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ORIGINAL ARTICLE

The Brazilian validation of a health literacy instrument: the newest vital sign

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ABSTRACT

Objective: This study aimed to perform the cross-cultural adaptation and validation of the NVS for Brazilian Portuguese.

Material and Methods: Two hundred and fifty adults responded to the adapted version of the NVS, the Brazilian version of the Rapid Estimate of Adult Literacy in Dentistry (BREALD-30), ten questions of the National Functional Literacy Index (NFLI), and a questionnaire about demographic and oral health-related aspects. Statistical analysis determined the internal consistency, stability, difficulty of items, and convergent/discriminant/predictive validities of the NVS. $p < .05$ was considered significant.

Results: The NVS displayed a good internal consistency (Cronbach's alpha = 0.79) and a fair stability (ICC = 0.57; 0.39–0.70 95% CI). Seventy-two percent of participants answered the easier question (#5) correctly, whereas only 28.4% were successful in responding the most difficult question (#1). The convergent validity of the NVS was demonstrated by its significant correlation with the BREALD-30 ($Rs = 0.601$, $p < .001$) and NFLI ($Rs = 0.544$, $p < .001$). The observation of higher NVS scores among health professionals, white and more educated people confirmed the discriminant validity of the instrument. Moreover, health literacy was a significant predictor of self-reported oral health and reason for dental utilization.

Conclusion: The NVS demonstrated adequate psychometric properties to be applied in Brazilian oral health epidemiological surveys.

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KEYWORDS
Health literacy; oral health; surveys and questionnaires

Introduction

Oral diseases occur by the interdependent relationship between biological and social factors [1], such as health literacy (HL) [2,3]. HL represents a set of cognitive and social skills that contribute to the motivation and capacity of patients to obtain, process, understand, and use basic health information and services needed to make appropriate health decisions [4,5]. It encloses word recognition, document interpretation, comprehension of reading, qualitative analysis, communication skills, and conceptual knowledge, which favor the acquisition, processing, and understanding of instructions [6]. In this sense, low HL levels negatively impact on the acquisition of dental knowledge, the self-perception of dental treatment needs, and the frequency of dental visits [7–9]. Additionally, dentists undervalue the inability of patients in interpreting technical terms during dental orientation, which result in the inefficient patient counseling and unsuccessful clinical interventions [10]. The coexistence of these factors with considerable stress and barriers to dental care increases the susceptibility of deprived populations to a poor oral health condition [11].

The U.S. Department of Health and Human Services [12] emphasized the importance of measuring HL, aiming to produce statistics for the improvement of health planning with focus on enhancing HL to encourage people in adopting healthy behaviors and lifestyles for the prevention of diseases. This attention is still more relevant in developing countries as Brazil, characterized by profound social inequalities [13]. Twenty-seven percent of Brazilian adults are classified as functional illiterates [14]. Several instruments have arisen to assess specific skills of HL; nevertheless, there is still a lack of variety of HL scales validated in Brazil, which present the following disadvantages: (a) extension: the Short Test of Functional HL in Adults [15] is composed by 36 questions, which take nearly 12 min for its application [16]; (b) evaluation of limited dimensions of HL: the Short Assessment of HL for Portuguese-Speaking Adults [17] and the Brazilian version of the Rapid Estimate of Adult Literacy in Dentistry (BREALD-30) [18] only test the people's abilities of reading and/or understanding lists of medical and dental terms; (c) scales developed for specific groups: the HL [19] and the Spoken Knowledge in Low Literacy Patients with Diabetes [20] must be applied only for elderly and diabetic patients, respectively; (d) scales validated in one country: the multidimensional Screener of Functional HL [21] is still restricted to Brazil, which hampers the comparability of its results. Moreover, only BREALD-30 was validated for identifying Brazilian people with low HL levels in a dental context.

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Supplemental data for this article can be accessed here.

Based on the aforementioned aspects, we considered the validation of The Newest Vital Sign (NVS, Pfizer Inc., New York, USA) [22], constructed for screening people from diverse countries [22–26] for limited HL in a rapid, reliable, and sensitive way. The NVS evaluates the individuals' capacity in reading, understanding, interpreting, and making decisions with basis on nutrition facts of an ice cream, covering the analysis of four specific dimensions of HL: numeracy, prose, cognitive capacity, and logical reasoning. These dimensions are directly related to abilities required from patients to prevent dental diseases, for instance, when people receive instructions to brush all surfaces of their teeth regularly. Therefore, the application of the NVS might add valuable information for the successful education and treatment of dental patients.

Taking into consideration that (i) the adherence and engagement of patients with oral healthy habits depend on their competence in handling quantitative and qualitative information, (ii) these competences are related to HL levels, (iii) there is a great contingent of Brazilian people under risk of low levels of HL, and (iv) affordable scales validated in Brazil to assess HL are still lacking in a oral health context, the aim of this study was to perform the cross-cultural adaptation and validation of the Newest Vital Sign to be employed in Brazilian oral epidemiological surveys. We hypothesize that the four HL dimensions measured by NVS scores would be associated with oral health-related outcomes.

