Development and Testing of the Test of Functional Health Literacy in Dentistry (TOFHLiD)

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Abstract

Objective: *This study aims to evaluate the reliability and validity of the Test of Functional Health Literacy in Dentistry (TOFHLiD), a new instrument to measure functional oral health literacy.* ***Methods:*** *TOFHLiD uses text passages and prompts related to fluoride use and access to care to assess reading comprehension and numerical ability. Parents of pediatric dental patients (*n *= 102) were administered TOFHLiD, a medical literacy comprehension test (TOFHLA), and two word recognition tests [Rapid Estimate of Adult Literacy in Dentistry (REALD), Rapid Estimate of Adult Literacy in Medicine (REALM)]. This design provided assessments of dental and medical health literacy by all subjects, both measured with two different methods (reading/numeracy ability and word recognition). Construct validity of TOFHLiD was assessed by entering the correlation coefficients for all pairwise comparisons of literacy instruments into a multitrait-multimethod matrix. Internal reliability of TOFHLiD was assessed with Cronbach's alpha. Criterion-related predictive validity was tested by associations between the TOFHLiD scores and the three measures of oral health in multivariate regression analyses.* ***Results:*** *The correlation coefficient for TOFHLiD and REALD-99 scores (monotrait-heteromethod) was high (*r *= 0.82,* P *< 0.05). Coefficients between TOFHLiD and TOFHLA (heterotrait-monomethod:* r *= 0.52) and REALM (heterotrait-heteromethod:* r *= 0.53) were smaller than coefficients for convergent validity. Cronbach's alpha for TOFHLiD was 0.63. TOFHLiD was positively correlated with OHIP-14 (*P *< 0.05), but not with parent or child oral health. TOFHLA was not related to dental outcomes.* ***Conclusions:*** *TOFHLiD demonstrates good convergent validity but only moderate ability to discriminate between dental and medical health literacy. Its predictive validity is only partially established, and internal consistency just meets the threshold for acceptability. Results provide solid support for more research, but not widespread use in clinical or public health practice.*

Key Words: oral health literacy, pediatric dentistry, instrument validation, TOFHLiD, TOFHLA, REALD, REALM

Introduction

Recent research highlights the importance of general health literacy in patient compliance and positive health outcomes (1-3). Among patients with chronic medical disorders, those who exhibit the greatest understanding of information provided in the health care setting are more likely to adhere to instructions for home care, postoperative care, medication schedules, and follow-up visits. These improved health behaviors, in turn, affect their health status.

Extension of this broader concept of literacy to health care requires us to consider the types of information provided in specific health care settings and the actions expected of patients as a result of the exposure to this information. Individuals who seek health care must schedule appointments, complete insurance forms, give consent, explain their medical history, engage in problem solving, and follow instructions for diagnostic procedures, prevention, treatments, and follow-up care. Functional literacy also is context specific. An individual who is able to apply information from materials with familiar content can struggle to comprehend and use information in materials written at the same level of complexity but containing new concepts or unfamiliar vocabulary, a commonly encountered situation in health care settings (4).

Research in oral health literacy has not evolved beyond assessments of reading levels of educational materials and analogies between findings in the medical literature and their conceptual applications to dentistry (3). A number of publications hypothesize that low dental health literacy can serve as a barrier to the use of information and result in poor oral health outcomes, particularly when combined with other risk factors (3,5,6). Some of these publi-

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cations also call for literacy research in dentistry. Any research agenda in its initial stages of implementation requires that adequate methods of measurement be available for the condition of interest. Several instruments have been developed to measure the literacy skills of patients seeking medical care, but not for dental patients (5–7).

Our prior work in dental health literacy was directed toward the development of two dental word recognition instruments (8,9). That research identified the importance of considering dental literacy as a separate construct from general health literacy. It also led to an appreciation of the potential importance of functional literacy in dentistry that might not be fully captured by word recognition instruments. The purpose of this article is to report on the development and testing of an instrument designed to measure functional oral health literacy. To this aim, we examine the reliability (internal consistency) and validity (construct and criterion predictive validity) of the **T**est of **F**unctional **H**ealth **L**iteracy in **D**entistry (TOFHLiD).

