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Is Dental Utilization Associated with Oral Health Literacy?

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Abstract

The objectives of this study were to examine the pattern of association between dental utilization and oral health literacy (OHL). As part of the Carolina Oral Health Literacy Project, clients in the Women, Infants, and Children's Special Supplemental Nutrition Program completed a structured 30-min in-person interview conducted by 2 trained interviewers at 9 sites in 7 counties in North Carolina. Data were collected on clients' OHL, sociodemographics, dental utilization, self-efficacy, and dental knowledge. The outcome, OHL, was measured with a dental word recognition test (30-item Rapid Estimate of Adult Literacy in Dentistry). Descriptive and multiple linear regression methods were used to examine the distribution of OHL and its association with covariates. After adjusting for age, education, race, marital status, self-efficacy, and dental knowledge, multiple linear regression showed that dental utilization was not a significant predictor of OHL ($P > 0.05$). Under the conditions of this study, dental utilization was not a significant predictor of OHL.

Keywords: dental care, access to health care, Medicaid, health services research, communication, cohort studies

Introduction

Oral health literacy (OHL) is defined as "the degree to which individuals have the capacity to obtain, process, and understand basic oral and craniofacial information and services needed to make appropriate health decisions" (National Institute of Dental and Craniofacial Research et al. 2005). The current understanding of OHL also includes cultural factors and conceptual knowledge necessary to make appropriate oral health decisions (Institute of Medicine [IOM] 2013). With consequences in both health practices and health-seeking behavior, OHL has an important role in addressing oral health problems and has been recently posited as a dimension of the causal model of early childhood caries (Guo et al. 2014). The U.S. Department of Health and Human Services (2010) developed a multiagency national action plan to improve health literacy, including OHL.

According to the IOM, low OHL in the United States creates challenges in recognizing the risk for oral diseases as well as in seeking and receiving dental care (IOM 2011, 2013; Holtzman et al. 2014). Holtzman and colleagues (2014) found that adults who use fewer sources of oral health information, a subset of health literacy skills, were more likely to fail appointments at a university-based dental clinic. Conversely, Macek and colleagues (2010) measured OHL using the Comprehensive Measure of Oral Health Knowledge and found no association with dental utilization in adults. Similarly, Jamieson and colleagues (2013) found that indigenous Australians had similar OHL scores whether their last dental visit was <1 y or >1 y ago; however, OHL for American Indians was lower if the last dental visit was >1 y ago versus 1 y ago.

In summary, the findings related to the association between dental utilization and OHL are conflicting; moreover, the current body of literature is limited to a unidirectional effect: the impact of OHL on dental utilization. To add clarity to our current understanding on the relationship between these 2 important factors that play an integral role in oral health outcomes, we sought to examine the unstudied directional effect: the impact of dental utilization on OHL. Accordingly, the aim of this study was to examine the pattern of association between dental utilization and OHL.

Methods

The Carolina Oral Health Literacy (COHL) Project relied on a prospective cohort study design, as described by Lee and colleagues (2011). The overarching goal of COHL was to examine OHL and its association with health outcomes among caregivers, infants, and children enrolled in the Special Supplemental Nutrition Program for Women, Infants, and

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Children (WIC) in North Carolina. Study participants were clients at 9 sites in 7 counties selected to generate a large and diverse population of low-income WIC clients. Written informed consent was obtained from all study participants, and the study was approved by the Biomedical Institutional Review Board at the University of North Carolina at Chapel Hill (Lee et al. 2011).

Baseline cross-sectional data from 1,405 caregivers were used to determine OHL levels in a population attending WIC clinics. Due to the small sample size and potential differences in health-seeking behavior, we excluded caregivers who were male and/or did not speak English, resulting in a sample size of 1,284 caregivers. Caregivers with missing data on the main independent variable (dental utilization) were excluded, resulting in a final analytic sample of 1,277. Observations with missing data on dental utilization ($n = 7$) were dropped.