Material and methods

Cross-cultural adaptation

This study was previously authorized by Pfizer Inc. and the authors of the original instrument. The Newest Vital Sign and its translation are subject to copyright protection owned by Pfizer Inc. and used with permission.

This experimental protocol was approved by the Human Research Ethics Committee of the Bauru School of Dentistry (#CAAE 34539714.7.0000.5417), in accordance with the ethical standards of the Declaration of Helsinki.

Conceptual, semantic, and item equivalence

The process of cross-cultural adaptation was conducted as described by Herdman et al. [27] and Reichenheim and Moraes [28]. Two dentists and one speech language pathologist, with expertise in health education and language, investigated the equivalence of concepts and items of the NVS for application to native Brazilian people. The theoretical framework and the target population of the instrument were elucidated by retrieving and analyzing previous publications [22–26].

The NVS was developed to identify people with limited HL, considering the following concept: *"health literacy is the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions"* [12]. The instrument comprises six questions that require reading, analysis, and interpretation of numbers and words contained in a nutrition label of a vanilla ice cream. These questions cover the critical appraisal of individuals to calculate the amount of calories and/or saturated fat found in specific portions of ice cream, within the context of restrictive and non-restrictive diets; additionally, the individuals should make decisions about the proper consumption of the dessert after analyzing its ingredients. These skills are similar to those analytical abilities that provide the understanding and the following of instructions given by health professionals. The underlying idea of the NVS is based on the achievement of better health outcomes, through the adjustments of the technical vocabulary of professionals in favor of the demands of their patients with limited HL [22].

In summary, the panel of specialists concluded:

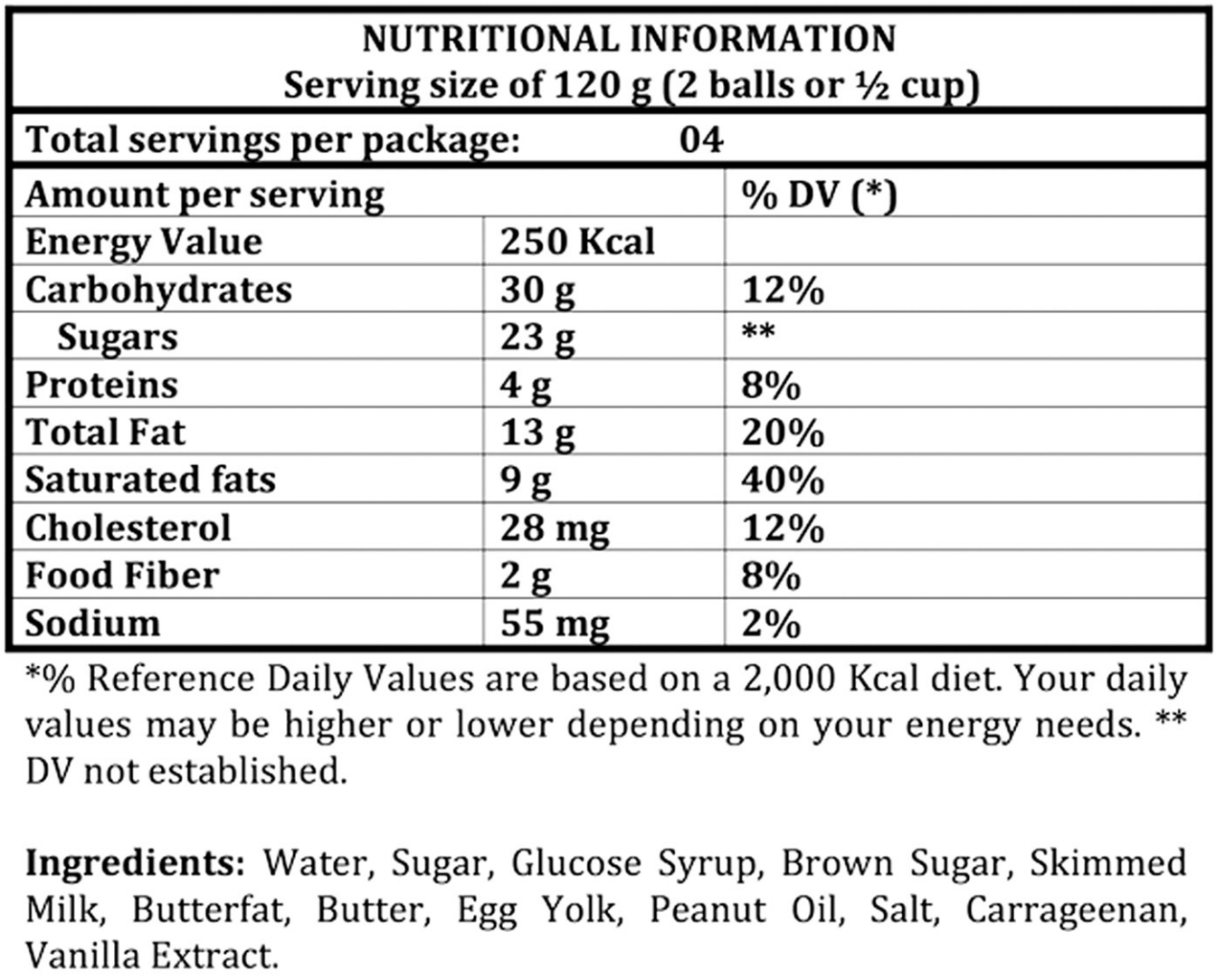
i. the definition of HL used to develop the NVS is appropriate and valid for unlimited cultures;
ii. there is a parallelism between the skills required to use a nutrition label and to understand/follow health instructions, which are directly linked to the concept of HL;
iii. the six questions of the NVS permit the understanding of the level of competencies of individuals in interpreting and acting on health information;
iv. the behavior of using nutrition labels should be more widespread among people with higher levels of HL, being indicative of a greater health awareness;
v. people more used to read and interpret nutritional facts in their daily life should present a better performance in the NVS.

