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The Development and Psychometric Evaluation of the Survey of Obstructive Sleep Apnea Functional Health Literacy

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Background and Objective Obstructive sleep apnea (OSA) is a highly prevalent disorder that disparately affects racial/ethnic minorities. OSA functional health literacy can contribute to health disparities. Documenting poor OSA functional health literacy is needed to inform research agendas, policy, and advocacy efforts. The objective of this study is to develop a scale for measuring OSA functional health literacy among diverse audiences and a variety of reading levels and to ascertain its reliability and validity.

Methods Development of the 18-item Survey of OSA Functional Health Literacy (SOFHL) was guided by literature review and input from experts. A convenience sample of persons enrolled in a clinical trial completed the survey (n = 194). Factor analysis was used to identify the number of dimensions in the SOFHL and their relationship to other domains that are relevant to OSA functional health literacy. Internal consistency reliability (alpha) was estimated for the SOFHL scales and correlations with educational attainment and income computed.

Results All respondents were Black and 29% reported average household income less than $10000 USD. Confirmatory factor analysis provided support for two dimensions: OSA general knowledge (alpha = 0.81) and OSA self-management efficacy (alpha = 0.71). OSA general knowledge was significantly correlated with education (r = 0.41) and income (r = 0.21), and OSA self-management efficacy was significantly correlated with education (r = 0.19) and less depression (r = -0.18).

Conclusions Higher educational attainment and socioeconomic status were associated with better OSA functional health literacy. These results provide preliminary support for the SOFHL, a measure that can be used to assess OSA functional health literacy.

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Key Words Obstructive sleep apnea, Sleep disorders, Health literacy, Surveys and questionnaires.

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INTRODUCTION

Obstructive sleep apnea (OSA) is a sleep disorder characterized by repetitive airway collapses and arousals during sleep. OSA is associated with excessive daytime sleepiness, fatigue, and poor concentration [1]. Individuals with OSA have elevated nervous system activation [2] and are at risk for hypertension and cardiovascular disease [3]; diabetes and depression [4]; and early mortality [5]. Approximately 30% of adults in the United States (U.S.) are at high risk for OSA, with less than half of these reporting an OSA diagnosis [6]. Black and Hispanic/Latino patients are at greater risk for OSA than are Whites [7]. The burden of OSA among racial/ethnic minorities is compounded by lower rates of OSA symptoms awareness and low intentions to seek evaluation and treatment for their condition [8]. Further, in a community-based sam-

ple of Black individuals, only 38% adhered to physician-recommended OSA evaluation [9]. Poor functional health literacy is linked with poorer rates of OSA assessment and limits optimal treatment and self-management of OSA, further exacerbating OSA racial/ethnic health disparities. Previous work suggests low functional health literacy, using general measures, may explain low adherence to recommended care [10].

Functional health literacy refers to the personal, cognitive, and social skills that determine the extent to which individuals can access, understand, and use information to promote and maintain good health [11]. Since most health information is provided in writing, limited literacy skills (reading, writing, and numeracy) are associated with functional limited health literacy pertaining to a particular condition. For example, research has shown that patients with diabetes and hypertension and low literacy skills demonstrate low health condition-specific literacy, such as limited knowledge of symptoms and treatment for their condition [12]. Research conducted by Schillinger et al. [13] among patients with diabetes, found that those with low health literacy were more likely to demonstrate worse disease management, including poor glycemic control and greater likelihood of retinopathy.

Failing to address low levels of functional health literacy may lead to healthcare inefficiencies and higher costs and may also be connected to early mortality [14]. Many of approximately 90 million adults in the U.S. with poor literacy are from lower socioeconomic backgrounds and racial/ethnic minorities [15]. Limited functional health literacy is associated with undiagnosed OSA and cardiovascular disease [16]. Thus, poor functional health literacy among low socioeconomic groups and racial/ethnic minorities limits the assessment of OSA symptom and treatment knowledge among these vulnerable subgroups, hindering our ability to reduce racial/ethnic health disparities.

Chronic diseases, such as OSA, often have complex diagnostic and treatment components [2]. Management of OSA may require disease-specific knowledge about symptom recognition and treatment options to ensure patients understand and feel confident about navigating the course of diagnosis and care [17]. One survey assessing sleep apnea self-efficacy was developed and evaluated in a sample that was primarily White sample (> 65%) [18]. In addition, another survey included sleep apnea knowledge items [18], but the race/ethnicity of the sample used to evaluate it was not reported [19]. Further, the efforts to develop existing scales to assess sleep apnea beliefs, knowledge, self-efficacy, or other domains have not typically reported the readability of the scale. However, research with older Black individuals found that they are prone to survey non-response when items are difficult to read [20]. Therefore, existing sleep apnea questionnaires have not been designed for vulnerable populations (e.g., racial/ethnic minorities) that are at increased risk for OSA.