Several published conceptual frameworks on OHL include a complex web of associations between OHL and self-efficacy/dental knowledge (Macek et al. 2010; U.S. Department of Health and Human Services 2010; Lee and Divaris 2014). The relationship between general health literacy and self-efficacy is also highlighted in the literature (Wolf et al. 2007; Torres et al. 2009; Osborn et al. 2010). It is unknown whether self-efficacy and dental knowledge are predictors of OHL; however, self-efficacy and dental knowledge are thought to interact with OHL to contribute to oral health disparities (Lee and Divaris 2014). For that reasons, our analysis on the association between dental utilization and OHL included models without self-efficacy (model A) and with dental knowledge (model B).

Our dependent variable (OHL) was measured by means of a validated word recognition test: the 30-item Rapid Estimate of Adult Literacy in Dentistry (REALD-30). The REALD-30 instrument has good convergent validity and internal consistency: Cronbach's $\alpha = 0.87$ (Lee et al. 2007). It includes 30 dentally related words arranged in order of increasing difficulty. Using the REALD-30, the adult participant reads the words aloud to the interviewers. One point is given to each word pronounced correctly and then summed for overall score. Thus, the REALD-30 is a continuous variable, with scores ranging from 0 (lowest literacy) to 30 (highest literacy).

The main independent variable (dental utilization) was measured with a question taken from the 1999–2000, 2001–2002, and 2003–2004 National Health and Nutrition Examination Surveys: "How long it had been since the participants' last dental visit?" (Centers for Disease Control and Prevention 2014). Dental utilization was characterized as a 4-level categorical variable: <12 mo, 12 to 23 mo, 2 to 5 y, and >5 y. Other control variables were age, education, race, marital status, self-efficacy, and dental knowledge. In cases where categorical variables had sparse categories, we combined the categories to form a new categorical variable. The final form of the categorical variable was based on the maximum adjusted R^2.

Age was measured in years. As opposed to a quadratic or linear form, a 3-knot spline form was used for age because it was the functional form with the highest adjusted R^2. Education was coded as a 4-level categorical variable: did not finish high school, high school or General Educational Development (GED), some technical or college, and college or higher. The GED is a high school equivalency examination. Race was coded according to 5 categories: white, African American, American Indian or Alaskan Native, Asian, and unknown. Asian and unknown race were combined due to small sample size ($n = 3$), resulting in a 4-category variable for race. Marital status was categorized as single, married, divorced/separated, other, and don't know. The fourth and fifth categories, other and don't know ($n = 5$), were combined due to small sample size, resulting in a 4-category variable for marital status.

Self-efficacy was assessed with the General Self-efficacy Scale (GSE), originally developed by Schwarzer and Jerusalem (1995) in Germany and translated into English by Rimm and Jerusalem (1999). Research underscores that the GSE has high reliability, stability, and construct validity (Schwarzer et al. 1999; Leganger et al. 2000), with a Cronbach alpha of 0.75 for the English version (Rimm and Jerusalem 1999).

The GSE is a 10-item psychometric scale designed to assess optimistic self-beliefs to cope with a variety of difficult demands in life. Caregivers were asked to answer 10 self-efficacy items, such as "I can always manage to solve difficult problems if I try hard enough" and "I can usually handle whatever comes my way," with the following answers: "not at all true," "hardly true," "moderately true," or "exactly true." The scaled score for each item ranged from 1 to 4, with higher scores indicating strong self-efficacy. All responses were summed to a composite score ranging from 10 to 40 points. Self-efficacy was included in the model as a continuous variable but is also presented as a quintile-category indicator variable with corresponding REALD-30 scores.

To assess dental knowledge, a 6-item knowledge survey was used (Mathu-Muju et al. 2008; Vann et al. 2010). Caregivers were asked to answer "agree," "disagree," or "don't know" to knowledge-related items, such as "Fluoride helps prevent tooth decay" and "Tooth decay in baby teeth can cause infections that can spread to the face and other parts of the body." The knowledge score was derived from the sum of correct responses and ranged from 0 to 6. Knowledge scores were transformed into 6 dummy variables, with each sum of correct answers as a separate dummy variable.

Descriptive statistics and graphics were used to explore the distribution of participants' demographic characteristics and OHL according to REALD-30 scores. Normal distribution of the error for REALD-30 scores was tested by observing the histogram and performing a combined skewness and kurtosis evaluation test based on the $P < 0.05$ criterion (D'Agostino et al. 1990). All analyses were conducted with STATA 12 (StataCorp LP, College Station, TX, USA).

