantified with Pearson correlation coefficients. Pearson correlation coefficient (r) has a value between -1 (perfect negative correlation) and 1 (perfect positive correlation). This statistical method was chosen because a linear relationship was assumed between KROHL and CAMBRA, 2 quantitative variables. Discrete data were described by relative frequencies and strata were compared with the chi-square test. KROHL strata were compared with one-way ANOVA. All analyses used IBM SPSS (v28, IBM Corp, Armonk, NY). Unless otherwise indicated, "significant" indicates $P < .05$.

Ethical Approval and Informed Consent

Informed written consent was obtained from each individual participant involved in the study, which comprised both the parent or legal guardian and their respective child. The collected data was de-identified. As part of the initial consenting participants signed informed consent regarding the submission of this investigation for potential publication in a journal. This study was conducted in accordance with the Declaration of Helsinki, and the protocol was reviewed and approved by the NYU Langone Health Institutional Review Board (Study number: i21-00194; Review Type: Expedited Category 5,7).

Results

Effect Size

The overall effect size of the Pearson Correlation Coefficient was estimated at $r = .0534$. This estimate indicated the linear relationship between KROHL and CAMBRA, ranging from -1 to 1 . A score of -1 indicates a total negative linear correlation, 0 signifies no correlation, and $+1$ represents a total positive correlation. The P -value for the relationship between KROHL and CAMBRA was non-significant ($P = .617$), suggesting that we cannot reject the null hypothesis of no correlation. Thus, we suspected that a high KROHL index

may indicate a low caries risk, but the analysis revealed a small, positive relationship at the level of parent caries knowledge and CAMBRA ($r = .218$; $P = .039$).

Test Statistic

Describing how far the observed data was from the null of no correlation between the KROHL and CAMBRA, the test statistic $T = .5018$ had a 95% level of acceptance: $[-1.9873; 1.9873]$. The 95% confidence level of correlation was $[-.1554, .2577]$, $df = 88$.

P-Value

The larger the P -value, the more support exists for the null hypothesis. The P -value was non-significant at .617 (61.7%), which indicated a high probability of rejection of a true null hypothesis or type I error.

Correlation Test Using T Distribution (Two-Tailed)

Because the null correlation was zero, we used the t -distribution to test the correlation. When " r " is not equal to zero, the distribution of the correlation is not symmetrical. Thus, we use the Z distribution over Fisher transformation to create the confidence interval.

KROHL, CAMBRA, and Clinical Outcomes

There was a small positive non-significant relationship between KROHL-Parent and CAMBRA-Child resulting from the Pearson Correlation Coefficient ($r(88) = .0534$, $P = .617$). Results of the Pearson analysis revealed that the KROHL score specific to the caries knowledge domain was slightly correlated ($r = .2128$) with CAMBRA ($P = .039$). In terms of the dmft score, there was no relation between the KROHL caries-specific parent knowledge and level of child caries experience ($r = -.083$, $P = .435$). Results indicated that KROHL and CMOHK are closely related to 4 oral health conditions. Based upon the average of 3 KROHL scores, the coefficient value was ($r = .495$), suggesting a positive KROHL-CAMBRA relationship ($P = .000$). Correlation is significant at the .01 level (2-tailed). Malocclusion was not significant ($P = .279$) (Table 1).

Comparison of Strata

KROHL Strata were compared with one-way ANOVA to determine if a significant difference existed between pairs of clinical means. (Table 2) When comparing the means between the "Do you consider English as your

Table 1. Pearson Correlation Summary.

		CAMBRA	DMFT	CMOHK
KROHL (Caries)	Pearson Correlation	0.218*	-0.091	0.418**
	Sig. (2-tailed)	0.039	0.396	0.000
KROHL (Periodontal Disease)	Pearson Correlation	0.058	-0.098	0.416**
	Sig. (2-tailed)	0.589	0.360	0.000
KROHL (Oral Cancer)	Pearson Correlation	-0.083	0.036	0.297**
	Sig. (2-tailed)	0.438	0.733	0.004
KROHL (Tooth Loss)	Pearson Correlation	-0.036	0.029	0.287**
	Sig. (2-tailed)	0.738	0.786	0.006
KROHL (Malocclusion)	Pearson Correlation	-0.108	0.041	0.115
	Sig. (2-tailed)	0.312	0.698	0.279
KROHL (Average of 3 Raters)	Pearson Correlation	0.053	0.205	0.495**
	Sig. (2-tailed)	0.617	0.052	0.000
N		90	90	90
		CAMBRA	DMFT	
BHLS (Reading Forms)	Pearson Correlation	-0.192	0.361**	
	Sig. (2-tailed)	0.070	0.000	
BHLS (Written Material)	Pearson Correlation	-0.169	0.196	
	Sig. (2-tailed)	0.112	0.064	
BHLS (Filling Forms)	Pearson Correlation	0.043	-0.078	
	Sig. (2-tailed)	0.686	0.468	
N		90	90	
		CAMBRA	DMFT	
CMOHK	Pearson Correlation	0.086	0.009	
	Sig. (2-tailed)	0.421	0.934	
N		90	90	