Therefore, the conceptual framework of the NVS was considered adequate for screening native Brazilian people for limited HL.

The NVS was literally translated to Brazilian Portuguese by three bilingual health professionals, independently. The structure of the score sheet was remained identical to the original version because of their excellent semantic equivalence. Distinctly of Rowlands et al. [26], the inclusion of an additional question for clarifying the reason of a possible allergic reaction was not considered, since the participants needed to recognize the peanut oil as a potential food allergen. On the other hand, the nutrition label was adapted according to similar products found in the Brazilian market; the amount of dietary fibers, fat calories, and servings per container are not included in the nutrition facts of Brazilian ice creams, differently of the information presented by Weiss et al. [22]. Notwithstanding, to facilitate the answer for the question #1 - *"If you eat the entire container, how many calories will you eat?"* we decided by the maintenance of the information of servings per container in the nutrition label (Figures 1 and 2).

Operational equivalence

Subsequently, the first version of the NVS was pretested in a sample of 10 adults who attended the dental clinics of the Bauru School of Dentistry, University of São Paulo, Brazil. The participants were asked to report their impression of the



NUTRITIONAL INFORMATION Serving size of 120 g (2 balls or ½ cup)		
Total servings per package:	**04**	
Amount per serving		**% DV (*)**
Energy Value	**250 Kcal**	
Carbohydrates	**30 g**	**12%**
Sugars	**23 g**	**
Proteins	**4 g**	**8%**
Total Fat	**13 g**	**20%**
Saturated fats	**9 g**	**40%**
Cholesterol	**28 mg**	**12%**
Food Fiber	**2 g**	**8%**
Sodium	**55 mg**	**2%**

*% Reference Daily Values are based on a 2,000 Kcal diet. Your daily values may be higher or lower depending on your energy needs. ** DV not established.

Ingredients: Water, Sugar, Glucose Syrup, Brown Sugar, Skimmed Milk, Butterfat, Butter, Egg Yolk, Peanut Oil, Salt, Carrageenan, Vanilla Extract.

Figure 1. The adapted version of a nutrition label of a vanilla ice cream used to support the answers of participants (back-translated-version).

instrument. All participants agreed on the efficiency of the NVS in screening patients for misunderstanding of health instructions. In addition, one participant pointed an ambiguous question that could hamper the comprehension of the entire document. Then, the researchers rephrased that sentence accordingly and asked the opinion of the same participant, who confirmed the resolution of the ambiguity.

Then, the instrument was back-translated by an English language specialist who did not participate in any other stage of this study. The semantic equivalence between the original and the adapted instrument was considered adequate by the panel of specialists.