This study has two objectives. First, we aim to develop the Survey of OSA Functional Health Literacy (SOFHL), a scale for assessing OSA functional health literacy among diverse audiences and a variety of reading levels. Second, we aim to assess the reliability and validity of the SOFHL. The SOFHL will be developed in collaboration with providers, community members, and expert researchers on community and health disparities research. We hypothesize that the lower responses on the SOFHL will be associated with lower income (hypothesis 1) and lower levels of education (hypothesis 2). In addition, building on the prior literature demonstrating that those with OSA are at greater risk for other chronic conditions, including diabetes, depression, hypertension, and heart problems [3,4], and that research has shown patients with these conditions and low literacy demonstrate lower disease-specific knowledge and treatment outcomes [12,13], we hypothesize that those with chronic conditions (hypertension, heart problems, diabetes, or depression) will demonstrate lower SOFHL scores (hypothesis 3).

METHODS

Scale Development

Measures

The development of the SOFHL was grounded in three steps: 1) a literature review, 2) input from experts in community and sleep health disparities research and clinical care, and 3) input from a board of community advisors (Fig. 1).

First, a review of the literature was conducted using PubMed and Google Scholar to identify prevailing functional health literacy components. We used the search criteria 'health literacy' and ('model' or 'conceptual framework' or 'conceptual model'). Our literature identified several methodological and systematic reviews of health literacy conceptual frameworks. Our efforts to design the SOFHL were guided, particularly by the review of frameworks from Cudjoe et al. [21] which identified knowledge and self-efficacy as the two most common conceptual components of health literacy. Our work was also guided by the integrated model of health literacy from Sørensen et al. [22] that articulates the importance of knowledge, competence, and motivation as the components of health literacy, which in turn enable a user to access, understand, appraise, and apply health information.

Second, we identified expert clinicians in the fields of sleep apnea, pulmonology, and critical care who were board-certified sleep specialists in a single, urban geographical area during the survey development phase (n = 6). In an email to the experts, we provided the definition of functional health literacy from the American Medical Association Council on Scientific Affairs as the skills necessary to read and comprehend health-related material and fully function as a patient [23]. We asked the experts to list functional health literacy-related issues associated with OSA care. Authors (RR, AS, GJL, and VNG) reviewed the email responses. Using the constant comparative method of qualitative

Fig. 1. Framework outlining our survey development process.

analysis, which includes several rounds of iterative review, synthesis, and discussion, authors refined the dimensions, supplemented where necessary with the results from the literature review, and then agreed upon a final list for expert review [24]. Then, in a focus group with the experts, we solicited feedback, edited, and then agreed through a majority vote on the expert-approved list of OSA functional health literacy items.

Third, we applied principles of community based participatory research via input from community advisors [25]. Advisors were selected based on their background and experience in health in their community, including faith-based leaders, barber shop owners, health fair organizers, and other individuals. The community advisers (n = 8) were 75% Black, 13% Hispanic/Latino, and 12% multi-racial. We asked the board of community-based advisors for their input on the proposed OSA functional health literacy items identified by experts. In the first phase, we presented the aim of the scale development and a draft of the OSA functional health literacy items. The members were asked to read the measures and provide feedback to the language and clarity of the items. A research assistant took notes during this meeting, and the research team updated measures according to this feedback. In the second phase, members were asked if they believed the measures, language, and comprehension were appropriate and feasible for members of their community.

The initial set of OSA functional health literacy questions consisted of 36-items with exploratory factor analysis suggesting three potential dimensions. Qualitative dimension reduction by committee resulted in 18 items and multi-trait scaling analysis (correlations of items with scales) revealed two constructs: 1) OSA general knowledge (13 items) and 2) OSA self-management efficacy (5 items). OSA general knowledge is the level of understanding or 'knowing' about OSA that varies in level of familiarity, and is gained by education, experience or association. Good OSA general knowledge means being familiar with information at a level that may promote OSA screening, self-management and would be included in public health campaigns targeting OSA. The OSA general knowledge scale items are written as statements of fact that requires choosing one of three response options; "I am confident this is true," "I am not sure this is true," and "I am confident this is not true." OSA general knowledge is an underpinning of OSA functional health literacy.