** Correlation is significant at the .01 level (2-tailed).

* Correlation is significant at the .05 level (2-tailed).

first Language?” group to the “Number of filled teeth” group, the *P*-value was significant at .033. In the “Number of Sealants present” group, the *P*-value was statistically significant at .040. When comparing the difference between the means of the “Number of Sealants present” group and the “Which of these words best describe your oral health?” group, the difference was significant at *P*-value of .013.

Caris Risk Assessment

Regarding the 3 BHLS questions, nearly half of the parents were very confident in reading and understanding health information. They had a relatively high level of confidence in filling out health forms. We compared parental self-perceived OHK to CAMBRA in cross-tabulation. Many children at extreme or high caries risk had parents who overestimated their ability to read, learn and fill out forms related to their oral health condition. A significant discordance between parents’ perceived OHK and high or even extreme caries risk in their children was observed (Table 3).

Sample Characteristics

Participating parents were 37 year old, on average (range 18-58), and the majority were women (76.7%). The average age of the child participant was 8.9 years old ranging from under 1 to 17 years with 60% female and 40% male. Fifty-five percent of the parents self-identified as Hispanic, 13% as African American, 7% Asian, and the remainder consisted of other groups. Approximately 60 parent-child participants did not consider English to be their first language with 47.8% speaking Spanish at home or with friends and relatives. The study had a relatively well-educated sample with 40% of adults reporting having completed college or more; 85.6% of participants reported having completed high school. Almost 3/4 of parents reported having dental insurance and 74.4% considered their oral health to be in good or very good condition (Table 4).

Evaluating Health Literacy

Among the 90 parents surveyed using the BHLS, a significant proportion consistently answered negatively

Table 2. Anova Summary Table.

			Sum of squares	df	Mean square	F	Sig.
Number of Filled Teeth * Do you consider English your first language?	Between Groups	(Combined)	10.756	1	10.756	4.676	0.033
	Within Groups		202.400	88	2.300		
	Total		213.156	89			
Number of Sealant Present * Do you consider English your first language?	Between Groups	(Combined)	20.000	1	20.000	4.347	0.040
	Within Groups		404.900	88	4.601		
	Total		424.900	89			
Number of Filled Teeth * Which of these words best describe your oral health?	Between Groups	(Combined)	14.376	1	14.376	6.364	0.013
	Within Groups		198.780	88	2.259		
	Total		213.156	89			

P value of <.05.

Table 3. KROHL-CAMBRA Crosstabulation (n=90).

KROHL	CAMBRA	
BHLS question	Parent response	% high to extreme
Difficulty understanding	Never	27% (24)
Problem learning health material	Never	37% (33)
Confident filling out forms	Always	34% (31)

Table 4. Demographic Variable.

	N	%
Parent gender (male)	21	23.3
Parent gender (female)	69	76.7
Child gender (male)	36	40.0
Child gender (female)	54	60.0
Ethnicity binary (hispanic)	55	61.1
Ethnicity binary (non-hispanic)	35	38.9
Parental education level (elementary or less)	13	14.4
Parental education level (high school)	41	45.6
Parental education level (college or more)	36	40.0
English first language (no)	60	66.7
English first language (yes)	30	33.3
Parental oral health status (poor)	23	25.6
Parental oral health status (good or very good)	67	74.4
Dental insurance (yes)	65	72.2
Dental insurance (no)	25	27.8
Total sample population	90	100

across all 3 screening areas. Notably, 45.6% of parents reported never having someone assist them in reading health-related materials, while 56.7% expressed full confidence in filling out medical forms themselves. The

same percentage (56.7%) indicated “never” to experiencing difficulties learning about their medical condition due to challenges understanding written information. For knowledge-related open-ended questions in the KROHL questionnaire, the inclusion of “I Don’t Know” (IDK) options reduced guesswork, creating a comfortable space for uncertain parents. Open-ended questions allowed for more detailed responses compared to the limited nature of multiple-choice questions. The IDK option was instrumental in identifying parental knowledge gaps and facilitating exploration of their conceptualization.