Multiple linear regression methods were used to examine the distribution of OHL and its association with covariates. Ordinary least squares regression was used to examine the association between dental utilization and OHL because we believe that the relationship is linear. Individuals who use more preventive dental care and see the dentist for problem-based care until dental needs are met are more likely to have higher OHL.

Pairwise correlations did not exceed 80%, and both mean and individual variance inflation factors approximated 1,

Table 1. Distribution of Baseline REALD-30 Scores by Demographic Characteristics among Carolina Oral Health Literacy Study Participants (*N* = 1,277).

			REALD-30	
Demographics	*n*	%	Mean (SD)	Range
Total sample	1,277	100	15.8 (5.2)	0 to 30
Dental utilization (last dental visit)				
<12 mo	730	57.2	15.8 (5.2)	0 to 29
12 to 23 mo	218	17.1	16.1 (5.5)	1 to 30
2 to 5 y	178	13.9	15.8 (5.6)	3 to 30
>5 y	151	11.8	15.4 (4.7)	2 to 27
Education				
Did not finish high school	306	24.0	13.1 (4.8)	1 to 26
High school diploma or GED	476	37.3	15.0 (4.9)	0 to 30
Some technical school or college	430	33.7	18.0 (4.7)	4 to 30
College or higher	65	5.1	20.7 (4.8)	11 to 29
Age, y[a]				
Spline 1: 17.2 to 29.3	935	73.2	15.5 (5.0)	0 to 30
Spline 2: 29.3 to 41.4	286	22.4	17.0 (5.6)	2 to 29
Spline 3: 41.4 to 53.5	51	4.0	14.7 (6.1)	3 to 28
Spline 4: 53.5 to 65.6	5	0.4	17.4 (7.6)	10 to 29
Race				
White	499	39.0	17.5 (4.8)	1 to 30
African American	520	40.7	15.3 (5.1)	2 to 30
American Indian	255	20.0	13.7 (5.3)	0 to 29
Asian/unknown	3	0.2	15.7 (1.5)	14 to 17
Marital status				
Single	856	67.0	15.2 (5.1)	0 to 30
Married	293	22.9	17.3 (5.3)	1 to 29
Separated/divorced	123	9.6	16.8 (5.6)	3 to 28
Other/don't know	5	0.4	15.6 (6.4)	5 to 21
Self-efficacy[b]				
Quintile 1: 15 to 29	196	15.3	13.7 (5.3)	2 to 27
Quintile 2: 30 to 32	315	24.7	16.1 (4.9)	2 to 29
Quintile 3: 33 to 35	300	23.4	16.5 (5.2)	1 to 28
Quintile 4: 36 to 37	247	19.3	16.1 (5.2)	2 to 30
Quintile 5: 38 to 40	219	17.1	16.1 (5.4)	3 to 30
Dental knowledge, no. correct of 6[c]				
0	1	0.1	0	0 to 0
1	2	0.2	14.5 (0.7)	14 to 15
2	29	2.3	11.3 (4.7)	1 to 19
3	117	9.2	13.1 (5.4)	3 to 29
4	263	20.6	15.3 (5.2)	2 to 28
5	584	45.7	16.4 (5.0)	1 to 30
6	281	22.0	16.6 (5.1)	3 to 29

GED, General Educational Development (high school equivalency examination); REALD-30, 30-item Rapid Estimate of Adult Literacy in Dentistry.
[a]Mean = 26.6 (SD = 6.9), median = 24.8, range = 17.2 to 65.6.
[b]Mean = 33.4 (SD = 4.1), median = 34, range = 15 to 40.
[c]Mean = 4.8 (SD = 1.0), median = 5, range = 0 to 6.

indicating no signs of serious multicollinearity. We found no evidence of heteroskedasticity using White's test ($P < 0.05$). Pregibon's (1980) link test was insignificant, indicating no significant specification error in the model. *F* tests and corresponding *P* values were obtained for the 6 covariates in the multivariate regression model. When self-efficacy and dental knowledge were included and excluded, we found no evidence of multicollinearity or heteroskedasticity using White's test ($P < 0.05$). To ensure the presence of no heteroskedasticity, regressions were run also with robust standard errors, which resulted in no change in significance or policy implications.

