

## Development and validation of a short form of the BOHLAT-P

Ramon Targino FIRMINO<sup>(a)</sup> 

Ana Flávia GRANVILLE-GARCIA<sup>(b)</sup> 

Cristiane Baccin BENDO<sup>(a)</sup> 

Fernanda Morais FERREIRA<sup>(a)</sup> 

Fernanda Ruffo ORTIZ<sup>(a)</sup> 

Colman Patrick MCGRATH<sup>(c)</sup> 

Saul Martins PAIVA<sup>(a)</sup> 

<sup>(a)</sup>Universidade Federal de Minas Gerais – UFMG, School of Dentistry, Department of Child and Adolescent Health, Belo Horizonte, MG, Brazil.

<sup>(b)</sup>Universidade Estadual da Paraíba, Department of Dentistry, Campina Grande, PB, Brazil.

<sup>(c)</sup>University of Hong Kong, School of Dentistry, Department of Dental Public Health, Hong Kong, China.

**Declaration of Interests:** The authors certify that they have no commercial or associative interest that represents a conflict of interest in connection with the manuscript.

### Corresponding Author:

Ramon Targino Firmino  
E-mail: ramontargino@gmail.com

**Abstract:** The authors developed and validated a short form of the Brazilian Oral Health Literacy Assessment Task for Paediatric Dentistry (BOHLAT-P). Data included responses from 200 parents of preschoolers to sociodemographic and oral health service access questions on the BOHLAT-P, the Brazilian Rapid Estimate of Adult Literacy in Dentistry (BREALD-30), and the Brazilian Early Childhood Oral Health Impact Scale (B-ECOHIS). Data on the preschoolers' dental caries experience (ICDAS-II) were also included. An item response theory-based approach was employed to develop the short form, while confirmatory factor analysis evaluated the instrument dimensionality. The validity and reliability of the short form were tested by statistical analysis using BREALD-30, B-ECOHIS, and sociodemographic and dental caries experience data. The short form (BOHLAT-P-30) comprises 30 items, is unidimensional, and presents better model fit estimates (TLI = 0.94; CFI = 0.94; RMSEA = 0.05) than those of the BOHLAT-P. Moreover, BOHLAT-P-30 demonstrated excellent reliability (Cronbach's alpha = 0.91; intraclass correlation coefficient [ICC] = 0.95). BOHLAT-P-30 scores were positively correlated with BREALD-30 scores ( $r = 0.71$ ), with the number of years of schooling ( $r = 0.60$ ), and with the number of hours spent reading ( $r = 0.33$ ). BOHLAT-P-30 scores were negatively correlated with B-ECOHIS scores ( $r = -0.21$ ), and with the number of teeth with cavitated caries ( $r = -0.18$ ). After controlling for confounding factors, BOHLAT-P-30 scores were not found to be associated with caries presence, or with the number of teeth with cavitated caries. The BOHLAT-P-30 had properties similar to those of the BOHLAT-P, and proved to be a valid measure to assess the OHL of Brazilian parents.

**Keywords:** Dental Caries; Quality of Life; Validation Study.

## Introduction

Oral health literacy (OHL) is recognized as one the most important determinants of oral health.<sup>1</sup> Theoretical models have acknowledged the role of low OHL in influencing an individual's oral health behaviors, and in increasing susceptibility to negative oral health outcomes.<sup>2</sup> Indeed, studies have associated limited OHL with low oral health knowledge,<sup>3</sup> poor ability to understand oral health information,<sup>4</sup> negative oral health behavior,<sup>5</sup> low user of oral health services,<sup>6,7</sup> and worse oral health condition.<sup>8,9</sup> Moreover,

<https://doi.org/10.1590/1807-3107bor-2022.vol36.0074>

Submitted: December 9, 2019  
Accepted for publication: January 27, 2021  
Last revision: April 21, 2021



low parental OHL has also been associated with worse oral health outcomes in related children.<sup>10</sup>

Most of the information concerning OHL stems from studies conducted in the United States, which evaluated OHL through word recognition instruments.<sup>3-6</sup> In these instruments, OHL is measured by the ability of subjects to correctly pronounce dental words. Although these instruments are practical and easy to apply, they only investigate the surface of this construct, and fail to measure other important aspects of OHL, such as reading comprehension, numeracy, and oral health knowledge.<sup>11</sup> These skills are more closely related to how individuals function in the oral health care environment,<sup>12</sup> and knowledge of these skills can contribute to a more in-depth understanding of the topic, and improve the communication between dentists and their patients.