OSA self-management efficacy is a person's belief or confidence that they can and/or will engage in OSA screening, follow-up, and/or self-care at home, such as exercising or managing the use of devices providing continuous positive airway pressure. OSA self-management efficacy is a strong predictor of a person's ability to function in the context of OSA healthcare. OSA self-management efficacy items are written as questions about

intentions to engage in self-care that begin with the term "How confident are you…," and required choosing one of three response options; "I am confident," "I am not sure," and "I am not confident." The full SOFHL questionnaire is provided in Supplementary Table 1 (in the online-only Data Supplement).

Sociodemographic characteristic

Sociodemographic characteristics measured included age, gender, race, employment, marital status, and health insurance. Educational attainment was measured by asking "What is the highest degree or level of school you have completed?" with response options "high school diploma or less," "some college," "bachelor's degree," and "graduate or professional school." Income was measured by asking "What was your total combined family income for the past 12 months?" with response options < $10000, $10000−$19999, $20000−$39999, $40000−$59999, and ≥ $60000. Health conditions were measured by asking participants "Have you been diagnosed with any of the following health problems?" Health conditions assessed in this study were hypertension, depression, heart problems, and diabetes.

Participants

Two hundred community-dwelling Black participants, at risk for OSA, completed surveys [26]. Eligibility criteria for this trial included 1) self-identification as Black (i.e., African American, Caribbean American, or Black American), 2) English speaking, and 3) at risk for OSA according to the Apnea Risk Evaluation Scale (defined by a score of 4 or higher on this survey) [27]. Participants for this study were recruited from community-based settings in New York City. Specifically, research staff visited faith-based organizations, barber shops, and community centers in predominantly Black neighborhoods. The response rate for the study was 37%. Participants were informed of the study and invited to participate. Interested and eligible participants received a copy of the consent form and were invited to ask the study staff any questions before signing the form and proceeding with the study and completing the baseline questionnaire via tablet computer. All research activities were approved by the NYU Grossman School of Medicine Institutional Review Board (IRB protocol: i13-01011).

Analysis

We used two criteria to identify the number of dimensions for the 18 SOFHL items: 1) parallel analysis [28] and 2) a scree plot of eigenvalues based on squared multiple correlations communality estimates [29]. Then, we estimated associations of the SOFHL scales with other variables [30]: income and educational attainment [31] and health conditions. According to Cohen's rule of thumb [32], 0.100 represents a small correlation, 0.243 a medium correlation, and 0.371 a large correlation. These correlation values are equivalent to the widely known effect size cutoffs of 0.20, 0.50, and 0.80 standard deviation (SD): r = d/SQRT [(d*d) + 4]. Then, differences in means of the SOFHL scales by demographic factors were examined for significance by t-test for dichotomous factors (i.e., hypertension, depression, heart problems, and diabetes) or analysis of variance (ANOVA) with Tukey test for polytomous variables (i.e., income and education).

We hypothesized that SOFHL scores would be positively associated with higher levels of educational attainment (hypothesis 1). Specifically, we posited detecting a medium effect size for the association of SOFHL scores with educational attainment. We hypothesized that SOFHL scores would be positively associated with higher income (hypothesis 2). Specifically, we posited a medium effect size for the association of SOFHL scores with income. Based on Schillinger et al. [13], we hypothesized that SOFHL scores would be inversely associated with hypertension and diabetes health status (hypothesis 3).

Finally, we assessed readability of the SOFHL using the Flesch-Kincaid (F-K) and Flesch reading ease (FRE) reading formals [33,34]. To do so, we calculated average sentence length (ASL, the number of words divided by the number of sentences), and the average number of syllables per word (ASW, the number of syllables divided by the number of words). We used the standard formula for estimating the F-K reading grade level score: (0.39 × ASL) + (11.8 × ASW) - 15.59. We also used the standard FRE formula: 206.835 - (1.015 × ASL) - (84.6 × ASW) [35,36]. Because the readability estimate for a passage is equivalent to the average of the readability of its component sentences, we used the F-K and FRE formulas to assess the readability of single items as well as the survey as a whole. Analyses were conducted with SAS 9.3 (SAS Institute, Inc., Cary, NC, USA).

RESULTS

The average age of the sample was 49 years (SD = 14 years); 100% self-identified as Black, and 51% were female. The highest level of educational attainment reported by 30% of the participants was high school, followed by some college (22%). Among participants, 23% reported earning less than $10000 USD. Thirty-nine percent reported hypertension, 30% reported depression, 18% reported heart problems, and 17% reported diabetes (Table 1).