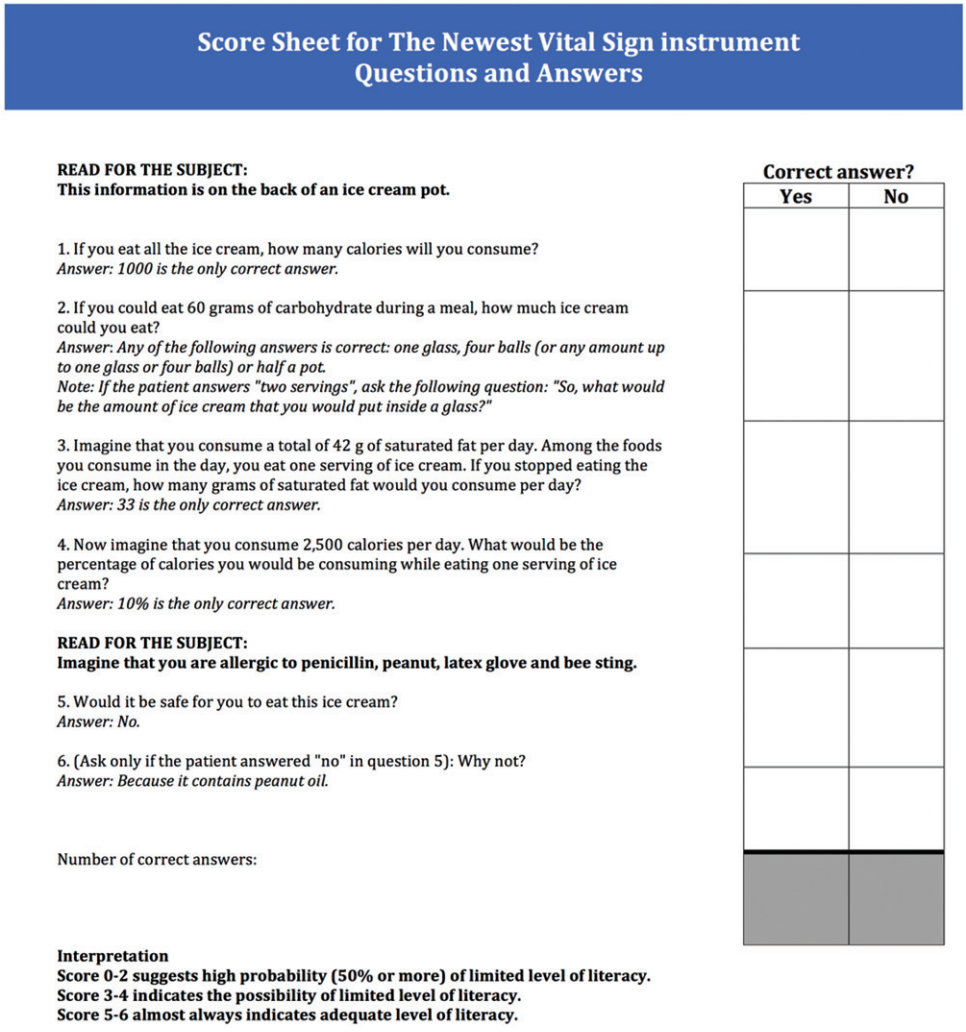
Validation

To validate the instrument, 250 adults aged 18–80 years with differing educational backgrounds were invited to participate in this study. They were recruited among patients who attended in the dental clinics of the Bauru School of Dentistry, University of São Paulo, Brazil. Illiterates, non-native Brazilian Portuguese speakers, patients with cognitive, vision, or hearing impairment, and subjects intoxicated by alcohol and/or drugs were excluded. All participants received information regarding the aims of the study and signed a statement of informed consent.

The participants completed the NVS, the Brazilian version of the Rapid Estimate of Adult Literacy in Dentistry (BREALD-30) [18], 10 questions of the National Functional Literacy Index (NFLI) [14], and a questionnaire about demographic and oral health-related aspects in one interview session. These tests were applied in the same order described above for all participants. To assess the stability of the NVS, it was re-applied to 25 subjects one month later.

Participants were asked to answer the six questions of the NVS with no time limit. They could refer to the label as often as desired. The participants received one point for each right answer, with the overall score ranging from 0 to 6 (see Supplemental file).

The BREALD-30 comprises 30 words arranged in order of increasing reading difficulty. It aims to evaluate OHL of patients by their ability in reading and pronouncing specific



Score Sheet for The Newest Vital Sign instrument
Questions and Answers

READ FOR THE SUBJECT:
This information is on the back of an ice cream pot.

1. If you eat all the ice cream, how many calories will you consume?
Answer: 1000 is the only correct answer.

2. If you could eat 60 grams of carbohydrate during a meal, how much ice cream could you eat?
Answer: Any of the following answers is correct: one glass, four balls (or any amount up to one glass or four balls) or half a pot.
Note: If the patient answers "two servings", ask the following question: "So, what would be the amount of ice cream that you would put inside a glass?"

3. Imagine that you consume a total of 42 g of saturated fat per day. Among the foods you consume in the day, you eat one serving of ice cream. If you stopped eating the ice cream, how many grams of saturated fat would you consume per day?
Answer: 33 is the only correct answer.

4. Now imagine that you consume 2,500 calories per day. What would be the percentage of calories you would be consuming while eating one serving of ice cream?
Answer: 10% is the only correct answer.

READ FOR THE SUBJECT:
Imagine that you are allergic to penicillin, peanut, latex glove and bee sting.

5. Would it be safe for you to eat this ice cream?
Answer: No.

6. (Ask only if the patient answered "no" in question 5): Why not?
Answer: Because it contains peanut oil.