OHL measurement is a pivotal step toward improving oral health and reducing oral health disparities.<sup>13</sup> However, little is known of the OHL of Portuguese-speaking populations. This scenario is a likely consequence of the reduced number of instruments that are available to research these subjects, and the only recently performed validation of these research instruments. The Brazilian version of the Rapid Estimate of Adult Literacy in Dentistry (BREALD-30), and the Rapid Estimate of Adult Literacy and Medicine (REALMD-20) are word recognition instruments.<sup>14,15</sup> The Brazilian Oral Health Literacy Assessment Task for Paediatric Dentistry (BOHLAT-P)<sup>16</sup> deserves special attention, since it was specifically designed to assess the OHL of adults in the context of pediatric dentistry.<sup>17</sup>

The BOHLAT-P evaluates three aspects of OHL, and has been found to have excellent psychometric properties, and be a valid and reliable instrument.<sup>16</sup> However, the length of the instrument (49 items) is considered its main limitation. Long instruments are considered difficult to administer in clinical settings, and to use in large epidemiological surveys, since they are time-consuming.<sup>18</sup> In contrast, short forms of instruments provide greater applicability of the measures, in a shorter time, and at lower costs and losses during data collection.<sup>19</sup> In this respect, the aim of the present study was to develop and validate a short form of the BOHLAT-P.

## Methodology

Data for the present study originated from a previous investigation that performed the validation of the HKORLAT-P instrument for the Brazilian Portuguese language.<sup>16</sup>

### Ethical statement

This study was conducted according to the Declaration of Helsinki, and was approved by the human research ethics committee (Protocol #59123316.1.0000.5149). The subjects were informed of the study goals before the study began, and signed an informed consent form.

### Study participants

The sample comprised preschool children aged 3–5 years and their parents/caregivers. Sample size was determined based on a correlation coefficient of 0.20 between the BREALD-30 and BOHLAT-P, an alpha of 0.05, and a test power of 80%, which resulted in a minimum sample size of 194.<sup>20</sup> Children enrolled in public or private preschools from Campina Grande, PB, Brazil, were eligible to participate. Parents younger than 18 years old, illiterate, whose first language was not Brazilian Portuguese and who had trouble expressing themselves, or who were intoxicated by drugs during the interview, were excluded from the study.<sup>14</sup> A non-probabilistic sampling method was employed to invite 243 pairs of preschoolers and their parents/caregivers to the study. A total of 200 pairs of preschoolers and their parents/caregivers participated in all stages of the investigation, and were included in the study ( $n = 200$ ) (response rate: 82.3%). A pilot study to test the methodology was conducted with 40 preschoolers and their parents prior to data collection. Participants of the pilot study were not included in the validation study.

### Study measures

Parents/caregivers received a set of questionnaires to be answered at home, and were instructed that the primary caregiver should answer all the questionnaires individually. The same person who answered the research questionnaires also underwent an interview. Clinical exams were also conducted to diagnose the dental caries in children.

### Demographic information and child dental experience

Information on years of education, monthly family income, reading habits, and the child's dental experience was also collected.

### BOHLAT-P

The BOHLAT-P has demonstrated consistent psychometric properties<sup>16</sup>. The instrument comprises 49 items that evaluate the OHL level of adults concerning pediatric dentistry, by testing the respondents' oral health knowledge, literacy and numeracy skills in three sections. The first one assesses oral health knowledge by asking respondents to indicate the names of structures pointed out in images of the oral cavity. The second section is a numeracy test divided into four groups of questions (clinical appointment card, two prescription labels, post-operative instructions, and a toothpaste tube). The third section is a comprehension test comprised of a conversation with parts left in blank, to be completed according to the provided optional responses, and a tooth-brushing guide with scattered instructions to be rearranged in the correct order. The total score ranges from 0 to 49 points, with higher scores indicating higher OHL. All respondents completed the instrument a second time 15 days after the first, in order to evaluate the test-retest reliability.

### The Brazilian version of the Rapid Estimate of Adult Literacy in Dentistry (BREALD-30)

The BREALD-30 is a list of 30 oral health-related words that were ordered according to how difficult they were to read. Individual interviews were conducted in a quiet, separate room at each preschool, where the primary parent/caregiver read the oral health-related word list aloud. A calibrated researcher (Kappa = 0.97-0.99) gave a score of one point for each correctly pronounced word, yielding a final score ranging from 0 to 30, with higher scores denoting higher OHL.

### The Brazilian version of the Early Childhood Oral Health Impact Scale (B-ECOHIS)

The B-ECOHIS is a 13-item questionnaire that addresses the impact of oral health problems on the quality of life of children and their families,

according to a parental report.<sup>21,22</sup> It is divided into two sections encompassing a total of six domains. The response options are: 0 = never, 1 = hardly ever, 2 = occasionally, 3 = often, 4 = very often, and 5 = don't know. Higher B-ECOHIS scores indicate a more negative impact of oral conditions on the oral health-related quality of life (OHRQoL).