Exploratory Factor Analysis

Parallel analysis of the 18 SOFHL items, indicated no more than 2 underlying factors and the scree plot of eigenvalues suggested 2 factors. The two-factor promax rotated pattern matrix indicated standardized factor loadings of 0.28 or above for 13 items on the OSA general knowledge factor and 0.22 or higher for 5 items on the OSA self-efficacy factor (Supplementary Table 2 in the online-only Data Supplement). The correlation among the two SOFHL factors (general knowledge and self-efficacy) was 0.38 ($p < 0.001$).

Table 1. Characteristics of the sample (n = 194)

Variable	Value
Age (year)	49 ± 14
Gender	
Male	90 (46)
Female	99 (51)
Missing	5 (3)
Race, Black	194 (100)
Education	
High school	58 (30)
Some college	42 (22)
Bachelor's degree	17 (9)
Graduate or professional school	13 (7)
Missing	64 (33)
Employment	
Employed	65 (34)
Unemployed	85 (44)
Missing	44 (23)
Income	
< $10000	45 (23)
$10000–$19999	33 (17)
$20000–$39999	26 (13)
$40000–$59999	22 (11)
≥ $60000	18 (9)
Missing	50 (26)
Marital status	
Married/living with partner	35 (18)
Separated	9 (5)
Widowed	9 (5)
Never married	13 (7)
Divorced	17 (9)
Single	69 (36)
Missing	42 (22)
Health insurance	
Private	35 (18)
Medicare	34 (18)
Medicaid	71 (37)
Military or Veteran's	2 (1)
None	11 (6)
Missing	41 (21)
Health conditions	
Hypertension	76 (39)
Depression	59 (30)
Heart problems	34 (18)
Diabetes	33 (17)

Data are presented as mean ± standard deviation or n (%).

SOFHL Component 1: OSA General Knowledge

Descriptive statistics for the items are shown in Table 2. Participant responses ranged from low confidence ("I am confident this is not true") for "exercise helps treat sleep apnea" (n = 6, 3%) to high confidence ("I am confident this is true") for "loud snoring can be a sign of sleep apnea" (n = 123, 61%). Product-moment correlations among the OSA knowledge scale items are shown in Table 3, and ranged from 0.02 to 0.56. Cronbach's coefficient alpha was 0.81. The knowledge scale mean was 50.3 (SD = 24.6, range = 92).

SOFHL Component 2: OSA Self-Management Efficacy

Participant responses ranged from low confidence ("I am not confident") in response to the question "How confident are you that you can start walking 15 minutes a day in the next six months?" (n = 5, 2%) to high confidence ("I am confident") for "How confident are you that your health will improve in the next 6 months?" (n = 113, 56%). Correlations among the 5-item OSA self-management efficacy items ranged from 0.09 to 0.49. Cronbach's coefficient alpha was 0.71. The self-efficacy scale had a mean of 62.7 (SD = 28.2, range = 80).

Bivariate Associations of SOFHL Sub-Component Scores with Demographic Variables

Table 4 shows the product-moment correlations between SOFHL sub-component scores (general knowledge and OSA self-management efficacy) with education, income, and chronic conditions (hypertension, depression, heart problems, and diabetes). In Table 4, we report the results of the independent samples t-tests or ANOVA-based significance tests and post hoc analyses comparing SOFHL sub-component means by education, income, and health conditions.

There were significant differences in OSA general knowledge based on education level [$F(2130) = 7.7$, $p < 0.001$; $r = 0.41$, $p < 0.01$]. A Tukey post-hoc test revealed that OSA general knowledge scores were higher in those who reported a bachelor's degree as compared to those who completed high school or fewer years of education (0.21, $p < 0.05$) and in those who reported a graduate or professional degree as compared to those who completed high school or fewer years of education (0.30, $p < 0.05$). Also, OSA general knowledge scores were higher among those who received a graduate or professional degree as compared to those who only completed some college (0.18, $p < 0.05$).

There were significant differences overall in OSA self-management efficacy scores based on education level [$F(3119) = 4.0$, $p < 0.01$; $r = 0.19$, $p < 0.001$). However, the Tukey post-hoc test did not show any significant comparisons of OSA self-management efficacy at each income level.

