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SCIENTIFIC INVESTIGATIONS

Tailored Approach to Sleep Health Education (TASHE): a randomized controlled trial of a web-based application

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Study Objectives: In a randomized controlled trial, we compared the effect of the Tailored Approach to Sleep Health Education (TASHE) on obstructive sleep apnea (OSA) self-efficacy among community-dwelling blacks in New York City.

Methods: Study participants were 194 blacks at high risk for OSA based on the Apnea Risk Evaluation System. TASHE intervention was delivered via a Wi-Fi–enabled tablet, programmed to provide online access to culturally and linguistically tailored information designed to address unique barriers to OSA care among blacks. Blacks in the attention-controlled arm received standard sleep information via the National Sleep Foundation website. Blacks in both arms accessed online sleep information for 2 months. Outcomes (OSA health literacy, self-efficacy, knowledge and beliefs, and sleep hygiene) were assessed at baseline, at 2 months, and at 6 months.

Results: We compared outcomes in both arms based on intention-to-treat analysis using adjusted Generalized Linear Mixed Modeling. TASHE exposure significantly increased OSA self-efficacy (OSA outcome expectation [β = .5; 95% CI: .1–.9] and OSA treatment efficacy [β = 0.4; 95% CI: .0–.8]) at 2 months but not at 6 months. Additionally, TASHE exposure improved sleep hygiene at 6 months (β = 6.7; 95% CI: 2.2–11.3) but not at 2 months.

Conclusions: Community-dwelling blacks exposed to TASHE materials reported increased OSA self-efficacy compared with standard sleep health education. Stakeholder-engaged, theory-based approaches, as demonstrated in the TASHE intervention, can be used successfully to deliver effective sleep health messages.

Clinical Trial Registration: Registry: ClinicalTrials.gov; URL: https://clinicaltrials.gov/ct2/show/NCT02507089; Identifier: NCT02507089.

Keywords: obstructive sleep apnea, sleep apnea, health disparities, black Americans, health communication

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BRIEF SUMMARY

Current Knowledge/Study Rationale: Blacks are twice as likely as whites to be at risk of obstructive sleep apnea (OSA), which is associated with adverse health outcomes. Despite these disparities, interventions aimed at OSA-related morbidity and mortality among blacks are limited.

Study Impact: This study evaluated a novel, web-based educational tool designed to address specific barriers to access adequate OSA care among blacks at risk of OSA. In this paper, we report the results of a randomized controlled trial that evaluated the effectiveness of tailored sleep health messages, versus nontailored messages, among community-dwelling blacks at risk of OSA.

INTRODUCTION

Obstructive sleep apnea (OSA) significantly increases the risk of hypertension,[1] cardiovascular diseases,[2] and diabetes.[3] Evidence shows that individuals who are untreated incur higher health care costs, relative to those in treatment.[4] In light of such evidence, both the National Academy of Medicine and the National Institutes of Health recognize OSA as a chronic disease requiring novel strategies to increase adoption of evidence-based treatment to reduce OSA-related morbidity and health care costs.[5] Despite the national recognition of the public health impact of OSA and availability of evidence-based therapies,[6–8] progress in reducing OSA-related morbidity and mortality has been limited. This is particularly notable among blacks, who experience a disproportionate OSA burden relative to their white counterparts[9,10] and are characterized by greater risks of adverse OSA-related health outcomes.[11,12] That poor adoption of physician-recommended sleep care[13] is likely the strongest contributor to the greater OSA burden among blacks,[1,14] rendering OSA a prime target for behavioral intervention to increase adherence to recommended care in this vulnerable group.[15]

Other factors, including psychosocial influences, are also important in understanding the disparity in OSA prevalence among blacks.[1,3–5] Evidence from our prior work suggested that only 38% of blacks adhered to physician-recommended OSA care.[13] This is in line with qualitative research conducted among

black men, which showed that they exhibited low intention to seek evaluation and treatment of OSA.[16] Indeed, focus-group data showed few were able to identify symptoms of OSA or knew the consequences of OSA.[16,17] Some even reported many false beliefs about OSA, such as OSA is a symptom of insomnia or that OSA has no bearing on chronic metabolic conditions (eg, hypertension, diabetes, obesity).