### Dental caries

All children underwent a clinical examination to diagnose dental caries according to the ICDAS-II criteria.<sup>23</sup> Clinical examinations were performed at preschools by a calibrated examiner (Kappa = 0.83-0.99). Oral examinations were carried out after tooth brushing by the examiner, equipped with a portable lamp positioned on the examiner's head (Petzl Zoom headlamp, Petzl America, Clearfield, UT, USA). The parents/caregivers of children with dental caries or other dental needs were advised to seek dental treatment.

### Data analysis

#### Item reduction methods

An Item Response Theory (IRT)-based approach was employed to devise a potential subset of questions that could adequately capture the construct addressed in the BOHLAT-P, without compromising its psychometric properties.<sup>24,25</sup> A two-parameter logistic model of the BOHLAT-P was used as a reference for item reduction. The goodness of fit of the model was evaluated by the following statistical parameters: Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Error of Approximation (SRMSEA), Akaike Information Criterion (AIC), Akaike Information Criterion corrected for small sample sizes (AICc), Sample Size-Adjusted Bayesian Information Criterion (SABIC), and Bayesian Information Criteria (BIC). An excellent model fit is indicated by the CFI and TLI values  $\geq 0.95$ , considering that values between 0.90 and 0.95 characterize an acceptable model fit. RMSEA and SRMSEA values lower than or equal to 0.06 indicate excellent fit, considering that an acceptable model fit is thus considered when the values are between 0.06 and 0.08. Furthermore, smaller AIC, AICc, SABIC, and BIC values indicate better adjustment.<sup>25,26</sup>

Item characteristic curves were plotted for each of the 49 items, to display the relationship between the probability of the item response and the underlying construct being measured. Item characteristic curves are a useful method to evaluate the amount of information captured by each item of a questionnaire. A greater area under the curve indicates that a greater amount of information was captured by the item<sup>25</sup>. Item discrimination parameters (*a* parameters), and item severity parameters (*b* parameters) for all individual items were obtained. Higher values indicate that an item is more difficult and/or more sensitive to discriminate, respectively, among respondents.<sup>25</sup> A group of researchers with experience in the development and validation of research instruments offered a shared judgment, based on the amount of information provided by each item (item characteristic curves), and on item difficulty and discriminant parameters, in order to decide what items would be removed from the instrument. An attempt was made to maintain items with different levels of difficulty and discriminant ability. Moreover, the authors strove to retain items that measured all three aspects of OHL, as designated in the original instrument (oral health knowledge, reading comprehension, and numeracy). IRT models, item characteristic curves, and item discrimination and difficulty parameters were estimated using R Software (version 3.5.0, R Development Foundation for Statistical Computing: Vienna, Austria).

The unidimensionality of the instrument<sup>16</sup> was confirmed by evaluating the factorial structure of the BOHLAT-P short form using the Confirmatory Factor Analysis (CFA). CFA was performed using the Mplus program (version 8.2, Muthén & Muthén: Los Angeles, USA). The following indices were applied to assess model fit:  $\chi^2$ , degrees of freedom (df), CFI, TLI, and RMSEA.<sup>26</sup> Lower  $\chi^2$  and df values indicate a better statistical adjustment.<sup>26</sup> CFA was performed for both the original and the short forms, to compare the model fit estimates.

The analyses of the psychometric properties (validity and reliability) for the short form were conducted using SPSS software (SPSS for Windows, version 25.0, IBM, Armonk, USA). The reliability of the new version was measured using internal consistency (Cronbach's alpha) and test-retest reliability (intraclass

correlation coefficients [ICC]); the resulting values of  $\geq 0.70$  were found to be acceptable.<sup>27</sup>

Convergent validity was evaluated by correlating the BREALD-30 scores with the short BOHLAT-P scores (Spearman's correlation test), while the Mann-Whitney test was used to determine discriminant validity by comparing the scores between children with dental caries (ICDAS  $\geq 2$ ), and those without (ICDAS  $< 2$ ), on the short form of the BOHLAT-P. Spearman's correlation test evaluated concurrent validity by testing the hypothesis that the BOHLAT-P short form scores would be positively correlated with the number of hours spent in reading activities, and with the number of years of schooling. Predictive validity was investigated using Spearman's correlation coefficient, and it was posited that the BOHLAT-P short form scores would negatively correlate with the B-ECOHIS scores. Four multivariate Poisson regression models were built, each with BREALD-30 scores, B-ECOHIS scores, dental caries and the number of teeth with cavitated caries as dependent variables. The independent variables were the BOHLAT-P short form scores, monthly family income, and years of schooling.