Results

The demographic characteristics of our analysis sample (N = 1,277) are presented in Table 1 with the corresponding REALD-30 distribution characteristics. The average age was 26.6 y. Thirty-nine percent of subjects were white, 41% African American, 20% American Indian, and 0.2% Asian and unknown race/ethnicity. Thirty-seven percent graduated high school or obtained a GED, and 5% graduated college. Fifty-seven percent visited the dentist within the past year. The average self-efficacy score was 33.4 (SD = 4.1). COHL participants

Table 2. Multiple Linear Regression Model for Oral Health Literacy (REALD-30 Score): Carolina Oral Health Literacy Study Participants (N = 1, 277).

	Model Coefficient (SE)	95% Confidence Interval	*F* Test (*P* Value)
Dental utilization (last dental visit)			0.06 (0.98)
<12 mo	Referent		
12 to 23 mo	–0.025 (0.35)	–0.72, 0.67	
2 to 5 y	0.11 (0.38)	–0.64, 0.86	
>5 y	0.12 (0.41)	–0.69, 0.93	
Education			70.78 (0.001)
Did not finish high school	–1.83[a] (0.34)	–2.50, –1.17	
High school diploma or GED	Referent		
Some technical school or college	2.70[a] (0.31)	2.09, 3.31	
College or higher	5.02[a] (0.63)	3.79, 6.25	
Age, y			1.64 (0.16)
Spline 1: 17.2 to 29.3	0.067 (0.043)	–0.019, 0.15	
Spline 2: 29.3 to 41.4	–0.10 (0.055)	–0.21, –0.0063	
Spline 3: 41.4 to 53.5	–0.065 (0.14)	–0.33, 0.20	
Spline 4: 53.5 to 65.6	0.26 (0.30)	–0.33, 0.84	
Race			28.37 (0.001)
White	2.12[a] (0.30)	1.52, 2.71	
African American	Referent		
American Indian	–0.89[b] (0.36)	–1.59, –0.19	
Asian/Unknown	0.82 (2.65)	–4.37, 6.02	
Marital status			0.92 (0.43)
Single	Referent		
Married	0.56 (0.34)	–0.12, 1.23	
Separated/divorced	0.36 (0.47)	–0.56, 1.28	
Other/don't know	–0.15 (2.06)	–4.20, 3.90	
Self-efficacy	0.13[a] (0.031)	0.069, 0.19	17.32 (0.001)

Adjusted R^2 = 0.2430.
GED, General Educational Development (high school equivalency examination); REALD-30, 30-item Rapid Estimate of Adult Literacy in Dentistry.
[a]Statistically significant at the 1% level.
[b]Statistically significant at the 5% level.

who had less education or were minorities had a lower mean REALD-30 score (Table 1).

The distribution of OHL (REALD-30) scores did not depart substantially from normality (χ^2 = 1.54, df = 2, P > 0.05) and had mean of 15.8 (SD = 5.2), median of 16, and a range of 0 to 30. The association between the dental utilization and REALD-30 score was not statistically significant (P > 0.05, data not shown). Therefore, the null hypothesis of no effect of dental utilization on REALD-30 score was not rejected.

Sociodemographic and dental-related predictors accounted for 24% of the OHL variance in the linear regression model (Table 2). Table 2 reveals that race, education, and self-efficacy made significant independent contributions to the model predicting OHL (P < 0.05). This table also shows that dental utilization, age, and marital status did not make significant independent contributions to the prediction of OHL (P > 0.05).

After adjusting for age, education, race, marital status, and self-efficacy, dental utilization was still not significantly associated with OHL (Table 2); moreover, this lack of association was unaltered with the absence of self-efficacy in the model (Table 3, model A) or with the inclusion of dental knowledge (Tables 3, model B). Although there was no evidence of heteroskedasticity in all 3 models, the regressions were completed with robust standard errors, which resulted in no change in significance.