There were differences in OSA general knowledge based on income [$F(4130) = 3.38$, $p < 0.05$; $r = 0.21$, $p < 0.01$). According to Tukey post-hoc analyses, those reporting income of ≥ $60000

Table 2. Descriptive statistics summarizing responses to the Survey of OSA Functional Health Literacy (n = 194)

	I am confident this is true	I am not sure	I am confident this is not true
OSA general knowledge			
1. When breathing stops during sleep this is called sleep apnea	116 (57)	61 (30)	9 (4)
2. Loud snoring can be a sign of sleep apnea	123 (61)	55 (27)	7 (4)
3. People with sleep apnea can be sleepy during the day	119 (59)	61 (30)	6 (3)
4. Being overweight is the main cause of sleep apnea	76 (38)	86 (43)	22 (11)
5. Using a continuous positive airway pressure machine means sleeping with an air mask	118 (58)	61 (30)	7 (4)
6. Losing weight is part of treating sleep apnea	80 (40)	76 (38)	19 (9)
7. Exercise helps treat sleep apnea	96 (48)	70 (35)	6 (3)
8. Special mouth pieces can be used to treat sleep apnea	71 (35)	89 (44)	13 (6)
9. Sleep apnea can cause depression	81 (40)	84 (42)	9 (4)
10. Walking 15 minutes a day can help treat sleep apnea	40 (20)	115 (57)	18 (9)
11. Waking with a headache can be a sign of sleep apnea	60 (30)	111 (55)	16 (8)
12. Sleep apnea can cause leg cramping	44 (22)	120 (59)	21 (10)
13. The tongue blocking the back of the throat causes sleep apnea	49 (24)	115 (57)	18 (9)
	I am confident	I am not sure	I am not confident
OSA self-management efficacy			
1. How confident are you about having a sleep test done in the next 6 months?	95 (47)	70 (35)	9 (4)
2. How confident are you that you can start walking 15 minutes a day in the next six months?	111 (55)	58 (29)	5 (2)
3. How confident are you that you will develop a nutrition plan in the next 6 months?	91 (45)	75 (37)	9 (4)
4. How confident are you that you can use an air mask every night to treat sleep apnea?	64 (32)	97 (48)	13 (6)
5. How confident are you that your health will improve in the next 6 months?	113 (56)	58 (29)	9 (4)

Data are presented as n (%).
OSA: obstructive sleep apnea.

had higher OSA general knowledge scores as compared to those reporting incomes of < $10000 (0.19, $p < 0.05$).

There were no statistically significant differences in either OSA general knowledge [$t(153) = -0.09$, $p = 0.923$] or OSA self-management efficacy [$t(141) = 1.14$, $p = 0.252$] by hypertension. There were no statistically significant differences in OSA general knowledge by depression [$t(150) = 1.73$, $p = 0.086$], but those without depression (0.65 ± 0.02) had a statistically significant higher score than those with depression (0.54 ± 0.04) on OSA self-management efficacy [$t(140) = 2.20$, $p < 0.05$]. There were no statistically significant differences in either OSA general knowledge [$t(150) = -1.82$, $p = 0.069$] or OSA self-management efficacy [$t(138) = -0.35$, $p = 0.725$] by heart problems. There were no significant differences in either OSA general knowledge [$t(152) = 0.21$, $p = 0.837$] or OSA self-management efficacy [$t(140) = -0.62$, $p = 0.519$].

Readability of the SOFHL

The SOFHL had an overall FRE score of 85 and F-K reading level of approximately 4th grade. The OSA general knowledge sub-component yielded an FRE score of 85 and F-K reading level of approximately 4th grade, while the perceived self-management efficacy yielded an FRE score of 85 and F-K reading level of approximately 6th grade. Item-by-item scores are displayed in Table 5.

DISCUSSION

Documenting community needs is a critical first step to addressing the burden of chronic disease, which is often shouldered disproportionately by race/ethnic minority groups. We developed and evaluated the SOFHL functional health literacy tool pertaining to OSA. Results from this study provide initial support for the reliability and validity of the SOFHL as a measure of OSA functional health literacy with OSA general knowledge and self-management efficacy sub-components, consistent with other health literacy scales [21,22]. Our hypothesis that SOFHL scores would be positively associated with education and income were supported. The finding that SOFHL scores are associated with education and income is consistent with previous research [31]. In our study, there were no significant associations between SOF-

Table 3. Product-moment correlations among Survey of OSA Functional Health Literacy items