## Results

### IRT analysis

Item discrimination parameters (*a*) ranged from -0.104 to 4.379. The most highly discriminative items were Q26 (*a* = 4.379), Q29 (*a* = 3.723), and Q25 (*a* = 3.252), in Part III of the instrument, and assessed reading comprehension skills. The least discriminating items were Q37 (*a* = -0.104), Q32 (*a* = 0.139) and Q44 (*a* = 0.439). Q32 was in Part II, while the remaining items were in Part III, and assessed reading comprehension and oral health knowledge. Item difficulty parameters (*b*) ranged from -17.629 to 2.659. The most difficult items were Q41 (*b* = 2.659), Q37 (*b* = 2.518), and Q39 (*b* = 0.911), which are in Part III of the instrument, and which mainly evaluated oral health knowledge. The least difficult items were Q32 (*b* = -17.629), Q21 (*b* = -2.273), and Q19 (*b* = -2.253), which were in Part II of the instrument, and primarily measured reading comprehension. The discriminant and difficulty parameters of all 49 items of the BOHLAT-P are presented in Table 1.

**Table 1.** Item discrimination (a) and severity (b) parameter estimates of the Brazilian Oral Health Literacy Assessment Task for Paediatric Dentistry (BOHLAT-P).

Item	Item parameters	
	a	b
Part I		
Q1	1.866	-0.796
Q2	1.922	-0.275
Q3	2.085	-0.684
Q4	0.990	-1.814
Q5	1.678	0.084
Q6	2.063	-0.267
Q7	2.343	-0.884
Q8	2.401	-0.462
Q9	0.778	-0.354
Q10	2.338	-1.650
Q11	1.680	-0.183
Q12	1.586	-2.049
Part II		
Q13	1.901	-1.192
Q14	1.538	-1.185
Q15	2.209	-1.610
Q16	2.301	-1.455
Q17	3.131	-1.752
Q18	1.175	-1.757
Q19	1.607	-2.253
Q20	1.361	-1.505
Q21	1.381	-2.273
Q22	2.408	-1.562
Q23	1.648	0.049
Q24	1.718	-1.171
Q25	3.252	-1.350
Q26	4.379	-1.572
Q27	2.240	-1.841
Q28	2.692	-1.692
Q29	3.723	-1.502
Q30	1.072	-2.174
Q31	2.314	-1.516
Q32	0.139	-17.629
Q33	0.624	-1.686

Continue

Continuation

Q34	1.852	-1.060
Q35	2.162	-1.457
Q36	1.045	-1.018
Part III		
Q37	-0.104	2.518
Q38	1.455	-0.993
Q39	1.125	0.911
Q40	1.553	0.466
Q41	0.489	2.659
Q42	1.816	-0.533
Q43	0.979	-1.909
Q44	0.439	0.525
Q45	1.530	0.867
Q46	1.544	-1.182
Q47	1.329	-0.166
Q48	0.891	0.102
Q49	0.911	-0.915

As illustrated by the item characteristic curves in Figure, wide-range variation existed in the amount of information provided by each item of the BOHLAT-P. Notably, items Q26, Q29, and Q25 offered greater information. These items were in Part II, and addressed reading comprehension. Conversely, Q32, Q33, and Q37 exhibited the flattest curves, implying a low level of information. These items evaluated reading comprehension (Q32, Q33) and oral health knowledge (Q37), and were in Parts II and III.

Nineteen items were excluded from the instrument: five items in Part I (Q2, Q4, Q5, Q9, and Q12), six in Part II (Q14, Q21, Q26, Q30, Q32, and Q33) and eight in Part III (Q37, Q41, Q43, Q44, Q46, Q47, Q48, and Q49). The new proposed version of the instrument has 30 items and was named the short form of the Brazilian Oral Health Literacy Assessment Test for Paediatric Dentistry (BOHLAT-P-30). Table 2 presents the IRT model fit parameters of the BOHLAT-P and the BOHLAT-P-30. The short form presented improved model adjustment over the original instrument.

### CFA

The unidimensionality of the BOHLAT-P-30 was confirmed by CFA. An error covariance between Q15 and Q16 was added to improve the overall model fit. The goodness of fit statistics were  $\chi^2 = 609.66$ , degrees of freedom (df) = 404, CFI = 0.94, TLI = 0.94, and RMSEA = 0.05. The authors also performed CFA for the BOHLAT-P, to compare model fit estimates between both versions. The goodness of fit statistics of the BOHLAT-P were  $\chi^2 = 1540.32$ , df = 1124, CFI = 0.92, TLI = 0.92, and RMSEA = 0.04. All the model fit estimates for both the original and the short forms are shown in Table 2. The short