Efforts have been made to address factors hindering adherence to recommended OSA care. However, attention has been paid mainly to perceived benefits of treatment,[18–20] rather than self-efficacy, the most important predictor of adherence to recommended care according to decades of research applying Bandura's social cognitive theory.[21] Converging evidence demonstrates that individuals with a high level of self-efficacy are more likely to engage in action-oriented healthful behavior, such as speaking to a health care provider or seeking physician-recommended medical care.[22,23] Self-efficacy refers to individuals' belief in their ability to perform recommended care tasks, such as seeking or adhering to recommended OSA evaluation and treatment in the field of sleep medicine.[24,25] It is evident that the failure to implement interventions to increase self-efficacy among blacks at risk of OSA may be, in part, liable for the observed undertreatment of OSA in this vulnerable population.[26]

Consistent with the National Institutes of Health's Sleep Disorders Research Plan seeking to promote sleep health nationally, we developed the Tailored Approach to Sleep Health Education (TASHE), a novel web-based educational tool, to deliver OSA health messages to community-dwelling blacks at risk of OSA. The TASHE materials were designed to provide culturally and linguistically tailored sleep health information to blacks to assist them in navigating the complex process of making informed decisions regarding OSA care. In this paper, we report the results of our randomized controlled trial (RCT) that evaluated the effectiveness of the tailored sleep health messages in improving OSA self-efficacy among community-dwelling blacks at risk of OSA.

METHODS

Study design and setting

In a 2-arm RCT we tested the effect of TASHE, versus attention-control, on OSA self-efficacy among community-dwelling blacks in New York City. Specifically, we administered validated questionnaires at baseline and compared responses at 2 months and 6 months postexposure to test the following hypotheses: participants in the TASHE condition will demonstrate higher OSA self-efficacy,[28] greater sleep apnea beliefs and knowledge, improved sleep hygiene,[29] and higher OSA-specific health literacy[30] compared with those in the control condition.

Participants were recruited from community-based settings, including faith-based organizations, community centers, barbershops, and beauty salons. Individuals were randomized to receive either a WiFi-enabled, preprogrammed tablet with access to the TASHE website (intervention) or nontailored OSA informational materials currently available at the National Sleep Foundation (attention control). Participants were asked to review tablet-delivered information regularly and received messages sent to their mobile device with reminders to review the TASHE website during a 2-month period, at which time they were asked to come back to the study center to return their tablet. Surveys were administered at baseline and 2 and 6 months.[27] All participants provided written informed consent approved by the Intuitional Review Board of NYU Langone Health.

Participants

A total of 524 potentially eligible individuals were contacted and recruited, 194 of whom met eligibility criteria and were enrolled into the study. Eligibility criteria included those who self-identified as black, African American, or Caribbean American; were 18 years of age or older; and were at moderate or greater risk of OSA, determined as a score of 4 or greater on the Apnea Risk Evaluation System,[31] which was used in previous studies involving blacks.[15] This screening tool includes questions on sleep patterns, daytime functioning, excessive daytime sleepiness, snoring and gasping, height, weight, neck size, sex, and diseases associated with risk of OSA (ie, hypertension, heart disease). Its validity is well documented with a sensitivity of.94, a specificity of.79, and a positive-predictive value of.91.[32] Those who met all study selection criteria were randomized to treatment groups immediately after screening. Randomization was accomplished by a computer-generated randomization paradigm. **Figure 1** shows the flow of participants through the study protocol using the CONSORT (Consolidated Standards of Reporting Trials) diagram. The TASHE website featured culturally and linguistically tailored sleep informational content, including texts and videos that were developed to align with the needs of blacks, to decrease cognitive load and to render messages understandable and actionable.

Measures

Participants completed surveys that captured demographic and clinical characteristics in addition to psychosocial and sleep-related factors at baseline, 2 months, and 6 months postenrollment.