Table 1
Characteristics of the Sample Used to Assess Reliability and Validity of an Oral Health Literacy Measure (TOFHLiD)

Characteristic		Number of respondents (%) (n = 102)
Gender	Male	12
	Female	88
Hispanic	Yes	11
	No	89
Race	White	64
	Black	20
	American Indian/Alaskan native	2
	Asian Indian	2
	Chinese	3
	Other	9
Primary language	English	84
	Other	16
Income	<$10,000	25
	$10,000-$29,999	10
	$30,000-$49,999	11
	$50,000-$69,000	18
	$70,000-$89,999	28
	>$90,000	7
Marital status	Married	66.6
	Separated	5
	Divorced	17.6
	Never married or single	7.8
	Living with partner	3
Relationship to child	Parent	95
	Grandparent	4
	Other	1
Median age	Parent	35 years, range 26 to 59
	Child	7 years, range 2 to 15
Parent's education	Did not finish high school	4
	High school diploma	18
	GED	3
	Some college	23.5
	College degree	29
	Postgraduate education	22.5

Methods

Overview. A total of 102 caregivers of pediatric dental patients seeking care at the University of North Carolina at Chapel Hill (UNC-CH) (88 percent) and the Orange County Health Department dental clinics (12 percent) completed an interview, in which we administered the TOFHLiD and other literacy assessments used to validate TOFHLiD. To be included in the study, the caregiver–child dyad had to include a child who was 15 years of age or younger and the parent had to speak English. Respondents were mostly female, married, parents of the child making the dental visit, well educated, frequent dental users, and spoke English as their primary language, but varied by race and income (Table 1). The interviews were conducted by two trained interviewers in quiet waiting areas or private consultation rooms. An average of 30 minutes was required to complete an interview.

Development of TOFHLiD. The Test of Functional Health Literacy in Adults (TOFHLA) served as a template for the development of TOFHLiD. TOFHLA consists of a 50-item reading comprehension test and a 17-item numerical ability test. For the reading comprehension section, respondents read and fill in missing words that have been selectively deleted from passages about instructions to prepare for an X-ray procedure, a Medicaid application, and a patient consent form. The numeracy section assesses one's ability to understand numbers found in directions for taking medicines, monitoring blood glucose, keeping scheduled appointments, and obtaining financial assistance.

A panel consisting of pediatric and public health dentists reviewed patient education and instructional materials used in the UNC-CH pediatric dental clinic and selected a sample from these materials for use in TOFHLiD. Like TOFHLA, the dental instrument contains reading comprehension and numeracy sections. The reading comprehension section for TOFHLiD consists of three passages about follow-up

instructions for a caregiver following the application of fluoride varnish to their child's teeth, consent for dental treatment, and a description of Medicaid rights and responsibilities. Similar to Parker and colleagues (6) we used a modified Cloze procedure (10,11) to convert these passages into tests of reading comprehension by omitting the fifth, sixth, or seventh word in a sentence. For each omitted word, we provided the correct word and three similar sounding words, from which respondents were asked to choose the word that would correctly complete the sentence. The Medicaid passage comes directly from the TOFHLA and is the only part of TOFHLiD not based on materials used in the UNC-CH clinics.

The numeracy section of the TOFHLiD has 12 questions related to four topics: instructions for fluoridated toothpaste use (five questions); a pediatric dental clinic appointment (three questions); bottle prescription labels for fluoride drops (two questions); and for fluoride tablets (two questions). As an example of its format and administration, we presented respondents with text that would appear on a label for a tube of fluoridated toothpaste or the box in which it is sold (Figure 1) and asked a series of questions. After they had read the label, the respondents were asked: a) the minimum number of times teeth should be brushed each day; b) if teeth should be brushed after breakfast; c) if a child $1\frac{1}{2}$ years of age should use this toothpaste; and d) the amount of toothpaste that should be used if a child is less than 6 years of age. The fifth item about toothpaste use displayed five pictures of toothbrushes with different amounts of toothpaste and asked respondents to select the one that matched the amount that should be used for a child younger than 6 years of age based on the instructions on the toothpaste label.