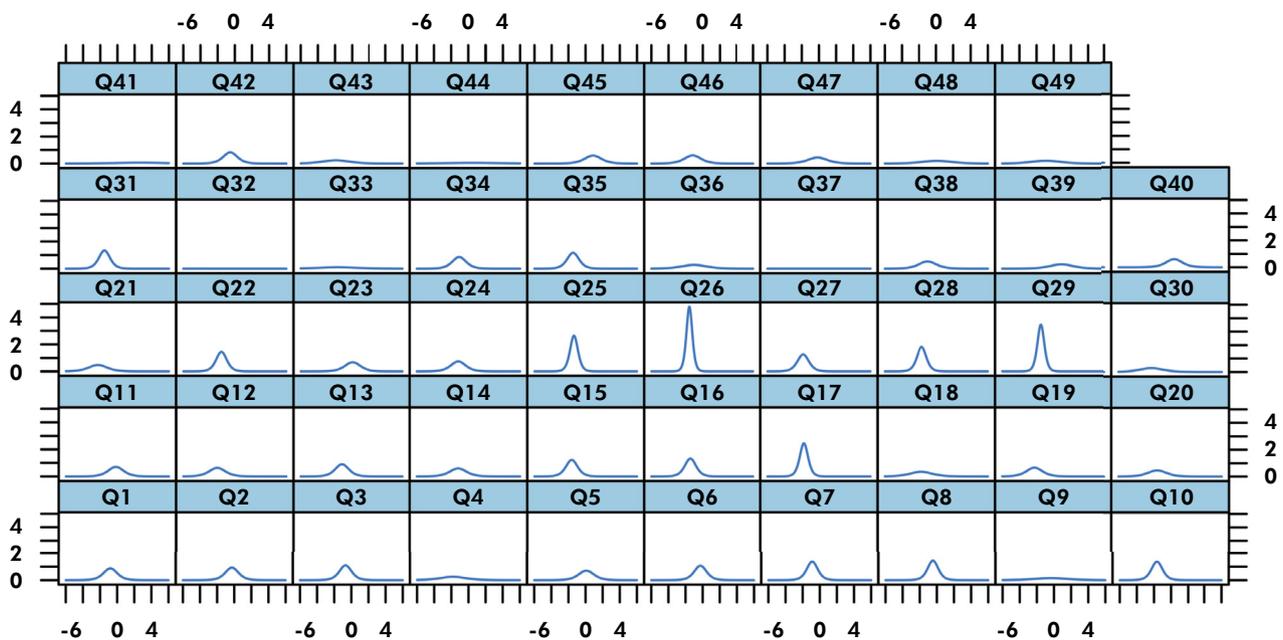
form presented better model adjustment than the original version.

### Reliability of the BOHLAT-P-30

The BOHLAT-P-30 demonstrated excellent internal consistency and test-retest reliability. Cronbach's alpha was 0.91, and ICC was 0.95 (95%CI: 0.94–0.96), indicating that both measures were above the recommended levels.<sup>26</sup>

### Validity of the BOHLAT-P-30

A significant and positive correlation was observed between the BOHLAT-P-30 and the



**Figure.** Item characteristic curves of the 49 items of the Brazilian Oral Health Literacy Assessment Task for Paediatric Dentistry (BOHLAT-P).

**Table 2.** Model fit parameter estimates of IRT and CFA analysis for the BOHLAT-P and the BOHLAT-P-30 instruments.

Variable	TLI*	CFI*	RMSEA**	SRMSR**	AIC***	AICc***	SABIC***	BIC***	$\chi^2$ ***	df***
IRT Models										
BOHLAT-P	0.92	0.92	0.06	0.08	8086.9	8279.0	8099.7	8410.2	-	-
BOHLAT-P-30	0.94	0.94	0.06	0.08	4549.86	4602.5	4557.6	4747.7	-	-
CFA Models										
BOHLAT-P	0.92	0.92	0.04	-	-	-	-	-	609.66	404
BOHLAT-P-30	0.94	0.94	0.05	-	-	-	-	-	1540.32	1124

\*Values  $\geq 0.95$  indicate excellent model fit. Values  $\geq 0.90$  and  $< 0.95$  indicate acceptable model fit; \*\*Values  $\leq 0.06$  indicate excellent model fit. Values  $\geq 0.06$  and  $\leq 0.08$  indicate acceptable model fit; \*\*\*Lower values indicate better adjustment.

BREALD-30 scores ( $p < 0.001$ ), attesting to the convergent validity of the instrument. There were also significant correlations of BOHLAT-P-30 scores with both the number of years of schooling, and the number of hours spent reading ( $p < 0.001$ ), highlighting the concurrent validity of the short form. The instrument also showed predictive validity, since a statistically significant negative correlation was observed between the BOHLAT-P-30 and B-ECOHIS scores (Table 3). Results for the discriminant validity of the BOHLAT-P-30 were obtained only at the bivariate level. The children of parents/caregivers with higher BOHLAT-P-30 scores had a significantly lower prevalence of

dental caries ( $p = 0.004$ ). However, this association lost significance in the adjusted model (Table 4).