The association between dental utilization and OHL was further tested by characterizing dental utilization as a 2-level categorical variable (last dental visit within 12 mo or >12 mo ago) while adjusting for age, education, race, marital status, and self-efficacy (data not shown). There remained no significant association between dental utilization and OHL with this dichotomous permutation of the main independent variable (P = 0.852).

A power calculation was performed according to the dichotomous variable for dental utilization to find the minimal detectable difference in REALD-30 scores between the groups with and without dental utilization in the past 12 mo (Gerstman 2008). The power calculation relied on data from this study (n = 730 with utilization in the past year, n = 547 without utilization in the past year; REALD-30 standard deviation of 5.2) to determine that we had >90% power (α = 0.05) to detect a difference as small as 0.95 of a REALD-30 point. The power calculation suggests that we had a >90% chance of detecting a true difference as small as 1 REALD-30 point.

Discussion

To our knowledge, this is the first study to examine the directional association between dental utilization and OHL. We found no significant association between dental utilization and OHL. The following are 3 potential explanations for this finding.

Table 3. Variations to the Multiple Linear Regression Model for Oral Health Literacy (REALD-30 Score): Carolina Oral Health Literacy Study Participants (N = 1,277).

	REALD-30, β (95% Confidence Interval)	
	Model A	Model B
Dental utilization (last dental visit)		
<12 mo	Referent	Referent
12 to 23 mo	–0.038 (–0.74, 0.66)	0.019 (–0.67, 0.71)
2 to 5 y	0.069 (–0.69, 0.83)	0.20 (–0.55, 0.94)
>5 y	0.098 (–0.72, 0.91)	0.34 (–0.46, 1.14)
Education		
Did not finish high school	–1.82 (–2.49, –1.15)[a]	–1.78 (–2.43, –1.12)[a]
High school diploma/GED	Referent	Referent
Some technical school/college	2.85 (2.24, 3.47)[a]	2.62 (2.02, 3.23)[a]
College or higher	5.33 (4.09, 6.57)[a]	4.81 (3.59, 6.03)[a]
Age, y		
Spline 1: 17.2 to 29.3	0.055 (–0.031, 0.14)	0.043 (–0.042, 0.13)
Spline 2: 29.3 to 41.4	–0.10 (–0.21, –0.0040)	–0.10 (–0.21, –0.0028)
Spline 3: 41.4 to 53.5	–0.062 (–0.33, 0.21)	–0.046 (–0.31, 0.22)
Spline 4: 53.5 to 65.6	0.25 (–0.34, 0.84)	0.23 (–0.35, 0.80)
Race		
White	2.00 (1.40, 2.60)[a]	2.01 (1.42, 2.60)[a]
African American	Referent	Referent
American Indian	–1.05 (–1.77, –0.35)[a]	–0.94 (–1.63, –0.25)[a]
Asian/unknown	0.58 (–4.65, 5.83)	–0.80 (–4.33, 5.93)[a]
Marital status		
Single	Referent	Referent
Married	0.55 (–0.13, 1.23)	0.58 (–0.091, 1.24)
Separated/divorced	0.39 (–0.54, 1.31)	0.42 (–0.50, 1.33)
Other/don't know	–0.40 (–4.48, 3.68)	–0.25 (–4.25, 3.75)
Self-efficacy		0.12 (0.055, 0.18)[a]
Dental knowledge		0.72 (0.46, 0.98)[a]
Adjusted R^2	0.2330	0.2601

GED, General Educational Development (high school equivalency examination); REALD-30, 30-item Rapid Estimate of Adult Literacy in Dentistry.
[a]Statistically significant at the 1% level.

First, there may be no association. The lack of association between dental utilization and OHL may be testament to the fixed nature of health literacy. Similar results were reported in the field of medicine by Hardie and colleagues (2011), who found that outpatient medical office visit utilization was similar for patients across literacy levels.

Second, the association may be misleading due to a lack of information relative to the reason for the visit (preventive vs. problem based). Although our data were appropriate to study the directional relationship between dental utilization and OHL by asking about past dental utilization and measuring OHL at the time of data collection, our data lacked specificity for the reason for the past dental visits. For example, those who visited the dentist *rarely or frequently* for problem-based care in the past may have had low OHL. Alternatively, those with a moderate number of visits in a pattern consistent with a history of regular preventive care may have in fact had high OHL. Our model did not distinguish preventive from problem-based dental visits; therefore, it was unable to identify whether those with past dental utilization in fact had frequent preventive dental care and high OHL. Future studies on dental utilization can clarify this health-seeking behavior by collecting more specific data on the type, setting, and classification of dental visits.