Number of correct answers:

Correct answer?	
Yes	No

Interpretation
Score 0-2 suggests high probability (50% or more) of limited level of literacy.
Score 3-4 indicates the possibility of limited level of literacy.
Score 5-6 almost always indicates adequate level of literacy.

Figure 2. Score sheet of the Brazilian version of the Newest Vital Sign (back-translated version).

dental terms. For each term read correctly, the subject receives one point, with a total score varying from 0 to 30. This instrument was previously validated in Brazil by a distinct research group [18].

The NFLI is based on the categorization of Brazilian adults aged 15 to 64 years, according to their education levels: illiterate, rudimentary, basic, and full literate [14]. In this study, participants answered 10 out of 35 items of NFLI, comprising simple interpretation of figures and documents, as described by Junkes et al. [18]. One point was given for each right answer, with an overall score range of 0 to 10.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 21.0 (IBM® SPSS® Statistics, New York, USA) and JMetrik© version 4.0.5 (Psychomeasurement Systems, Charlottesville, USA).

The internal consistency and stability of the NVS were determined by Cronbach's alpha and intraclass correlation coefficient (ICC) for absolute concordance, respectively.

The Andersen's likelihood ratio was employed to determine the evidence of differential item functioning (DIF), with the aim of detecting item bias in the internal structure of the instrument. This analysis assessed the null hypothesis that scaling is equal between two groups, as follows: gender (male/female), age (<36 years-old/≥36 years-old), race (white/non-white), education (<12 years/≥ 12 years), occupation (other/health professionals), self-reported oral health (good-excellent/regular-poor), time since last dental visit (<1 year/≥1 year), and reason for dental utilization (prevention/treatment). The dichotomization of the variables "age" and "time since last dental visit" was based on the 50th percentile of their values distribution (35 years-old and <1 year).

The monotonicity of data was certified by a linear regression model between the dependent variable of "NVS scores" and the independent variable of "predictive values of factors" ($R^2 = .995$, $p < .001$). The hypothesis of conditional independence of the items of the NVS was rejected, since significant chi-square values were demonstrated by the Mantel-Haenszel test for all pairwise questions [$X^2 = 7.29$ ($p = .01$)–88.71($p < .001$)]. In these situations, the application of the unidimensional Rasch model is recommended for scaling the dependent items of both unidimensional or multidimensional instruments, based on the statistical equality of the tests of dimensionality and local independence [29].

The unidimensional Rasch scale model was applied to assess the sequence of items by their increasing difficulty, with a separation index of at least 0.15 logits. To assess the goodness-of-fit of each item to the model, the infit mean square (MSQ) statistics should be between 0.7 and 1.3 [30], and the outfit MSQ statistics should be <2.0 logits [31].

The sensitivity and specificity for a selected cut score in the receiver operating characteristic analysis and the stratum-specific likelihood ratio (SSLR) were used to find the optimal cutoff points for identifying OHL levels according to those described in the original instrument [20]. BREALD-30 scores <27 were considered as indicative of limited oral HL.

The Spearman's rank test determined the convergent validity of the NVS with the BREALD-30 and NFLI. For discriminant and predictive validity, the Mann Whitney U test was used to detect significant differences of the NVS scores between the dichotomized demographic and oral health-related variables, as aforementioned. The predictive performance of the NVS for oral health outcomes was analyzed by logistic regression models, which included only factors with significant Wald statistics. p values $< .05$ were considered significant.

Results

The distribution of participants by HL levels, demographic characteristics, and oral health outcomes are summarized in Table 1. They were predominantly composed of women (64.0%) and white (79.2%) people, with a mean age of 37.52 years (±15.01), ranging from 18 to 80 years-old.

The mean score of the NVS was 2.70 (±2.00, range 0–6), with the variance of 3.99. If item deleted, the scale mean varied between 1.98 (Q5) and 2.42 (Q1), while the scale variance varied from 2.71 (Q2) to 3.16 (Q5) (Table 2). Cronbach's alpha was 0.79, revealing an adequate internal consistency of the NVS and its subscales. The values of Cronbach's alpha if item deleted varied from 0.73 (Q2) to 0.79 (Q5) (Table 2). A fair stability of the instrument was indicated by the value of ICC for absolute concordance (0.57; 0.39–0.70 95% CI, $p < .001$). The values of skewness (0.20) and kurtosis (–1.27) revealed a deviation of data from normality.

The DIF analysis showed statistically significant differences between people of particular demographic characteristics, such as race (LR-value 59.70, $df = 6$, $p = .001$), age (LR-value 85.97, $df = 6$, $p < .001$), education levels (LR-value 85.36, $df = 6$, $p < .001$), and occupation (LR-value 60.84, $df = 6$, $p = .002$). Moreover, the internal structure of the NVS was adequate in the differentiation of groups of individuals that distinctly reported their oral health levels (LR-value 94.36, $df = 6$, $p < .001$) and their reasons for dental visit (LR-value 88.45, $df = 6$, $p = .002$). The instrument did not demonstrate the evidence of DIF for gender and time since last dental visit ($p > .05$).