We selected written materials for constructing TOFHLiD that had reading levels similar to materials used for TOFHLA (Table 2). The Gunning Fox Index (12) was used to determine the reading levels for most of the selected passages (varnish passage = grade 7.0, consent for dental care passage = grade 14.0, Medicaid passage = grade 10.4, and toothpaste prompt = grade 9). This index, or other similar reading level indices, could not be used to calculate the reading level for the other two prompts (prescription labels and appointment card) because at least 100 words are needed in the paragraph to make this assessment.

A preliminary analysis of items in the numeracy section of TOFHLiD yielded low values for Cronbach's

Figure 1
Test of Functional Health Literacy in Dentistry toothpaste tube prompt

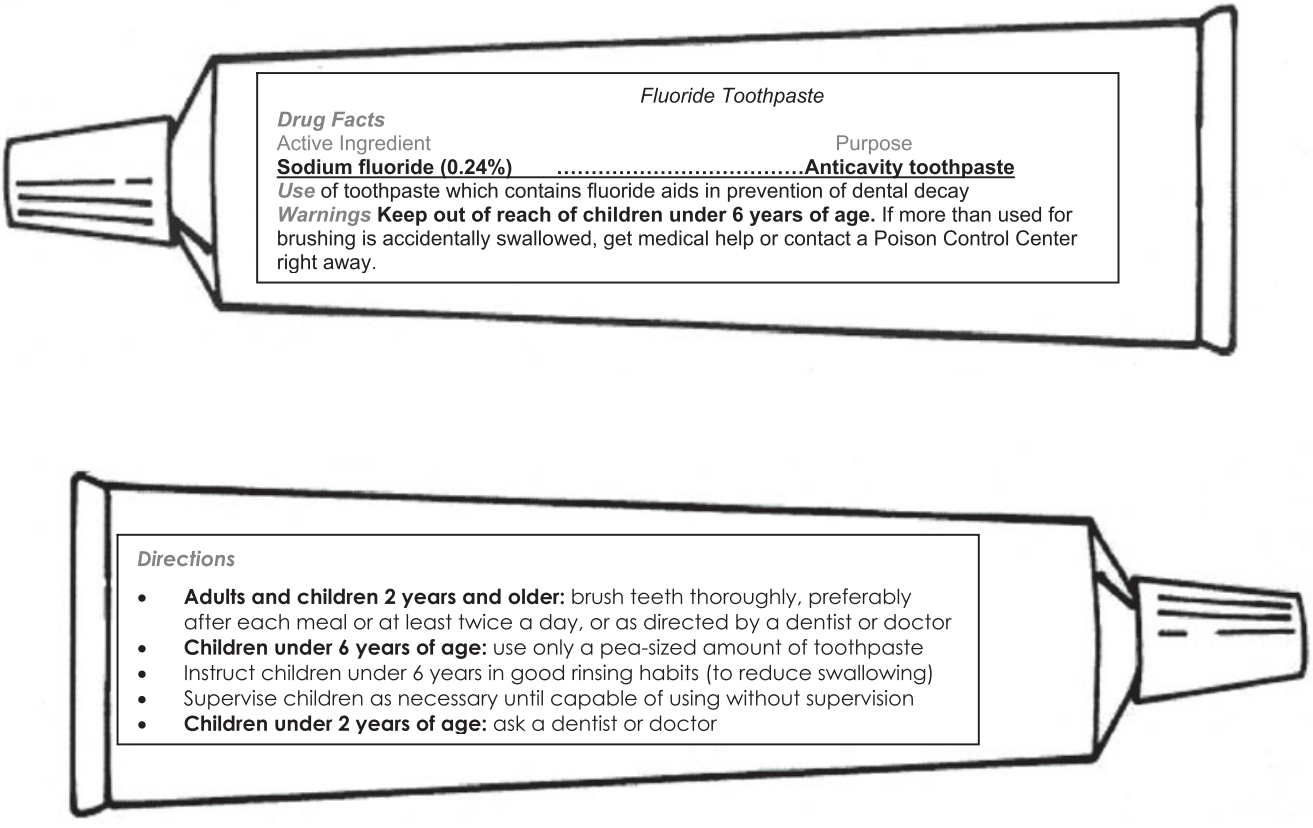

Table 2
Reading Level Using the Gunning Fox Index and Scoring Methods for Oral Health Literacy (TOFHLiD) and Medical Health Literacy (TOFHLA)