Demographic and health variables

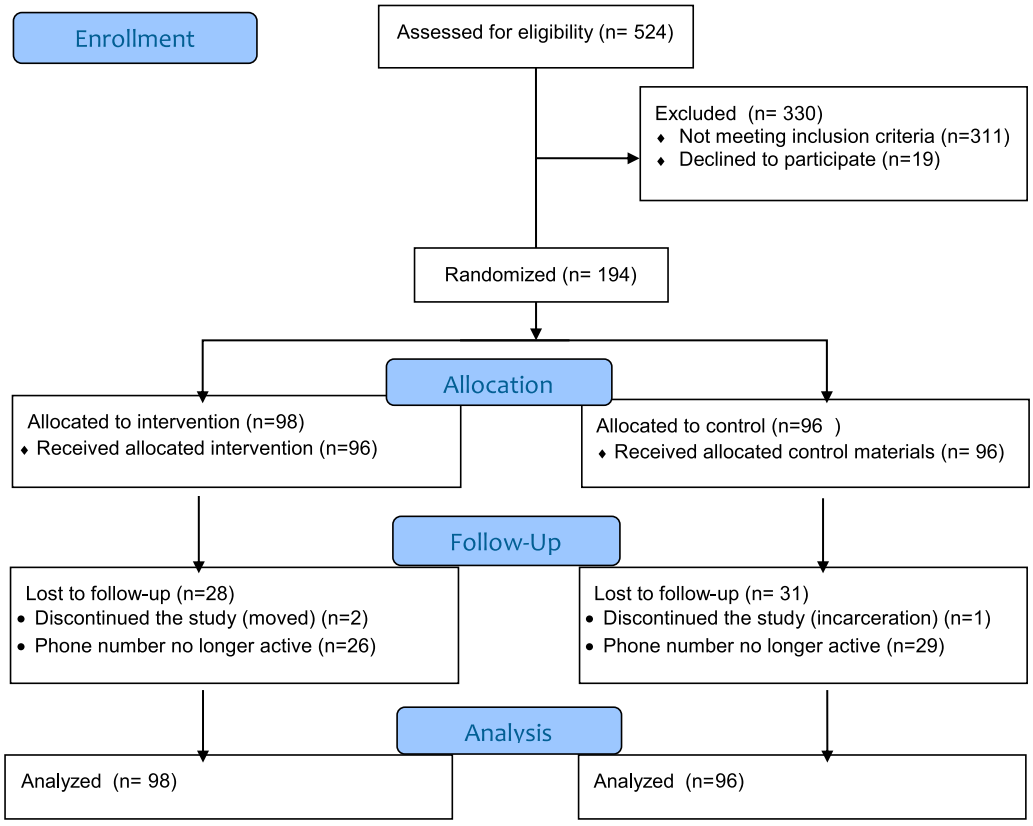
Participants provided responses to demographic questions including age, sex, education, income, marital status, and health insurance. They were asked whether they had received a diagnosis of chronic health conditions, including medical and psychological illnesses. Additionally, we administered the Center for Epidemiologic Studies–Depression scale, a short self-report scale designed to measure depressive symptomatology in the general population.[33]

Our primary outcome measure was OSA self-efficacy. Secondary outcomes included OSA risk, health literacy, and knowledge and beliefs as well as sleep hygiene.

OSA self-efficacy

OSA self-efficacy was assessed using the 26-item Sleep Apnea Self Efficacy (SEMSA) scale.[28] Participants were asked to respond to a series of statements regarding their confidence in using recommended OSA treatment, which includes using a positive airway pressure (PAP) device during sleep at night,

Figure 1—CONSORT diagram outlining the flow of participants through the TASHE study.



CONSORT = Consolidated Standards of Reporting Trials; TASHE = Tailored Approach to Sleep Health Education.

despite certain challenges such as travel, disturbing a bed partner, or nasal stuffiness, using 4-point scales of validity ("not at all true" to "very true"). Responses were averaged into 3 cognitive subscales, including the perceived risk of OSA (eg, the extent to which a participant believes he or she is at risk for OSA), PAP outcome expectations (eg, that OSA conditions can improve and yield desirable benefits such as improved quality of life), and treatment efficacy (eg, the extent to which a participant believes treatment will improve his or her condition). Lower responses indicated lower OSA self-efficacy.

OSA health literacy

OSA health literacy was assessed with the newly developed Sleep Apnea Health Literacy Scale (SAHLS), a validated scale for assessing knowledge about OSA symptoms, treatment, and maintenance.[30] The SAHLS contains 15 items, which examined literacy regarding OSA treatment and symptoms. Participants marked responses on 3-point scales based on statements ranging from 1 ("I am certain this is not true") to 2 ("I am not sure") and 3 ("I am very certain this is true"). The responses were summed to provide a single score on the OSA health literacy scale, whereby higher scores indicated higher literacy levels.

OSA risk

OSA risk was measured with the validated Apnea Risk Evaluation System scale,[31] which assesses OSA risk factors, including chronic conditions, neck size, drowsiness during various daily activities (eg, "lying down in the afternoon" on a 4-point scale of drowsiness), and snoring (eg, "how often have you snored" on a 4-point scale of frequency). Sleep hygiene practices were examined using the Sleep Hygiene Index (SHI), a 13-item scale assessing unhealthy sleep practices with responses summed to indicate a global assessment of poor sleep hygiene. Responses were collected on a 5-point scale, with high scores indicating worse sleep hygiene.