The six items of the NVS fitted the Rasch scale model for rating scale of difficulty, with the infit MSQ statistics varying from 0.83 and 1.26 and the maximum value of outfit MSQ statistics of 1.98 (Table 3). Seventy-two percent of participants answered the easier question (#5) correctly, whereas only 28.4% were successful in responding the most difficult question (#1).

The accuracy of the NVS for screening people with limited HL levels was 0.79 (0.74–0.85 95% CI). It was detected three thresholds of likelihood ratios of NVS scores for the identification of different levels of HL. The first threshold encompassed the scores 0, 1, and 2, with SSLR varying from 2.57 through 4.08 (Rasch scale model, $\theta = -3.81$ – –0.83). The second threshold encompassed the scores 3 and 4 with SSLR of 0.49 and 0.82 ($\theta = 0.11$ – 0.99). The scores 5 and 6 showed SSLR values of 0.16 and 0.09 ($\theta = 2.05$ – 3.48), respectively. A cutoff point of ≤2 demonstrated a great capacity to identify people with limited OHL, with sensitivity of 0.81 and specificity of 0.72. One hundred and twenty-five subjects were considered with high likelihood of limited literacy (range 0–2), 58 subjects with possible limited

Table 1. Distribution of individuals according to HL categories, demographic characteristics, and oral health outcomes.

		HL (NVS)		
	Total	Limited	Possibly limited	Adequate
Gender				
Male	90 (36.0%)	41 (45.6%)	21 (23.3%)	28 (31.1%)
Female	160 (64.0%)	84 (52.5%)	37 (23.1%)	39 (24.4%)
Race				
White	198 (79.2%)	89 (44.9%)	48 (24.2%)	61 (30.9%)
Black	51 (20.4%)	36 (70.6%)	10 (19.6%)	5 (9.8%)
Asian	1 (0.4%)	0 (0%)	0 (0%)	1 (100%)
Education				
≤8th grade	59 (23.6%)	55 (93.2%)	2 (3.4%)	2 (3.4%)
9–12th grade	90 (36.0%)	54 (60.0%)	21 (23.3%)	15 (16.7%)
College	70 (28.0%)	16 (22.9%)	24 (34.3%)	30 (42.8%)
Postgraduation	31 (12.4%)	0 (0%)	11 (35.5%)	20 (64.5%)
Occupation				
Other	214 (85.6%)	118 (55.1%)	46 (21.5%)	50 (23.4%)
Health technician	7 (2.8%)	4 (57.1%)	1 (14.3%)	2 (28.6%)
Health professional	29 (11.6%)	3 (10.3%)	11 (37.9%)	15 (51.8%)
Self-reported oral health				
Excellent	29 (11.6%)	5 (17.2%)	7 (24.1%)	17 (58.7%)
Very Good	41 (16.4%)	6 (14.6%)	11 (26.8%)	24 (58.6%)
Good	84 (33.6%)	46 (54.8%)	21 (25.0%)	17 (20.2%)
Regular	72 (28.8%)	49 (68.1%)	15 (20.8%)	8 (11.1%)
Poor	22 (8.8%)	17 (77.3%)	4 (18.2%)	1 (4.5%)
Do not know/do not answer	2 (0.8%)	1 (50.0%)	1 (50.0%)	0 (0%)
Last dental visit				
<1 year	201 (80.4%)	97 (48.3%)	48 (23.9%)	56 (27.8%)
1–2 years	26 (10.4%)	12 (46.2%)	7 (26.9%)	7 (26.9%)
2–5 years	14 (5.6%)	10 (71.4%)	2 (14.3%)	2 (14.3%)
>5 years	8 (3.2%)	5 (62.5%)	1 (12.5%)	2 (25.0%)
Do not know/do not answer	1 (0.4%)	1 (100%)	0 (0%)	0 (0%)
Reason for last dental visit				
Prevention	106 (42.4%)	37 (34.9%)	30 (28.3%)	39 (36.8%)
Treatment	144 (57.6%)	88 (61.1%)	28 (19.4%)	28 (19.5%)

Table 2. Results of the reliability of each item of the NVS.

Item	Scale mean if item deleted	Scale variance if item deleted	Cronbach's alpha if item deleted
Q1	2.42	3.03	0.77
Q2	2.22	2.71	0.73
Q3	2.35	2.83	0.75
Q4	2.33	2.85	0.75
Q5	1.98	3.16	0.79
Q6	2.20	2.76	0.74

Table 3. The difficulty scaling of items of the Brazilian version of the NVS.