	TOFHLA		TOFHLiD	
Section	Number of items	Reading level grade	Number of items	Reading level grade
Reading comprehension				
Instructions	16	4.3	29	7.0
Consent form	14	19.5	19	17.0
Medicaid rights	20	10.4	20	10.4
Weights	1 (50/50)		1.04167 (48/50)	
Numeracy	17	9.4	12	11
Weights	N/A		6.25 (50/8)	

TOFHLiD, Test of Functional Health Literacy in Dentistry; TOFHLA, Test of Functional Health Literacy in Adults.
( ) = weighting.

alpha (overall = 0.38, toothpaste use = 0.58, appointment card instructions = 0.61, fluoride tablet or drop instructions = 0.21). Because of this low internal consistency among fluoride tablet/drop prescription items, they were eliminated from the final version of TOFHLiD that was validated in this study.

The final scoring for TOFHLiD as well as TOFHLA, presented for comparison purposes, are displayed in Table 2. Correct responses to items in the three reading comprehension passages of TOFHLiD were weighted to sum to a maximum score of 50, and the number of correct answers to the questions in the numeracy section also were weighted to obtain a maximum score of 50. These two component scores are summed, providing a possible overall score of 0 to 100, with the higher score representing better health literacy.

After the initial development of the instrument and Institutional Review Board approval, we pilot-tested the instrument using 17 interviews with subjects recruited from pediatric dental clinics. Results of the pilot test were used to refine the initial TOFHLiD and improve the data collection methods. We also used these interviews to standardize the interviewers, who had been trained by someone experienced in the use of TOFHLA. Subjects used in the pilot study are not included in the reported analysis.

Assessments of Validity and Reliability. Assessments of the performance of TOFHLiD were based on tests that examined the instrument's construct validity, criterion-related predictive validity, and internal reliability (or consistency).

Test of Construct Validity. To examine construct validity, caregivers in the study were administered three additional health literacy tests: the TOFHLA (6), the 66-item Rapid Estimate of Adult Literacy in Medicine (REALM) (7), and the 99-item Rapid Estimate of Adult Literacy in Dentistry (REALD-99) (9). REALM and REALD-99 are word recognition tests that assess medical and dental health literacy, respectively. The two tests require subjects to read aloud common medical and dental words that are arranged in order of increasing difficulty. Scoring is based on correct, dictionary-defined pronunciation. One point is assigned for each word pronounced correctly, and the total number of points represents the subject's overall performance on the test. Thus, the scores for REALM and REALD-99 can range from 0 to 66 or 99, respectively.

We examined construct validity of TOFHLiD using the multitrait-multimethod (MTMM) matrix put forth by Campbell and Fiske (13). The MTMM matrix is widely accepted in some social sciences as a method for evaluating convergent and discriminant validity among multiple instruments measuring the same or overlapping constructs (traits). In this approach, convergent validity is supported by large correlations between matching scales from different instruments and discriminant validity is supported when coefficients for convergent validity are larger than correlations among different scales using either the same or different measurement methods. To our knowledge, this method has not been used in dentistry, probably because it requires that each of at least two constructs be assessed by at least two methods on the same individual, a requirement that results in a high response burden for subjects.