## Discussion

The present study proposed to develop and evaluate the psychometric properties of a short form of the BOHLAT-P. It provided evidence of the validity and reliability of the short instrument (BOHLAT-P-30). To the best of our knowledge, this is the first attempt to develop and validate a short form of the HKOHLAT-P.

Our findings confirm that the OHL measured by the BOHLAT-P-30 has a unique general factor,

**Table 3.** Convergent, divergent, concurrent and predictive validity of the short form of the Brazilian Oral Health Literacy Assessment Task for Paediatric Dentistry (BOHLAT-P-30)

Variable	r*	p-value
BREALD-30 scores	0.719	< 0.001
Years of schooling	0.605	< 0.001
Hours spent reading	0.332	< 0.001
B-ECOHIS scores	-0.217	0.002
Number of teeth with cavitated caries	-0.182	0.010
Median (Interquartile range)		
Dental caries		
Yes	23.0(8)	0.004**
No	26.0(5)	
Did the child ever visit the dentist?		
Yes	24.0(9)	0.803**
No	24.0(8)	

\*Spearman's correlation coefficients of the BOHLAT-P-30 and designated variables. \*\* Mann-Whitney test. Results significant at the 5% level.

**Table 4.** Multivariate poisson regression models (adjusted rate ratios with lower and upper 95% confidence intervals in parentheses) for BOHLAT-P-30 scores with BREALD-30 scores, number of teeth with cavitated caries, presence of dental caries and B-ECOHIS scores.

Variable	BREALD-30	Number of teeth with cavitated caries	Presence of dental caries	B-ECOHIS
BOHLAT-P-30	1.024* (1.017–1.031)	0.994 (0.948–1.042)	0.999 (0.990–1.009)	0.965* (0.932–0.998)
Monthly family income	1.015 (0.994–1.036)	0.906 (0.696–1.178)	0.882* (0.814–0.956)	0.916 (0.719–1.167)
Years of schooling	1.009* (1.002–1.017)	0.901* (0.837–0.971)	1.007 (0.985–1.030)	0.969 (0.907–1.035)

\*Statistically significant association at the multivariate level ( $p < 0.05$ ).

as observed for the long version of the instrument.<sup>16</sup> The addition of an error covariance between items Q15 and Q16 of the instrument was required, because of the high correlation between these items. The high correlation of other items enhanced our understanding regarding the items of the instrument that evaluate the set of complementary and interrelated skills underlying a single construct.

We observed excellent Cronbach's alpha and ICC values, thus indicating that the proposed instrument is highly reliable. These figures are similar to those reported in the BOHLAT-P validation study,<sup>16</sup> and are far superior to those of the validation of the original instrument performed in Hong Kong.<sup>17</sup> Cronbach's alpha for the BOHLAT-P-30 was slightly lower than that of the BOHLAT-P, which is a likely consequence of the fewer number of items.

Both the convergent and the concurrent validity of the instrument were ascertained. This is consistent with the HKOHLAT-P developmental study,<sup>17</sup> and the BOHLAT-P validation study<sup>16</sup>. During the validation of the long instrument to Brazilian Portuguese, predictive validity was present only at the bivariate level,<sup>16</sup> whereas this property remained at the multivariate level in the present investigation. Future studies are still required to clarify the relationship between OHL and OHRQoL.

Consistent with the results of the BOHLAT-P validation study,<sup>16</sup> the discriminant validity of the BOHLAT-P-30 was only partially supported. Although children from respondents with higher OHL had a lower prevalence of dental caries, this association lost significance in the adjusted model. The same pattern occurred for the number of teeth with cavitated caries. Furthermore, previous OHL validation studies have also analyzed validity measures by associating OHL with clinical conditions, and have also failed to find significant results.<sup>28,29</sup> These findings evidence that OHL has an indirect or mediating effect on the causative pathway of oral conditions, as discussed in previous theoretical models.<sup>2</sup>

Use of the same dataset employed in the validation of the BOHLAT-P for item reduction is a limitation of the study. Since the exclusion of items led to some alterations in the number of response alternatives, we recommend that the BOHLAT-P-30 be further applied

in other research settings, particularly those using larger samples, to confirm whether the instrument remains understandable. Previous validation studies, including that which developed the HKOHLAT-P, relied on care-seeking subjects.<sup>14,17,28</sup> Since these individuals are able to navigate through the health care system, they are not representative of the general population. In the present investigation, we opted to use a preschool-based sample that enhances the external validity of the results.