	Measure												
	1	2	3	4	5	6	7	8	9	10	11	12	13
OSA general knowledge													
1. When breathing stops during sleep this is called sleep apnea	-												
2. Loud snoring can be a sign of sleep apnea	0.45†	-											
3. People with sleep apnea can be sleepy during the day	0.39†	0.47†	-										
4. Being overweight is the main cause of sleep apnea	0.22†	0.14	0.24†	-									
5. Using a continuous positive airway pressure machine means sleeping with an air mask	0.41†	0.42†	0.56†	0.20†	-								
6. Losing weight is part of treating sleep apnea	0.20†	0.35†	0.40†	0.47†	0.35†	-							
7. Exercise helps treat sleep apnea	0.23†	0.35†	0.50†	0.38†	0.41†	0.56†	-						
8. Special mouth pieces can be used to treat sleep apnea	0.23†	0.31†	0.24†	0.23†	0.32†	0.40†	0.27†	-					
9. Sleep apnea can cause depression	0.14	0.26†	0.31†	0.15	0.34†	0.35†	0.42†	0.23†	-				
10. Walking 15 minutes a day can help treat sleep apnea	0.22†	0.19*	0.07	0.21†	0.18*	0.34†	0.25†	0.12	0.06	-			
11. Waking with a headache can be a sign of sleep apnea	0.29†	0.38†	0.33†	0.17*	0.35†	0.28†	0.24†	0.26†	0.25†	0.12	-		
12. Sleep apnea can cause leg cramping.	0.09	0.34†	0.27†	0.08	0.17*	0.12	0.11	0.17*	0.19†	0.08	0.47†	-	
13. The tongue blocking the back of the throat causes sleep apnea	0.28†	0.21†	0.10	0.18*	0.13	0.05	0.10	0.02	0.21†	0.11	0.26†	0.25†	-
OSA self-management efficacy													
1. How confident are you about having a sleep test done in the next 6 months?	-												
2. How confident are you that you can start walking 15 minutes a day in the next six months?	0.46†	-											
3. How confident are you that you will develop a nutrition plan in the next 6 months?	0.38†	0.49†	-										
4. How confident are you that you can use an air mask every night to treat sleep apnea?	0.16*	0.33†	0.38†	-									
5. How confident are you that your health will improve in the next 6 months?	0.22†	0.43†	0.33†	0.09	-								

*$p < 0.05$, †$p < 0.01$.
OSA: obstructive sleep apnea.

HL responses and health conditions (i.e., hypertension, heart problems, or diabetes), with the exception of an inverse relationship between depression diagnosis and the SOFHL subscale pertaining to OSA self-management efficacy. Our readability estimates indicate that the SOFHL is easy to read for an individual at a 4th grade reading level and overall reading score using the FRE score of 85 (on a scale from 0 to 100, with scores above 80 defined as "easy").

Therefore, the SOFHL is likely to be accessible for a diverse audience from a variety of educational and literacy levels, and have utility for assessing OSA functional health literacy in community-based settings. The development of an accessible measure of OSA functional health literacy is a significant contribution of this study. Few other scales assessing sleep or OSA beliefs or other parameters measured readability statistics, with the exception of the Apnea Knowledge Test which reported a score of 79 FRE formula [19].

A significant body of literature has shown that functional health

literacy is associated with a number of important population health and disease management behaviors, such as adherence to physician-recommended treatment [37], chronic condition self-management [38], and quality of life [39]. Prior research has also demonstrated low rates of general functional health literacy among vulnerable populations [40]. Our findings are consistent with this research, showing that individuals with very low income (i.e., < $10000) and education (i.e., high school diploma) had the lowest SOFHL scores. Our findings may be understood in part by several factors. First, individuals from low-income backgrounds may receive healthcare in low resourced settings where providers do not have enough time or bandwidth to deliver OSA risk or care information. Also, individuals with limited income may live in disinvested neighborhoods, that may also have limited access to parks or areas for walking or exercising and may have few grocery stores or shops with healthy foods. Finally, racism and discrimination, taking either implicit or explicit forms, places individuals from racial/ethnic minority backgrounds and lower socioeconomic strata at risk for a variety of poor health outcomes. Thus, there are clear community and societal influences that place marginalized groups at risk for limited functional health literacy.

Table 4. Product-moment correlations of the Survey of OSA Functional Health Literacy component scores with education, income, and health condition diagnoses (n = 194)

	OSA general knowledge	OSA self-management efficacy
Education	0.41†	0.19‡
Income	0.21*	0.07
Hypertension	0.01	-0.10
Depression	-0.14	-0.18*
Heart problems	0.14	0.03
Diabetes	-0.17	0.06

*p < 0.05, †p < 0.01, ‡p < 0.001.
OSA: obstructive sleep apnea.

It is perplexing that the SOFHL scales were not associated with either hypertension, heart problems, or diabetes. This is contrary to the previous literature, which shows associations between chronic health conditions and health literacy [13]. It could be that, overall, the levels of OSA functional health literacy were quite low in both groups in our study, therefore precluding our ability to observe a significant difference by chronic condition diagnosis.