As aforementioned, each subject in this study was tested with two instruments for measuring dental health literacy – TOFHLiD (the instrument to be validated) and REALD-99 – and two for medical health literacy – TOFHLA and REALM. According to the MTMM approach, all possible pairwise correlation coefficients are calculated for scores from the four instruments and compared using a 2 × 2 matrix. If TOFHLiD is valid, the "MTMM" correlation of TOFHLiD (a comprehension test of dental health literacy) with REALD-99 (a word recognition test of dental health literacy) should be statistically significant and stronger than the "MTMM" correlation between TOFHLiD and TOFHLA (a comprehension test of medical health literacy) and the "MTMM" correlation between TOFHLiD and REALM (a word recognition test of medical health literacy).

Test of Predictive Validity. The predictive validity of TOFHLiD was determined by testing three hypotheses based on the assumption that functional oral health literacy is associated with dental health outcomes independent of educational attainment and dental utilization (1,3,14,15). We reasoned that those who have higher oral health literacy levels are more likely to be compli-

ant, for example, with preventive recommendations such as suggested recall schedules and fluoride use for both themselves and their child than those with lower literacy levels and therefore will have better oral health. Thus, the following outcome measures were regressed on TOFHLiD scores in multivariate regression models as a test of predictive validity: a) participating caregivers' assessments of their own oral health-related quality of life (OHRQoL) (linear regression); b) caregivers' global ratings of their oral health (logistic regression); and c) caregivers' global ratings of the child's oral health status (logistic regression). Caregivers completed the short-form Oral Health Impact Profile (OHIP-14) (16) to provide a measure of the impact of their dental disease on their OHRQoL. The OHIP-14 consists of 14 items with scores ranging from 0 to 14, with a higher score indicating worse OHRQoL. Perceptions of oral health status were measured by queries of "How would you describe the condition of your [your child's] teeth?", with response options being "Excellent," "Very good," "Good," "Fair," "Poor," or "Don't know" (17).

Questions in the interview also provided control variables for the regression analyses. They included parents' use of dental services, educational attainment, and a number of sociodemographic characteristics (age of parent and child, sex, race, ethnicity, marital status, primary language, and annual family income). We also analyzed the association of TOFHLA and the three dental outcomes, assuming that we would not find an association because we hypothesize that health literacy in medicine and dentistry are not identical constructs.

To address issues related to the small sample size, response categories for each of the two oral health status perception questions were combined to yield a dichotomous variable that compared responses of "Excellent," "Very good," and "Good" with "Fair" and "Poor" in the logistic regression models. Overall OHIP-14 scores were calculated by summing the number of responses for which the respondent indicated that they had experienced discomfort or difficulty "fairly often" or "often" on each item, and tested in an ordinary least squares regression model. All control variables were included in regression models as binary variables except the ages of the parent and child, which were included as linear measures.

Test of Internal Reliability. Internal reliability of TOFHLiD was determined using Cronbach's alpha (18) and evaluated according to published guidelines (19,20). Alpha values for TOFHLiD and those for the other three literacy instruments were entered into the MTMM matrix as "reliability diagonals" for comparison with coefficients used to determine construct validity.

Results

Descriptive Results. Because the same passage about Medicaid rights is used in the medical and dental instruments, we calculated a weighted TOFHLiD score that excluded the Medicaid section and used only the first two passages. Convergent validity was almost identical for TOFHLiD with (r = 0.82) and without (r = 0.79) the passage. Heterotrait-monomethod correlation coefficients (0.52 versus 0.49) and heterotrait-heteromethod coefficients (0.53 versus 0.54) likewise were very similar. Because of these findings, the Medicaid passage was included in all analyses for this paper.

Table 3 displays descriptive information for the four health literacy instruments included in this study. Mean scores suggest a high level of medical and dental literacy. Scores resulting from the dental instruments are larger than those from the medical instruments, particularly on the numeracy sections of the functional literacy instruments and for the word recognition tests.

Construct Validity of TOFHLiD

Convergent validity. Convergent validity is established by an MTMM matrix when different measures of the same construct (monotrait-heteromethod) are highly correlated. We found TOFHLiD and REALD-99 scores, our two measures of oral health literacy, to be highly correlated (r = 0.82) and significantly different from 0 ($P < 0.05$) (Table 4).