The literature on general health literacy has carefully examined the directionality of the effect of literacy on health care utilization, suggesting that the reason for the visit may play an important factor in understanding the relationship between dental utilization and OHL. Griffey and colleagues (2014) found higher emergency department utilization for patients with inadequate health literacy as compared with patients with adequate health literacy. Similarly, Hardie and colleagues (2011) found fewer hospital admissions and emergency department visits for patients with higher health literacy versus patients with lower health literacy. Interestingly, there was lower utilization of preventive medical health services, such as vaccinations and mammograms, for patients with inadequate health literacy (Scott et al. 2002).

While these previous findings suggest that more acute health care utilization and less preventive health care utilization may be associated with general health literacy, the association is not entirely consistent. Cho and colleagues (2008) found that hospitalization and emergency visits were not associated with health literacy. In summarizing the current findings, it is not possible to draw a conclusion whether the lack of association between dental utilization and OHL is due to the specificity in our measurement of utilization or an absence of

association, but similar studies in medicine seem to suggest that instrument specificity may be a factor.

Third, the lack of association between dental utilization and OHL may be a reflection of ineffective doctor-patient communication. In a national sample, 81% of pediatricians were aware of situations in the previous 12 mo wherein a parent had not sufficiently understood health information that had been delivered (Turner et al. 2009). In the same study, 44% of pediatricians were aware of a communication-related error in patient care within the previous 12 mo (Turner et al. 2009).

In combination with the literature on health literacy and the patient-provider interaction, the results of our study have real implications for interventions related to OHL. Our results suggest that interventions that accommodate for existing levels of OHL are preferred over interventions that seek to improve patients' OHL through the provider-patient interaction.

In the field of medicine, there have been successful interventions for communicating with patients with low general health literacy. Such patients had fewer hospitalizations after participating in a heart failure self-management program as compared with the usual care (DeWalt et al. 2006). Likewise, a health care provider–directed intervention increased colorectal cancer screening rates for men with low health literacy (Ferreira et al. 2005). The potential for improving doctor-patient communication, especially with patients who have low literacy skills, is also recognized by professional organizations such as the American Dental Association and the Institute of Medicine (Rozier et al. 2011; IOM 2013).

The results of our findings are generally consistent with previous work in health literacy. Race and education were strongly associated with OHL, reaffirming a previous report by Martin and colleagues (2009). However, our findings differ from previous medical studies wherein marital status was not associated with OHL. Martin and colleagues found that unmarried individuals were associated with lower health literacy, although the association was weak ($P < 0.05$). Despite being nonmodifiable, race, education, and marital status provide data for studying health-related knowledge, behaviors and practices, as well as for targeting interventions to individuals at risk for low OHL.

Limitations

The predictive model for OHL presented in this study is limited by the model's assumptions. Although the model had no strong evidence of multicollinearity, misspecification, or heteroskedasticity, these conclusions are limited by the sensitivity of the tools used to test these assumptions. It is possible that the model is subject to endogeneity, such as omitted variable bias.

The current study illustrates a pattern of association between dental utilization and OHL, which should be distinguished from causality. Due to the possibility of OHL's influencing dental utilization, there is a causal loop that cannot be disentangled from the inverse relationship. Despite the lack of causal implications, this investigation illustrates no significant pattern of association between dental utilization and OHL and thus is an important first step in unraveling the relationship between these integral concepts in a previously unstudied area.

Author Contributions

J.M. Burgette, contributed to analysis and interpretation, drafted and critically revised the manuscript; J.Y. Lee, contributed to conception, design, data acquisition, analysis, and interpretation, critically revised the manuscript; A.D. Baker, contributed to conception, design, and data acquisition, critically revised the manuscript; W.F. Vann Jr, contributed to conception, design, data analysis, and interpretation, critically revised the manuscript. All authors gave final approval and agree to be accountable for all aspects of the work.

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