Functional health literacy is a key component of population health, and is known to be lower among disadvantaged groups, health literacy presents a significant barrier to reducing health

Table 5. Survey of OSA Functional Health Literacy items and F-K and FRE reading level scores

	F-K	FRE
OSA general knowledge		
1. When breathing stops during sleep this is called sleep apnea	4.0	85
2. Loud snoring can be a sign of sleep apnea	4.0	88
3. People with sleep apnea can be sleepy during the day	4.0	78
4. Being overweight is the main cause of sleep apnea	4.0	85
5. Using a continuous positive airway pressure machine means sleeping with an air mask	4.0	87
6. Losing weight is part of treating sleep apnea	4.0	82
7. Exercise helps treat sleep apnea	5.0	66
8. Special mouth pieces can be used to treat sleep apnea	2.0	95
9. Sleep apnea can cause depression	6.0	66
10. Walking 15 minutes a day can help treat sleep apnea	5.0	78
11. Waking with a headache can be a sign of sleep apnea	4.0	88
12. Sleep apnea can cause leg cramping	2.0	88
13. The tongue blocking the back of the throat causes sleep apnea	4.0	88
OSA self-management efficacy		
1. How confident are you about having a sleep test done in the next 6 months?	5.0	84
2. How confident are you that you can start walking 15 minutes a day in the next six months?	7.0	80
3. How confident are you that you will develop a nutrition plan in the next 6 months?	7.0	72
4. How confident are you that you can use an air mask every night to treat sleep apnea?	6.0	79
5. How confident are you that your health will improve in the next 6 months?	4.0	90

F-K scores are interpreted as grade level (i.e., 4th grade level and higher). FRE scores are interpreted as follows: 0–30 (very difficult); 30–50 (difficult); 50–60 (fairly difficulty); 60–70 (standard); 70–80 (fairly easy); 80–90 (easy); 90–100 (very easy).
OSA: obstructive sleep apnea, F-K: Flesch-Kincaid, FRE: Flesch reading ease.

disparities. Without the ability to measure OSA functional health literacy, we have limited means to understand the contributing factors to low OSA functional health literacy, so that we may improve these critical domains and address the inequities in OSA care among vulnerable populations.

Promoting health literacy has been elevated to a national priority for public health management [15]. In accordance with this national imperative, we assert that it is vital to advance functional health literacy pertaining to specific conditions, such as OSA. While several measures for general health literacy exist [11], there are few scales specific to OSA, a condition which disproportionately affects racial/ethnic minorities. Research suggests limited literacy is a significant barrier to health among race/ethnic minority groups. This study described the development of scales to assess aspects of literacy pertaining to sleep apnea knowledge regarding symptoms, diagnostic, and clinical management to facilitate future research to quantify this impediment to OSA management and design interventions that aim to ameliorate OSA disparities.

Limitation and Future Research

This study is subject to at least several limitations. First, although this study aimed to design the SOFHL to assess OSA functional health literacy among diverse audiences and a variety of reading levels, our sample was comprised of a community-based cohort located in a single geographic area. Therefore, our results may not be generalizable to our intended audience, which includes race/ethnic minorities at a variety of reading levels. For instance, the recruited for this study may have unique features that may limit the generalizability of the scale to other race/ethnic groups and geographic locations. A more diverse sample with other racial/ethnic groups is important for future research to ensure the scale is suitable for assessing OSA functional health literacy among other racial/ethnic minority groups that are burdened by OSA such as Hispanic/Latin American and Asian individuals. To address these limitations, future studies should investigate the validity and reliability of the measure in a more heterogenous sample across different settings. Additionally, future research may also examine if the underlying structure of the SOFHL items demonstrated here can be replicated in different samples, such as members of the health system (e.g., nurses or clinicians), so that all information, interactions, and processes could benefit from the ability to assess OSA functional health literacy. Finally, the correlations among measures of the SOFHL ranged from small to large yet were acceptable according to Cohen's rule.

Conclusion

Poor functional health literacy is a significant barrier to timely diagnosis and treatment of OSA. However, most of the research on functional heath literacy relies on general health literacy instead of disease-specific literacy and lacks group tailoring that might elucidate context-based barriers to OSA health literacy germane to racial/ethnic minorities. We developed the SOFHL as a tool to assess OSA functional health literacy. This study summarizes the development of the SOFHL and preliminary findings that the tool may be appropriate, readable, and accessible for patient and community-based populations. In addition, intervention in low socioeconomic status subgroups of the population may benefit from this easy-to-use instrument to identify literacy gaps and to evaluate targeted intervention efforts.