Discriminant Validity. Discriminant validity is inferred by a relatively small correlation between different traits, either measured by the same method (i.e., TOFHLiD and TOFHLA scores) or different methods (i.e., correlation of TOFHLiD and REALM scores). As expected, correlation coefficients between TOFHLiD scores and either TOFHLA (r = 0.52, $P < 0.05$) or REALM scores (r = 0.53, $P < 0.05$) were statistically

Table 3
Descriptive Information for Dental and Medical Literacy Instruments (n = 102)

Measure	Mean	SD	Min	Max
Dental health literacy				
TOFHLiD				
Total	93.7	5.0	77	100
Reading comprehension section	47.2	2.5	36	50
Numeracy section	44.9	5.4	31	50
REALD-99	83.4	12.3	36	99
Medical health literacy				
TOFHLA				
Total	87.5	7.0	68	100
Reading comprehension section	48.8	1.6	42	50
Numeracy section	38.5	6.3	20	50
REALM	62.3	5.9	22	66

TOFHLiD, Test of Functional Health Literacy in Dentistry; TOFHLA, Test of Functional Health Literacy in Adults; REALD, Rapid Estimate of Adult Literacy in Dentistry; REALM, Rapid Estimate of Adult Literacy in Medicine.

different from 0, but were smaller than the coefficients for convergent validity (Table 4).

Predictive Criterion-Related Validity of TOFHLiD. For the outcome variables, 63 percent of parents reported their own dental health as good or better. Nearly 80 percent of parents reported their children's dental health to be good or better. The average OHIP-14 score was 4.1 [standard deviation (SD) = ±4.4; min = 0, max = 14].

TOFHLiD scores were associated with the child's oral health status and the caregivers' OHIP-14 scores ($P < 0.05$) in bivariate analyses, but not the oral health status of the caregiver. In the three regression models, TOFHLiD was associated with OHIP-14, but not with child or caregiver oral health status (Table 5). This relationship between TOFHLiD and OHIP-14 was independent of caregiver dental use and education. TOFHLA scores were not associated with any of the three dental outcomes ($P > 0.10$) in bivariate or multivariate analyses (results not shown).

Reliability of TOFHLiD (Internal Consistency). Cronbach's alphas for overall scores for all the health literacy instruments are displayed in the diagonal of Table 4. Cronbach's alpha for the overall TOFHLiD score was 0.63. The reading comprehension and numeracy sections produced alphas of 0.65 and 0.59, respectively.

Table 4
Multitrait-Multimethod Matrix Comparing Correlations Coefficients for Reading and Numeracy Comprehension (TOFHLiD and TOFHLA) and Word Recognition (READLD-99 and REALM)

		Reading/Numeracy		Word recognition	
Trait		TOFHLiD	TOFHLA	READLD-99	REALM
Reading and numeracy	TOFHLiD	0.**63**			
	TOFHLA	[0.52]	0.**67**		
Word recognition	READLD-99	*0.82*	{0.39}	**0.86**	
	REALM	{0.53}	*0.82*	[0.79]	0.**92**

Bold, monotrait-monomethod (reliability diagonal), i.e., internal consistency of items; Italics, monotrait-heteromethod (validity diagonal), i.e., convergent validity; [], heterotrait-monomethod, i.e., discriminant validity; {}, heterotrait-heteromethod, i.e., discriminant validity; TOFHLiD, Test of Functional Health Literacy in Dentistry; TOFHLA, Test of Functional Health Literacy in Adults; READLD, Rapid Estimate of Adult Literacy in Dentistry; REALM, Rapid Estimate of Adult Literacy in Medicine.
Values in the reliability diagonal are Cronbach's alpha. All other values are Spearman's pairwise correlation coefficients, which are all statistically significant at $P < 0.05$.

Discussion

The purpose of this study was to develop an instrument to assess functional oral health literacy and to test its reliability and validity. Our primary approach to the assessment of the resulting instrument's performance was through the use of an MTMM matrix. With only a few exceptions, the results fit the pattern expected for the relative strength of coefficients displayed in the matrix. Thus results of this preliminary study suggest that the TOFHLiD demonstrates acceptable reliability and validity. However, further research is needed to understand its performance with regard to discriminant and predictive validity and to improve on its reliability.