Notably, the use of an IRT-based approach allowed us to identify important parameters, such as discrimination and difficulty indexes, and the amount of information captured by each item of the BOHLAT-P, and then use this information to guide the item selection process. During this process, we also considered the skill measured by the item, to ultimately develop a final instrument with a balanced set of items. Overall, we were able to substantially reduce the test length, while still obtaining an instrument with robust model fit estimates and psychometric properties, thus encompassing items that evaluate the three skills proposed by the original questionnaire. The psychometric properties of the short form are very similar to those of the long instrument, and confirm previous assumptions of redundancy in the BOHLAT-P.<sup>16</sup>

The present study provides evidence of the validity of BOHLAT-P-30, a new OHL instrument likely to help researchers fill important gaps in the literature. Future investigations employing this instrument will be able to provide an in-depth understanding of the construct among Brazilian parents/caregivers, in a more focused fashion than the currently available word-recognition instruments. In addition, the short form can feasibly be applied in large epidemiological studies, because it requires less fieldwork and resources, thus reducing the respondent's burden. The development and validation of the BOHLAT-P-30 also offer interesting opportunities from a clinical perspective. Dentists can use the BOHLAT-P-30 to screen the OHL of parents/caregivers of pediatric patients, and adjust the level of communication accordingly. Such an approach can identify patients with increased susceptibility to adverse oral health outcomes, thus allowing dentists to tailor specific patient-centered health promotion strategies, and improve the quality of dental care.

## Conclusion

The BOHLAT-P-30 was found to have psychometric properties and a factorial structure similar to the BOHLAT-P, and be a valid instrument to assess the OHL of Brazilian parents.

## Acknowledgements

This study was supported by the Brazilian Coordination of Higher Education, Ministry of Education (CAPES), the Research Foundation of the State of Minas Gerais (FAPEMIG), and the National Council for Scientific and Technological Development (CNPQ).

## References

1. Podschun GD. National plan to improve health literacy in dentistry. *J Calif Dent Assoc.* 2012 Apr;40(4):317-20.
2. Guo Y, Logan HL, Dodd VJ, Muller KE, Marks JG, Riley JL 3rd. Health literacy: a pathway to better oral health. *Am J Public Health.* 2014 Jul;104(7):e85-91. <https://doi.org/10.2105/AJPH.2014.301930>
3. Hom JM, Lee JY, Divaris K, Baker AD, Vann WF Jr. Oral health literacy and knowledge among patients who are pregnant for the first time. *J Am Dent Assoc.* 2012 Sep;143(9):972-80. <https://doi.org/10.14219/jada.archive.2012.0322>
4. Tam A, Yue O, Atchison KA, Richards JK, Holtzman JS. The association of patients' oral health literacy and dental school communication tools: a pilot study. *J Dent Educ.* 2015 May;79(5):530-8. <https://doi.org/10.1002/j.0022-0337.2015.79.5.tb05912.x>
5. Sanzone LA, Lee JY, Divaris K, DeWalt DA, Baker AD, Vann WF Jr. A cross sectional study examining social desirability bias in caregiver reporting of children's oral health behaviors. *BMC Oral Health.* 2013 Jun;13(1):24. <https://doi.org/10.1186/1472-6831-13-24>
6. Baskaradoss JK. The association between oral health literacy and missed dental appointments. *J Am Dent Assoc.* 2016 Nov;147(11):867-74. <https://doi.org/10.1016/j.adaj.2016.05.011>
7. Calvasina P, Lawrence HP, Hoffman-Goetz L, Norman CD. Brazilian immigrants' oral health literacy and participation in oral health care in Canada. *BMC Oral Health.* 2016 Feb;16(1):18. <https://doi.org/10.1186/s12903-016-0176-1>
8. Haridas R, S S, Ajagannanavar SL, Tikare S, Maliyil MJ, Kalappa AA. Oral health literacy and oral health status among adults attending dental college hospital in India. *J Int Oral Health.* 2014 Nov-Dec;6(6):61-6.
9. Holtzman JS, Atchison KA, Macek MD, Markovic D. Oral health literacy and measures of periodontal disease. *J Periodontol.* 2017 Jan;88(1):78-88. <https://doi.org/10.1902/jop.2016.160203>
10. Firmino RT, Ferreira FM, Paiva SM, Granville-Garcia AF, Fraiz FC, Martins CC. Oral health literacy and associated oral conditions: a systematic review. *J Am Dent Assoc.* 2017 Aug;148(8):604-13. <https://doi.org/10.1016/j.adaj.2017.04.012>
11. Parthasarathy DS, McGrath CP, Bridges SM, Wong HM, Yiu CK, Au TK. Efficacy of instruments measuring oral health literacy: a systematic review. *Oral Health Prev Dent.* 2014;12(3):201-7. <https://doi.org/10.3290/j.ohpd.a32681>
12. Dickson-Swift V, Kenny A, Farmer J, Gussy M, Larkins S. Measuring oral health literacy: a scoping review of existing tools. *BMC Oral Health.* 2014 Dec;14(1):148. <https://doi.org/10.1186/1472-6831-14-148>
13. American Dental Association Council on access prevention and interprofessional relations. Health literacy in dentistry action plan 2010-2015. Chicago: American Dental Association; 2009 [cited 2019 Nov 15]. Available from: [https://www.ada.org/en/~media/ADA/Member%20Center/Files/topics\\_access\\_health\\_literacy\\_dentistry](https://www.ada.org/en/~media/ADA/Member%20Center/Files/topics_access_health_literacy_dentistry)
14. Junkes MC, Fraiz FC, Sardenberg F, Lee JY, Paiva SM, Ferreira FM. Validity and Reliability of the Brazilian Version of the Rapid Estimate of Adult Literacy in Dentistry—BREALD-30. *PLoS One.* 2015 Jul;10(7):e0131600. <https://doi.org/10.1371/journal.pone.0131600>
15. Cruvinel AF, Méndez DA, Oliveira JG, Gutierrez E, Lotto M, Machado MA, et al. The Brazilian version of the 20-item rapid estimate of adult literacy in medicine and dentistry. *PeerJ.* 2017 Aug;5:e3744. <https://doi.org/10.7717/peerj.3744>
16. Firmino RT, Granville-Garcia AF, McGrath CP, Bendo CB, Ferreira FM, Paiva SM. Validation for Brazilian Portuguese language of the Hong Kong Oral Health Literacy Assessment Task for Paediatric Dentistry (BOHLAT-P). *Int J Paediatr Dent.* 2020 Mar;30(2):234-43. <https://doi.org/10.1111/ipd.12585>
17. Wong HM, Bridges SM, Yiu CK, McGrath CP, Au TK, Parthasarathy DS. Validation of the Hong Kong Oral Health Literacy Assessment Task for paediatric dentistry (HKOHLAT-P). *Int J Paediatr Dent.* 2013 Sep;23(5):366-75. <https://doi.org/10.1111/ipd.12021>
18. Goursand D, Ferreira MC, Pordeus IA, Mingoti SA, Veiga RT, Paiva SM. Development of a short form of the Brazilian Parental-Caregiver Perceptions Questionnaire using exploratory and confirmatory factor analysis. *Qual Life Res.* 2013 Mar;22(2):393-402. <https://doi.org/10.1007/s11136-012-0145-3>
19. Jokovic A, Locker D, Guyatt G. Short forms of the Child Perceptions Questionnaire for 11-14-year-old children (CPQ11-14): development and initial evaluation. *Health Qual Life Outcomes.* 2006 Jan;4(1):4. <https://doi.org/10.1186/1477-7525-4-4>