OSA knowledge and beliefs

The validated Apnea Knowledge Test (AKT)[34] was utilized to assess knowledge and beliefs; this questionnaire is designed to assess respondents' knowledge of OSA and treatment using PAP based on 13 multiple-choice items. High AKT scores indicated better knowledge of OSA and its treatment; lower scores indicated poor understanding of OSA and PAP. Second, OSA-related beliefs were examined using the validated Apnea Belief Scale (ABS)[34]; this is a questionnaire that includes 24 statements that evaluated patients' beliefs about OSA and PAP treatment.[34] Scores on the ABS range from low (24) to high (120); high ABS scores indicate accurate beliefs about the illness and treatment and lower scores indicate misconceptions about OSA and PAP usage.

Interventions

Our previous research revealed several barriers to OSA care, which were used to develop sleep health information in this web-based educational tool.[13,15] The messages embedded in TASHE were written at the fifth- to sixth-grade reading level as determined by the Flesch Kincaid Reading Ease formulas.[35,36] The messages also included visuals (eg, pictures and videos), which intentionally featured black role models addressing various aspects of OSA care delivery to ensure a high degree of congruence with the intended audience. Thus, the TASHE website is unique in delivering OSA materials to blacks in a manner that enhanced acceptability of the messages and autonomous decision making.

TASHE messages were developed within a health literacy framework using criteria from the Suitability Assessment of Materials. Accordingly, messages were drafted in a way that minimizes the use of jargon to decrease cognitive load.[37] Messages were also developed based on established message-tailoring strategy, requiring that video content be consistent with previous research, which advocates that messages reflect the realities of patients living in similar communities.[38] Perhaps more importantly, content of the TASHE website was developed using a stakeholder-engaged process including patients with OSA, community health champions, and health care providers (**Figure 2**).[39] This community-engaged method is considered an effective approach to develop health interventions that address health disparities.[40]

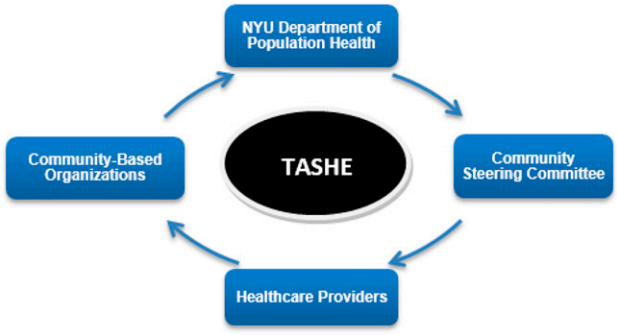
We performed heuristic testing to solicit feedback from community-dwelling blacks to ensure the intervention was sufficiently and appropriately tailored to their needs and easy to understand and use. In-depth interviews were conducted for the heuristic testing in accordance with the "think aloud" one-on-one interview protocol.[39] All participants randomized to the TASHE arm received a WiFi-enabled, preprogrammed tablet and were prompted to review the materials on their tablet within the first week of randomization. Results of the heuristic testing supported the approach and utilization of the web-based tool. Results also enabled final design changes (eg, addition of a location-enabled map to identify nearby sleep clinics)[39] prior to the deployment of the clinical trial described herein.

Participants in the RCT were asked to review materials weekly for 2 months before returning to the research office to complete their follow-up assessments. Illustrations of the TASHE-based materials are provided in **Figure 3**. Details of the study design can be found elsewhere.[27] Individuals randomized to the attention-control arm were exposed to nontailored websites, which included online resources from national organizations (eg, the National Sleep Foundation). Previous studies have suggested that most health information websites largely feature content at a 10th-grade reading level.[41]

Statistical analyses

All data were collected at baseline and 2 and 6 months post-enrollment. All study demographic factors were compared between TASHE and control using the appropriate statistical test (either chi-square or analysis of variance [ANOVA]). Sleep and OSA outcomes were compared between the intervention and control arms using repeated-measures ANOVA with a Greenhouse-Geisser correction for F values. The primary outcome (SEMSA) and secondary outcomes were assessed at each time point. We conducted intention-to-treat analyses and mixed-effects linear modeling with robust estimation to model the effect of exposure to the TASHE intervention, compared with data from the control arm, over time (baseline, 2 months, and 6 months) on outcome variables. We tested 3 separate models: (1) unadjusted, (2) age and sex adjusted, and (3) remaining covariates, including income, employment, marital status, depression, and OSA risk factors (eg, alcohol consumption and smoking history). All data were analyzed using SPSS version 25 (IBM Corporation, Armonk, NY).