Table 5
Multivariate Regression Results for Oral Health Literacy (TOFHLiD) and Dental Outcomes (n = 102)

Outcome measure	OHIP-14	Parental oral health status	Child oral health status
Oral health literacy measure			
TOFHLiD Score	−0.50** (0.029)	−0.0021 (0.075)	−0.47 (0.21)
Control variables			
Dental use in past year (yes versus no)	0.75 (1.07)	−0.14 (0.79)	−0.31 (0.61)
Parent's education (GED or less versus ≥ some college)	−2.18* (0.98)	−1.47** (0.75)	−0.89 (0.63)
Parent's gender (male versus female)	2.13* (1.25)	0.21 (0.80)	1.42* (0.76)
Hispanic (yes versus no)	−2.10** (0.98)	−0.94 (0.99)	0.34 (0.79)
Race (White versus other)	1.73** (0.69)	2.01**	−0.16 (0.54)
Parent's age	0.72 (0.67)	0.69 (0.55)	0.57 (0.42)
Child's age	0.92 (0.54)	0.88 (0.49)	1.94** (0.23)
Primary language (English versus other)	−1.45 (1.26)	−1.83 (1.22)	−0.21 (0.69)
Income (≤$49,000 versus >$49,000)	0.44 (1.03)	0.82 (0.69)	0.88 (0.56)
Marital status (married versus not married)	0.64 (0.98)	0.22 (0.79)	−0.017 (0.55)
Constant	−2.37 (9.84)	3.76 (7.59)	0.68 (5.65)

* Significance at $P < 0.10$ level; ** Significance at $P < 0.05$ level.
Standard errors are in parentheses.
TOFHLiD, Test of Functional Health Literacy in Dentistry.

The correlation coefficient for TOFHLiD and REALD-99 was 0.82, providing strong evidence of convergent validity for TOFHLiD. Results for discriminant validity are less straightforward than for convergent validity. According to principles for interpreting the MTMM, a conclu-sion that TOFHLiD has discriminant validity requires that correlation co-efficients for both the heterotrait-monomethod (i.e., correlation of TOFHLiD and TOFHLA scores) and the heterotrait-heteromethod (i.e., correlation of TOFHLiD and REALM scores) be smaller than those derived from the monotrait-heteromethod used to evaluate convergent validity (i.e., correlation of TOFHLiD and REALD-99 scores). Because TOFHLiD and TOFHLA scores share the same method of measurement, they might still be strongly correlated, but the correlation of TOFHLiD and REALM scores should yield the lowest values of all the correlations in the matrix because they sup-posedly share neither the construct nor the method.

Compared to the correlation between TOFHLiD and REALD-99, correlations coefficients between TOFHLiD scores and TOFHLA (r = 0.52, $P < 0.05$) or REALM scores (r = 0.53, $P < 0.05$) were smaller, but they were similar in value and both significantly different from 0. Therefore, TOFHLiD displayed only moderate ability to discriminate between dental and medical literacy, suggesting that either the scales overlap because of similar methods, trait covariance, or some combination of both or that TOFHLiD is not sensitive enough to substantially differentiate between them if they are in fact separate constructs. Based on our results, we believe that functional dental and medical literacy are correlated. However, the correlation may not be sufficiently strong enough to recommend the use of one of the existing medical literacy instruments in studies involving dental health literacy. We also conclude that this study provides evidence that TOFHLiD has sufficient discriminant power to justify further exploration.

We reached these conclusions based on several observations. First, the modest methods effect found in heterotrait-monomethod correlation coefficients was expected because TOFHLiD was constructed with similar sections for reading comprehension and numerical abilities, and using prompts with reading levels similar to those used in TOFHLA. Second, REALM, which was used to provide heterotrait-heteromethod coefficients, assumes a strong correlation between word recognition and reading ability, again providing the possibility of a strong method effect because of the overlap of reading skills required of the two instruments. Third, the pattern of coefficients for TOFHLA in the MTMM matrix was almost identical to that for TOFHLiD, suggesting not only that the two scales overlap but that they have similar construct validity in the sample used in this study. Finally, the results of our predictive validity assessment, discussed in the next paragraph, support the independent nature of dental and medical literacy. We found that TOFHLA was not associated with any of the three oral health outcomes, while TOFHLiD was associated with one of these outcomes.