Item	Mean	SD	Difficulty (SE)	Infit MSQ	Outfit MSQ
Q1	0.28	0.45	1.52 (0.20)	1.13	1.19
Q2	0.48	0.50	−0.20 (0.18)	0.83	0.85
Q3	0.35	0.48	0.87 (0.19)	0.93	0.81
Q4	0.37	0.48	0.73 (0.19)	0.96	1.06
Q5	0.72	0.45	−2.52 (0.23)	1.26	1.98
Q6	0.50	0.50	−0.40 (0.18)	0.92	0.80

Table 4. Mean scores (±SD) of the NVS according to socio-demographic characteristics and oral health-related aspects.

	NVS
Gender	
Male	2.76 ± 2.10
Female	2.67 ± 1.95
Race	
White	2.89 ± 2.05**
Non-White	1.98 ± 1.64
Age	
<36 years-old	3.47 ± 1.85**
≥36 years-old	1.90 ± 1.84
Education	
<12 years	1.25 ± 1.27**
≥12 years	3.42 ± 1.91
Occupation	
Health professionals	3.81 ± 1.95**
Other professionals	2.51 ± 1.95
Self-reported oral health	
Good – Excellent	3.22 ± 2.07**
Regular/Poor	1.86 ± 1.56
Last dental visit	
<1 year	2.77 ± 2.00
≥1 year	2.43 ± 2.00
Reason for last dental visit	
Prevention	3.31 ± 1.93**
Treatment	2.25 ± 1.93

*$p < .05$; **$p < .01$.

literacy (range 3–4), and 67 subjects with adequate literacy (range 5–6).

The convergent validity of the instrument was demonstrated by its significant correlation with the BREALD-30 ($Rs = 0.601$, $p < .001$) and NFLI ($Rs = .544$, $p < .001$). In addition, the NVS scores presented discriminant validity, with higher values among health professionals, white and more educated people ($p < .001$). In contrast, scores were similar among individuals with distinct time since last dental visit ($p = .27$). Self-reported poor/regular oral health conditions and dental treatment needs were associated with lower NVS scores (Mann-Whitney U test, $p < .001$; Table 4). These results are consistent with those demonstrated by DIF analysis.

HL measured by the NVS was a significant predictor for "reason for dental utilization" and "self-reported oral health" (Table 5). The odds ratio values showed greater chances of self-perception of good oral health conditions and dental visits motivated by prevention among individuals with higher levels of HL.

Discussion

These findings indicate that this version of the Newest Vital Sign demonstrated appropriate psychometric properties, linked to internal consistency, stability, and convergent, discriminant, and predictive validities, when considering the sample of this study. Indeed, instruments that simultaneously evaluate multiple skills, such as communication, reading, numeracy, comprehension, and logical reasoning seem advantageous to undertake a comprehensive screening of patients for limited HL in epidemiological studies. To the best of our knowledge, this is the first validated version of the NVS based on oral health outcomes.

Table 5. Logistic regression models for reason for dental utilization and self-reported oral health.

	B	SE	Wald	df	*p*	OR
Reason for last dental visit: Prevention						
NVS (Possible limited literacy)	0.95	0.37	6.54	1	.01	2.59
NVS (Adequate literacy)	0.22	0.37	0.35	1	.56	1.24
Education (≥12 years)	0.19	0.35	0.28	1	.60	1.21
Occupation (Other)	−0.71	0.40	3.12	1	.08	0.49
Time since last dental visit (≥1 year)	0.71	0.36	3.84	1	.05	2.03
Constant	−0.29	0.27	1.11	1	.29	0.75
Self-reported oral health: Good-Excellent						
Education (≥12 years)	0.86	0.35	6.18	1	.01	2.37
NVS (Possible limited literacy)	1.23	0.47	6.82	1	.01	3.42
NVS (Adequate literacy)	1.10	0.48	5.21	1	.02	2.99
Occupation (Other)	−2.15	0.77	7.76	1	.01	0.12
Age (<36 years-old)	0.29	0.32	0.86	1	.35	1.34
Race (White)	0.35	0.36	0.92	1	.34	1.42
Time since last dental visit (≥1 year)	0.76	0.38	3.97	1	.04	2.14
Constant	−1.92	0.40	22.88	1	<.001	0.15

df: degrees of freedom; OR: odds ratio; SE: standard error.

The cross-cultural adaptation of the NVS provided a trustworthy instrument founded on the application of a typical Brazilian nutrition label, which does not include information about servings per container, dietary fiber, and fat calories, usually found in American products. The maintenance of its six items was justified by the decrease of scale variance if any of the items were deleted, that is, the power of discrimination of the instrument would be reduced. To facilitate the answer for the question #1, we decided to maintain the amount of servings per container in the nutrition label of the present version, even though its presence was not necessary to improve the accuracy of patient's answers. This decision seemed to have no effect on the results, since the question #1 showed the highest rate of incorrect responses, being rated as the most difficulty question of the instrument by the Rasch model. This finding may be connected with the inadequate mathematical skills observed in Brazil [32]. Furthermore, we believe that the difficulty grade of the question #5 was linked to its binary nature, which facilitates the achievement of better performances. This assumption is supported by both observations of the largest reduction of scale mean (–26.7%) and the smallest reduction of variance (20.8%) if question #5 deleted. Additionally, the borderline outfit MSQ statistics indicates that this question is unproductive for the measurement of the individual's capacity by itself, which was verified by the reduced rate of the correct answers (50%) for the question #6. However, the relevance of the question #5 also lays in the introduction of a new section of evaluation, more focused on other abilities, such as document interpretation, comprehension of reading, and qualitative analysis.