Figure 2—Multilevel community-engaged model for developing the TASHE intervention.



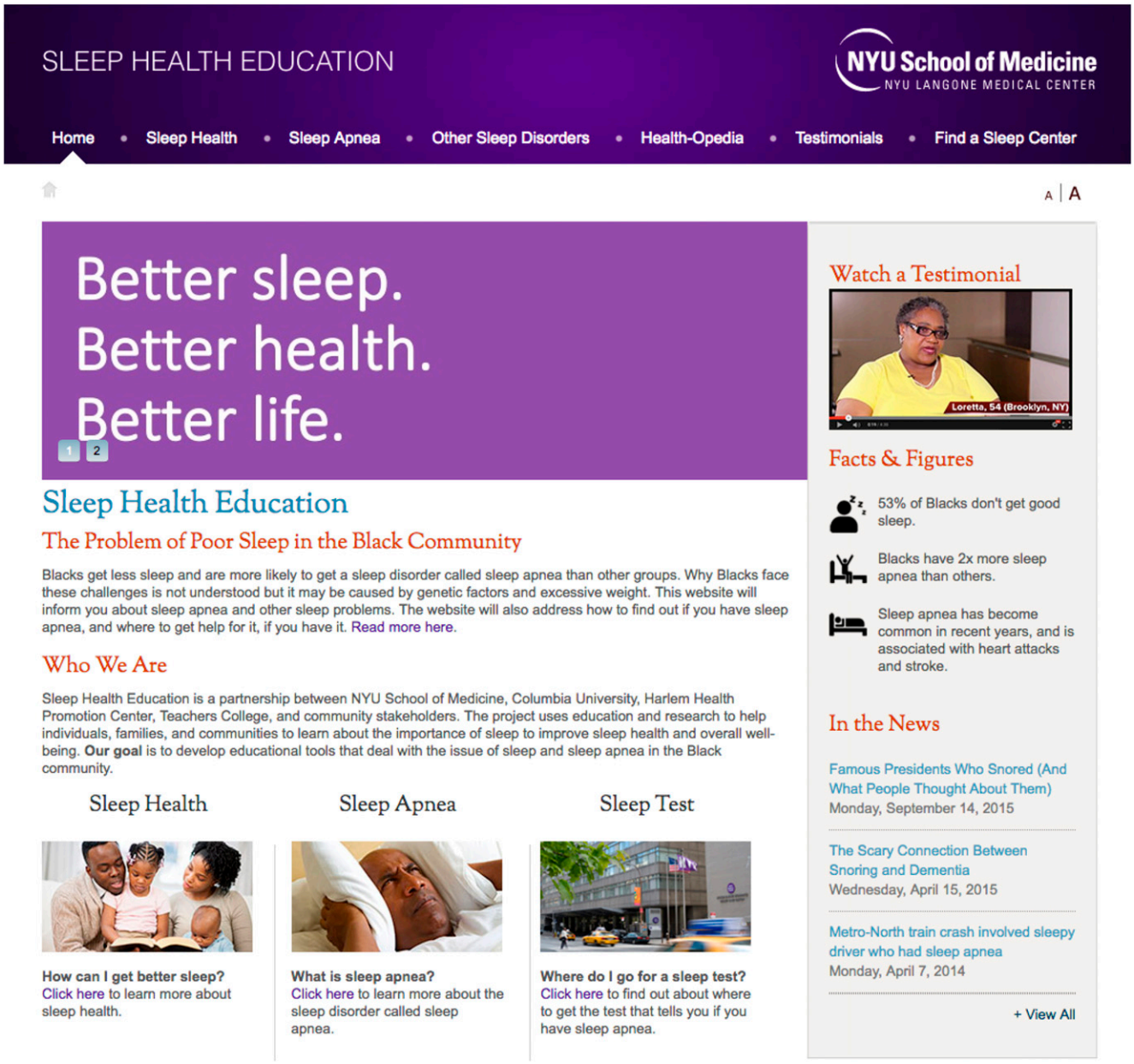
NYU, New York University; TASHE = Tailored Approach to Sleep Health Education.