20. Hulley SB, Cummings SR, Browner WS, Grady DG, Newman TB. *Designing clinical research*. Philadelphia: Lippincott Williams & Wilkins; 2013.
21. Tesch FC, Oliveira BH, Leão A. [Semantic equivalence of the Brazilian version of the Early Childhood Oral Health Impact Scale]. *Cad Saude Publica*. 2008 Aug;24(8):1897-909. Portuguese. <https://doi.org/10.1590/S0102-311X2008000800018>
22. Scarpelli AC, Oliveira BH, Tesch FC, Leão AT, Pordeus IA, Paiva SM. Psychometric properties of the Brazilian version of the Early Childhood Oral Health Impact Scale (B-ECOHis). *BMC Oral Health*. 2011 Jun;11(1):19. <https://doi.org/10.1186/1472-6831-11-19>
23. Ismail AI, Sohn W, Tellez M, Amaya A, Sen A, Hasson H, et al. The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries. *Community Dent Oral Epidemiol*. 2007 Jun;35(3):170-8. <https://doi.org/10.1111/j.1600-0528.2007.00347.x>
24. Stucky BD, Lee JY, Lee SY, Rozier RG. Development of the two-stage rapid estimate of adult literacy in dentistry. *Community Dent Oral Epidemiol*. 2011 Oct;39(5):474-80. <https://doi.org/10.1111/j.1600-0528.2011.00619.x>
25. Hambleton RK, Swaminathan H, Jane Rogers H. *Fundamentals of Item Response Theory*. Measurement methods for the social sciences. Newbury Park: Sage; 1991.
26. Kline RB. *Principles and practice of structural equation modeling*. 4th ed. New York: Guilford Press; 2015.
27. Kline P. *Handbook of psychological testing*. 2nd ed. Abington: Routledge; 2000.
28. Peker K, Köse TE, Güray B, Uysal Ö, Erdem TL. Reliability and validity of the Turkish version of the Rapid Estimate of Adult Literacy in Dentistry (TREALD-30). *Acta Odontol Scand*. 2017 Apr;75(3):198-207. <https://doi.org/10.1080/00016357.2016.1278079>
29. Stein L, Pettersen KS, Bergdahl M, Bergdahl J. Development and validation of an instrument to assess oral health literacy in Norwegian adult dental patients. *Acta Odontol Scand*. 2015;73(7):530-8. <https://doi.org/10.3109/00016357.2015.1007477>