Predictive validity for TOFHLiD was only partially supported by our results. Parents' perceptions of their own dental health and that of their children were not associated with dental health literacy in multivariable analyses. We do not know if these findings mean that TOFHLiD does not have predictive validity or if there is no causal association between dental literacy and perceptions of oral health status. It also is important to note that the distribution of dental health status responses were skewed toward healthy reports and may not have contained enough variation to detect a difference. We chose to use these global measures of oral health because studies of both adults' assessments of their own health status and that of their children generally find that global ratings are associated with the presence of dental disease (21,22) and existing frameworks would suggest such a relationship. However, the literature lacks evidence on the association between dental health literacy and self-reported oral health status because it has not been tested.

We found oral health literacy levels of caregivers to be correlated with their self-reported impacts of dental disease, thus confirming one of the hypotheses used to test for predictive validity. As a measure of OHRQoL, OHIP-14 ratings are thought to be affected by a number of factors including disease, health, personal characteristics, and the environment in which one lives (23). Health perceptions such as our global measures of oral health are but one domain of the several possible determinants of OHRQoL. Thus OHIP-14 might be a better variable for testing predictive validity because it includes more factors that might be influenced by dental health literacy.

Estimates in the reliability diagonal should consistently be the highest in the matrix because a scale should be more highly correlated with itself than anything else. We found Cronbach's alpha to be 0.63 for TOFHLiD, only slightly larger than the heterotrait-monomethod coefficient of 0.52 and less than the monotrait-heteromethod coefficient of 0.82. However an alpha value of 0.60 is considered to be minimally acceptable (20), and it was almost identical to the value of 0.67 found for TOFHLA.

We removed the fluoride prescription segment of the numeracy section because of its low reliability. Although this strategy improves the reliability of the overall instrument, it might reduce its validity. It is possible that prescription labels do not provide useful assessments of numeracy skills even though they provide critical information that allows the patient to achieve the correct dosage at the frequency and methods that will be most effective. In a recent study to develop a quick assessment of functional health literacy, Weiss and colleagues (24) used a prescription label prompt along

with a consent form, self-care instructions, nutrition label, and instructions for medications. Of the five, the nutrition prompt was the most effective in identifying low literacy, and it was the one that required the most complex numeracy skills.

In summary, our conclusions are that TOFHLiD demonstrates good convergent validity but only moderate ability to discriminate between dental and medical health literacy. Its predictive validity is not fully established in this study, and the value for Cronbach's alpha is at the lower range of values needed to demonstrate acceptable internal consistency. These results do not support the widespread use of TOFHLiD in clinical or public health practice, but do provide a solid foundation for more research.

Future work with this oral health literacy instrument should include further conceptual development to guide selection of test materials, an assessment of test–retest reliability, and further testing of TOFHLiD's discriminant validity. We recommend four primary strategies to pursue research that will provide additional insights into how well TOFHLiD does and can perform. First, its discriminant validity should be tested by including a trait more dissimilar than the medical literacy used in this study and whose measurement does not rely as much on similar methods. Second, any such testing should include more prompts that would allow the testing of a larger number of skills required in dentistry than were tested in this study. The literacy skills needed in the dental environment should be more clearly identified before additional prompts are selected for testing, particularly for skills in dealing with numbers. Of course, testing in a larger and more diverse population that includes a larger sample of respondents who are not regular users of dental care would subject TOFHLiD to a more thorough test of its reliability and validity. The restricted range of TOFHLiD scores recorded for this sample made the interpretation of results in which predictive validity was assessed difficult to interpret. Finally, causal models need to be established so that predictive validity of this or other new dental literacy instruments can be tested adequately.

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