Discussion

The discordance between parents’ perceived OHK and the caries risk in their children suggests that there is a notable difference or mismatch between what parents believe they know about oral health and the real risk of their children developing dental caries. This finding could have several implications. It may indicate a lack of awareness or accurate information among parents regarding factors that contribute to caries risk in children. It could also highlight the importance of effective communication between healthcare providers and parents to ensure that parents have a clear understanding of

oral health issues and preventive measures. Further research or information would be needed to understand the specific reasons behind this discordance and to develop targeted strategies for improving parental awareness and education on oral health to better align with the actual risk factors for caries in children.

The link between parental oral health knowledge (POHK) and children's dental caries risk is crucial for promoting oral health. Informed parents tend to adopt better oral hygiene practices, reducing the risk through regular brushing, flossing, and mindful dietary habits. Understanding oral health basics increases awareness of routine dental check-ups and timely professional interventions. Knowledgeable parents are proactive in preventing dental issues, ensuring fluoride exposure, monitoring sugar intake, and promoting positive oral health behaviors. They are more likely to recognize early signs of dental problems, preventing the escalation of caries risk.

Parents as role models influence children's habits, and effective communication of oral health knowledge positively shapes children's attitudes toward oral hygiene. Socioeconomic factors and access to oral health education can influence the association, with families of lower socioeconomic status facing challenges. Cultural practices impact oral health behaviors, and tailored education aligned with cultural beliefs enhances intervention effectiveness. Collaboration between parents and healthcare providers, especially dental professionals, is crucial. Monitoring oral health knowledge over time provides insights into the effectiveness of educational programs and their influence on children's dental caries risk.

The KROHL questionnaire builds on prior research exploring the interplay between literacy, knowledge, and oral health theories. It investigates key hypotheses connecting POHK to adverse outcomes in children with elevated caries risk. Analysis revealed that parents with adequate literacy reported limited oral health knowledge, aligning with elevated pediatric CAMBRA and dmft/DMT scores. Limitations include a relatively small sample size, potentially limiting the power to explore KROHL-CAMBRA relationships adequately. Cross-sectional data preclude demonstrating a causal link between KROHL and CAMBRA. The inclusion of self-reported BHLS data in the KROHL questionnaire presents limitations, as tailored oral health literacy measures show stronger correlations with oral health approaches.

Conclusion

While additional studies are required for a broader patient population, the KROHL index may assess the caries risk in children with parents having limited oral health knowledge (OHK). Currently, there is no standard measure for

parental OHK, although various oral health literacy tools claim to address certain aspects of the issue. From the oral health literacy (OHL) perspective, knowledge is actionable by oral health care providers once identified. This study is the first to correlate oral health knowledge with CAMBRA, suggesting a positive association. Larger studies across diverse populations are needed to further analyze this relationship. A positive correlation between parental oral health knowledge and children's dental caries risk indicates that well-informed parents contribute to lower caries risk through better preventive practices. Addressing knowledge gaps and promoting parental education can effectively prevent dental caries in children.

List of Abbreviations

AVOVA	Analysis of variance
BHLS	Basic Health Literacy Screening
CAMBRA	Caries Management By Risk Assessment
CMOHK	Comprehensive Measure of Oral Health Knowledge
CRA	Caries risk assessment
df	Degrees of freedom
DMFT	decayed, missing, filled teeth (permanent)
dmft	decayed, missing, filled teeth (primary)
FPC	Finite Population Correction Factor
H_0	null hypothesis
IBM	International Business Machines Corporation, a multinational technology company headquartered in Armonk, N.Y.
IDK	I don't know
KROHL	Knowledge Related to Oral Health Literacy questionnaire
OHK	oral health knowledge
OHL	oral health literacy
POHK	parental oral health knowledge
r	Pearson Correlation Coefficient
SD	Standard deviation
SPSS	Statistical Package for the Social Sciences
WHO	World Health Organization

Author Contributions

UTB: Contributed to conception and design; Contributed to acquisition, analysis, or interpretation; Drafted the manuscript; Critically revised the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. SS: Contributed to conception and design; Critically revised the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. MJ: Contributed to the statistical analysis and interpretation; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy.

Data Availability

Due to the nature of this research, participants in this study did not agree for their data to be shared publicly, so supporting data is not available.

Declaration of Conflicting Interests

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Supplemental Material

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