RESULTS

We recruited 194 individuals (30.4% were lost to follow-up in both arms; see the CONSORT flow diagram in **Figure 1**). Overall, there were no significant differences in demographic characteristics of participants in the 2 study arms at baseline. Similarly, participants did not differ with regard to self-reported health status and physician-diagnosed chronic health conditions (**Table 1**).

Table 2 displays self-reported outcome measures for participants in the TASHE and attention-controlled arms, at baseline and 2 and 6 months postrandomization. According to repeated-measures ANOVA, SAHLS scores did not vary significantly by condition ($F = .92$; $P = .642$). SHI scores did not vary significantly by condition ($F = .85$; $P = .410$). Apnea belief scores did not vary significantly by condition ($F = .67$; $P = .110$). Apnea knowledge scores did not vary significantly by condition ($F = .93$; $P = .684$). SEMSA risk did not vary significantly by condition ($F = .74$; $P = .105$). SEMSA outcome expectations did vary significantly by condition ($F = .57$; $P = .001$), and SEMSA treatment expectations did not vary significantly by condition ($F = .91$; $P = .585$).

Figure 3—Screenshots of the TASHE website intervention materials.



TASHE = Tailored Approach to Sleep Health Education.

Effect of the intervention on primary outcomes—SEMSA

As shown in Table 3, compared with the control condition, there was a significant positive effect of the intervention on the outcome expectation dimension of the SEMSA scale, at the 2-month assessment period (model 1β = 0.5; 95% CI: 0.1, 0.9), with adequate adjustment for age and sex effects; similar results were obtained for responses measured at 2 months, adjusting for all other demographic covariates (model 2: β = 0.7; 95% CI: 0.3, 1.1). A significant positive effect of the intervention exposure was noted for the treatment efficacy dimension of OSA self-efficacy at 2 months after controlling for demographic factors (model 1: β = 0.4; 95% CI: 0.0, 0.8) and for additional covariates, including depression, marital status, income, depression, employment, and alcohol consumption (β = 0.6; 95% CI: 0.1, 1.1).

Effect of the intervention on secondary outcomes

There was no significant difference between the TASHE and attention-controlled arms for apnea knowledge or apnea beliefs scores. Results from the mixed-effects model revealed a significant positive effect of the intervention on several sleep measures. First, compared with participants in the control arm, those in the intervention arm demonstrated a significant increase in SHI at 6 months controlling for age and sex (model 1:

Table 1—Participant baseline characteristics (total and by group assignment).

Variable	Total (N = 194)		Control (n = 98)		Intervention (n = 96)		*P*
	n	%	n	%	n	%	
Age*	48.6 ± 14.09		48.9 ± 13.75		48.4 ± 14.43		.814
Sex							.956
Male	90	47.6	46	47.4	44	47.8	
Female	99	52.4	51	52.6	48	52.2	
Race/ethnicity							.281
Black	194	100.0	98	100.0	96	100.0	
Education							.465
High school	58	38.1	31	20.3	27	17.8	
Some college	42	27.6	26	17.1	16	10.5	
Technical school certificate	8	5.2	4	2.6	4	2.6	
Associate degree	14	9.2	9	5.9	5	3.3	
Bachelor's degree	17	11.1	6	3.9	11	7.2	
Graduate or professional school	13	8.5	7	4.6	6	3.9	
Employment							.050
Employed	65	43.3	41	50.0	24	35.3	
Unemployed	85	56.7	41	50.0	44	64.7	
Income							.564
<$10,000	45	29.4	25	16.3	20	13.1	
$10,000–$19,999	33	21.6	16	10.5	17	11.1	
$20,000–$39,999	26	17.0	18	11.8	8	5.2	
$40,000–$59,999	22	14.4	9	5.9	13	8.5	
$60,000–$100,000	18	11.8	11	7.2	7	4.6	
>$100,000	9	5.9	3	2.0	6	3.9	
Marital status							.655
Married/living with partner	35	23.0	22	14.5	13	8.6	
Separated	9	5.9	5	3.3	4	2.6	
Widowed	9	5.9	3	2.0	6	3.9	
Never married	13	8.6	6	3.9	7	4.6	
Divorced	17	11.2	10	6.6	7	4.6	
Single	69	45.4	38	25.0	31	20.4	
Health insurance							
Private	35	21.9	19	20.7	16	23.5	.622
Medicare	34	21.3	16	18.4	18	26.5	.654
Medicaid	71	44.4	44	50.6	27	39.7	.015
HMO	7	4.4	6	6.9	1	1.5	.058
Military or veteran's	2	1.3	2	2.3	0	0.0	.160
None	11	6.9	5	5.7	6	8.8	.728
Chronic conditions							
Hypertension	76	42.0	34	18.8	42	23.2	.085
Diabetes	32	17.8	14	7.8	18	10.0	.214
Depression	58	32.6	27	15.2	31	17.4	.246
Anxiety	58	32.4	29	16.2	29	16.2	.419
Heart problems	34	19.2	17	9.6	17	9.6	.459
Sleep apnea	55	31.5	26	14.9	29	16.6	.216