Implications for Policy and Practice

OSA is a prevalent disorder with concerning adverse health outcomes that disparately affects racial/ethnic minorities. OSA functional health literacy can contribute to health disparities. This study summarizes the development of the SOFHL and preliminary findings that the tool may be appropriate, readable, and accessible with the ultimate aim of informing public health efforts to address OSA race/ethnic disparities.

Supplementary Materials

The online-only Data Supplement is available with this article at https://doi.org/10.17241/smr.2021.00885.

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Conflicts of Interest

The authors have no financial conflicts of interest.

Authors' Contribution

Conceptualization: Robbins R, Seixas A, Newsome Garcia V, Hays RD, Calderón JL, Jean-Louis G. Data curation: Robbins R, Hays RD. Formal analysis: Hays RD. Funding acquisition: Jean-Louis G. Project administration: Robbins R, Seixas A. Writing—original draft: Robbins R. Writing—review & editing: all authors.

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Supplementary Table 1. The SOFHL

	(1) I am confident this is true	(2) I am not sure	(3) I am confident this is not true
Please choose the option that best matches your response			
1. When breathing stops during sleep this is called sleep apnea	☐	☐	☐
2. Loud snoring can be a sign of sleep apnea	☐	☐	☐
3. People with sleep apnea can be sleepy during the day	☐	☐	☐
4. Being overweight is the main cause of sleep apnea	☐	☐	☐
5. Using a continuous positive airway pressure machine means sleeping with an air mask	☐	☐	☐
6. Losing weight is part of treating sleep apnea	☐	☐	☐
7. Exercise helps treat sleep apnea	☐	☐	☐
8. Special mouth pieces can be used to treat sleep apnea	☐	☐	☐
9. Sleep apnea can cause depression	☐	☐	☐
10. Walking 15 minutes a day can help treat sleep apnea	☐	☐	☐
11. Waking with a headache can be a sign of sleep apnea	☐	☐	☐
12. Sleep apnea can cause leg cramping	☐	☐	☐
13. The tongue blocking the back of the throat causes sleep apnea	☐	☐	☐
	(1) I am confident	(2) I am not sure	(3) I am not confident
Please choose the option that best matches your response			
1. How confident are you about having a sleep test done in the next 6 months?	☐	☐	☐
2. How confident are you that you can start walking 15 minutes a day in the next 6 months?	☐	☐	☐
3. How confident are you that you will develop a nutrition plan in the next 6 months?	☐	☐	☐
4. How confident are you that you can use an air mask every night to treat sleep apnea?	☐	☐	☐
5. How confident are you that your health will improve in the next 6 months?	☐	☐	☐

Scoring instructions: The SOFHL can be scored by measuring the proportion of correct answers in each component to total questions in each component. To score the general knowledge component, count the number of '1' responses over 13 total questions for a % score. To score the self-efficacy component, count the number of '1' responses over 5 total questions for a % score. Higher scores on each component indicate higher overall levels of OSA functional health literacy.
OSA: obstructive sleep apnea, SOFHL: Survey of OSA Functional Health Literacy.

Supplementary Table 2. Results of the oblique promax rotation common factor analysis of Survey of OSA Functional Health Literacy items indicating support for a two-factor solution

	Factor 1	Factor 2
1. When breathing stops during sleep this is called sleep apnea	0.50	-0.01
2. Loud snoring can be a sign of sleep apnea	0.37	-0.16
3. People with sleep apnea can be sleepy during the day	0.58	0.17
4. Being overweight is the main cause of sleep apnea	0.49	-0.19
5. Using a continuous positive airway pressure machine means sleeping with an air mask	0.56	0.22
6. Losing weight is part of treating sleep apnea	0.67	-0.04
7. Exercise helps treat sleep apnea	0.57	0.17
8. Special mouth pieces can be used to treat sleep apnea	0.59	0.02
9. Sleep apnea can cause depression	0.47	0.06
10. Walking 15 minutes a day can help treat sleep apnea	0.28	-0.01
11. Waking with a headache can be a sign of sleep apnea	0.59	-0.04
12. Sleep apnea can cause leg cramping	0.50	-0.12
13. The tongue blocking the back of the throat causes sleep apnea	0.37	-0.16
Please choose the option that best matches your response		
1. How confident are you about having a sleep test done in the next 6 months?	0.11	0.45
2. How confident are you that you can start walking 15 minutes a day in the next 6 months?	0.33	0.51
3. How confident are you that you will develop a nutrition plan in the next 6 months?	0.19	0.47
4. How confident are you that you can use an air mask every night to treat sleep apnea?	0.31	0.22
5. How confident are you that your health will improve in the next 6 months?	0.03	0.61

OSA: obstructive sleep apnea.