Interestingly, the internal consistency of this NVS was greater than other versions, which showed Cronbach's alpha

values varying between 0.67 and 0.78 [22–26]. These differences could be supported by the use of a regional nutrition label applied strictly to native Brazilian patients, without special health conditions. The performance of distinct populations in the NVS ranged from 1.6 to 3.5 in different validation studies [22–26]. The average score of 2.7 obtained by the current participants was higher than those obtained by U.S. Hispanics (1.6) [22], Dutch chronic patients (1.8) [23], and elderly Japanese people (2.1) [24]. These diverse outcomes could be explained by the well-known low HL levels observed among non-white people [9,33–35], chronic patients [2], and older age groups [36].

Although this SSLR analysis also yielded three levels of HL, the present thresholds were characterized by distinct cutoff points in comparison with the results demonstrated by Weiss et al. [22]. The scores of BREALD-30 < 27 were considered as a representative of limited HL, based on the measures of central tendency observed in this population (mean $= 25.42$, median $= 26$, and mode $= 30$). We defined these parameters because the authors of BREALD-30 did not provide cutoff points to establish different levels of OHL [18]. Even with this limitation, the BREALD-30 was adopted to make the diagnosis of participants with limited OHL, because it was the unique validated method available in Brazil with the same purpose.

Concisely, the NVS analyzes predominantly three skills of HL: numeracy, prose, and document literacy [22]. Due to the lack of specific Brazilian instruments, the convergent validity of the NVS was assessed through its correlation with instruments that measure other abilities, such as reading and pronunciation (BREALD-30), or document interpretation (NFLI). This version of the NVS was moderately correlated with the BREALD-30 and NFLI. According to Nielsen-Bohlman, Panzer and Kindig [37], this analysis is possible because the direct correlation between reading and numeracy skills. Indeed, our results confirm the association between HL and demographic characteristics, such as educational levels, race, and occupation, similarly to prior studies [9,33–35,38,39]. Despite this strong association, the NVS detected limited or possible limited levels of HL among graduate and postgraduate people, which indicates that HL is not equivalent to the level of education, as demonstrated by van der Heide et al. [40]. Hence, the measurement of HL should be used in epidemiological surveys in preference to the educational status of participants.

In the logistic regression models, HL was a significant predictor of "reason for dental utilization" and "self-reported oral health". Instead, "time since last dental visit" was not affected by HL, in accordance with Jamieson et al. [8] and Burgette et al. [33]. This result could be influenced by the fact that all variables were determined through the recall and opinion of the participants, which could lead to the inaccurate reports and the observer-expectancy effect [41,42].

Although the NVS was effective in screening patients for limited HL, this instrument must be used with caution. Similarly to previous studies [22–26], this validation was performed on a convenience sample that might not be representative of the whole Brazilian population, especially in relation to the exclusion of illiterates and the high percentage of health professionals. This design was important to permit the minimal understanding of the instrument for all participants and to analyze the potential for discrimination of the NVS scores between different occupations. In addition, the effective use of the NVS in follow-up studies might be limited due to its fair stability. This result could be justified by two main hypotheses: (i) the participants' prior knowledge of the NVS questions could lead to different patterns of answers during the retest, and/or (ii) the possible decrease of the participant's commitment over time. Moreover, the same order of application of the instruments for all participants could increase the influence of learning effects and fatigue on these results, although the BREALD-30 and NVS evaluated distinct domains of HL. Likewise, the measurement of HL is focused on some specific dimensions, with a preponderant emphasis on numeracy. Finally, the predictive value of the NVS was exclusively built on oral health outcomes, without considering general health status.

The fields of clinical health and epidemiological research can benefit from the adaptation and validation of the NVS. The researchers can disclose the association between HL and health conditions, through a synthetic analysis of multiple skills needed for the development of HL. The collected data might provide information to health policy makers toward the building of education and counseling strategies, with individualized approaches to deprived groups. Moreover, this tool can inform the clinicians about the ability of patients in understanding and dealing with health instructions, empowering professionals to identify specific groups of individuals with communication drawbacks and low education levels.

In summary, this Brazilian version of the Newest Vital Sign demonstrated appropriate psychometric properties to be applied as an instrument for a rapid screening of individuals with limited HL levels in epidemiological surveys. However, further studies need to be carried out in order to confirm its validity for application in distinct population groups.

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