(continued on following page)

Table 1—Participant baseline characteristics (total and by group assignment). (continued)

Variable	Total (N = 194)		Control (n = 98)		Intervention (n = 96)		*P*
	n	%	n	%	n	%	
Self-reported health							.112
Excellent	13	7.3	8	4.5	5	2.8	
Very good	53	30.0	29	16.4	24	13.6	
Good	59	33.3	25	14.1	34	19.2	
Fair	48	27.1	28	15.8	20	11.3	
Poor	4	2.2	2	1.1	2	1.1	
Depression (CES-D)*	17.9 ± 11.4		18.1 ± 11.7		17.6 ± 10.9		.340
Apnea Risk Evaluation System							
OSA risk							.458
Mild	63	39.1	32	19.88	31	19.3	
Moderate	59	36.6	28	17.39	31	19.3	
Severe	39	24.2	21	13.04	18	11.2	

N = 194. *P* values reported correspond to the appropriate statistical test, including either ANOVA or chi-square. ANOVA = analysis of variance; CES-D = Center for Epidemiologic Studies–Depression; HMO = health maintenance organization; OSA = obstructive sleep apnea.
*Values represent means ± SDs.

Table 2—Comparing self-reported sleep outcome measures captured at baseline and at 2 and 6 months using repeated-measures ANOVA.

Sleep-Related Outcomes	Baseline	2 Months	6 Months	*F, P* Value
SAHLS				.92, .642
Intervention	11.8 ± 7.6	15.7 ± 5.8	16.3 ± 7.4	
Control	13.7 ± 6.5	16.3 ± 6.0	16.8 ± 4.6	
SHI				.85, .410
Intervention	20.4 ± 9.6	17.9 ± 9.8	19.8 ± 8.4	
Control	22.1 ± 9.6	18.7 ± 9.9	15.0 ± 9.1	
ABS				.67, .110
Intervention	62.2 ± 21.7	69.7 ± 16.2	64.9 ± 23.8	
Control	61.8 ± 25.1	60.0 ± 25.3	62.3 ± 21.2	
AKT				.93, .684
Intervention	2.7 ± 1.9	3.3 ± 1.8	3.4 ± 1.7	
Control	2.8 ± 1.7	3.2 ± 1.8	3.6 ± 1.7	
SEMSA				
Risk Perception				.74, .105
Intervention	2.2 ± 0.7	2.4 ± 0.7	2.6 ± 0.8	
Control	2.3 ± 0.7	2.5 ± 0.8	2.4 ± 0.8	
Outcome Expectation				.57, .001
Intervention	2.5 ± 0.9	3.0 ± 0.7	3.1 ± 0.9	
Control	2.7 ± 0.7	2.9 ± 0.8	3.2 ± 0.7	
Treatment Efficacy				.91, .585
Intervention	2.2 ± 0.9	2.6 ± 0.7	2.7 ± 0.7	
Control	2.5 ± 0.8	2.6 ± 0.9	2.9 ± 1.0	

Values are means ± SDs unless otherwise indicated; N = 194. *P* values reported correspond to the repeated measures ANOVA. ABS = Apnea Belief Scale; AKT = Apnea Knowledge Test; ANOVA = analysis of variance; SAHLS = Sleep Apnea Health Literacy Scale; SEMSA = Self-Efficacy Measure for Sleep Apnea; SHI = Sleep Hygiene Inventory.

Table 3—Mixed-effects modeling of the intervention effect on sleep outcomes.

	Model 1			Model 2		
	β	95% CI		β	95% CI	
		Lower	Upper		Lower	Upper
SAHLS						
Intervention × time (2 months)	1.0	−2.3	4.3	7.3	1.7	13.0
Intervention × time (6 months)	2.4	−3.9	8.8	3.2	−0.8	7.3
SHI						
Intervention × time (2 months)	0.9	−2.7	4.4	1.7	−2.8	6.2
Intervention × time (6 months)	6.7*	2.2	11.3	3.0	−2.6	8.5
ABS						
Intervention × time (2 months)	9.4	−0.9	19.7	9.5	−2.3	21.4
Intervention × time (6 months)	2.8	−9.0	14.6	3.1	−8.8	14.9
AKT						
Intervention × time (2 months)	0.1	−0.6	0.8	0.3	−0.5	1.1
Intervention × time (6 months)	-0.2	−1.1	0.8	−0.6	−1.7	0.4
SEMSA						
Risk Perception						
Intervention × time (2 months)	0.1	−0.2	0.4	0.1	−0.3	0.5
Intervention × time (6 months)	0.2	−0.2	0.6	0.2	−0.3	0.6
Outcome Expectation						
Intervention × time (2 months)	0.5*	0.1	0.9	0.7*	0.3	1.1
Intervention × time (6 months)	0.2	−0.3	0.7	0.2	−0.3	0.7
Treatment Efficacy						
Intervention × time (2 months)	0.4*	0.0	0.8	0.6*	0.1	1.1
Intervention × time (6 months)	0.1	−0.4	0.6	0.1	−0.5	0.7

N = 194. Model 1 adjusted for age and sex covariates. Model 2 adjusted for model 1 plus all additional covariates, including marital status, income, depression, employment, alcohol consumption. ABS = Apnea Belief Scale; AKT = Apnea Knowledge Test; CI, confidence interval; SAHLS = Sleep Apnea Health Literacy Scale; SEMSA = Self-Efficacy Measure for Sleep Apnea; SHI = Sleep Hygiene Inventory.
*Significant ($P < 0.05$).

β = 6.7; 95% CI: 2.2, 11.3). However, this effect was no longer significant after adjusting for marital status, income, employment, depression, alcohol consumption, and smoking history. There was no difference in SAHLS between the TASHE and control arms.

DISCUSSION

In this study, we developed and tested the effectiveness of the web-based tool referred to as the TASHE. The main finding of this RCT is that exposure to the TASHE materials was associated with a significant increase in self-efficacy at 2 months, as measured by the SEMSA. However, this effect was not sustained at 6 months. Specifically, we observed a significant, positive effect on OSA outcome expectation and treatment efficacy at 2 months postexposure. Analyses of secondary outcomes showed that participants exposed to the TASHE materials exhibited a significant improvement in sleep hygiene, independent of participants' sex and age. However, the results were not significant after adjusting for marital status, household income, employment status, alcohol consumption, and the presence of depression.

These findings are consistent with the extant literature showing that self-efficacy is a strong predictor of the likelihood that individuals will engage in desired behavior change in health practices.[21] Further, as our study showed a positive effect on the outcome expectation and treatment efficacy dimensions of the SEMSA scale, constructs that are similar to the notion of perceived benefits, this finding is congruent with previous research, which has shown that perceived benefits of OSA treatment is associated with increased adherence behavior.[18–20] The utilization of OSA self-efficacy in our study enables a direct contrast with evidence based on observations from other fields of study. Indeed, a meta-analysis of 79 RCTs showed that behavioral interventions improved self-efficacy among patients with cancer.[42] Evidence also suggests that self-efficacy is an important construct in understanding behavior change among patients with cardiovascular disease.[43] The present study addressed this important gap in the sleep field, which relates to lack of systematic studies investigating effects of behavioral and educational programs on improving OSA

self-efficacy care, although it is evident that individuals at risk of OSA do not routinely seek OSA care.[44,45] Notwithstanding, it is worth noting that a systematic review highlighted a few creative strategies that could be used to increase adherence to recommended OSA care.[46] One such behavioral intervention showed improvement in OSA self-efficacy, leading to increased use of positive airway pressure therapy.[47] Yet, none of the published studies were designed specifically to increase OSA care among black/African-American populations. Thus, our study makes a significant contribution to the field of sleep medicine by demonstrating the usefulness of a tailored educational website in improving OSA self-efficacy among blacks, a group that is at high risk of OSA.

Research has shown that, although blacks are at greater risk of OSA and experience a higher prevalence of apnea-related morbidity,[48,49] they are less likely to seek OSA care than individuals in other racial/ethnic groups.[50] Indeed, only 38% of blacks referred for a sleep evaluation adhered to physician-recommended care.[13] Available evidence also suggests that blacks are less likely to adhere to treatment recommendations.[6] Thus, the finding of increased outcome expectation and treatment efficacy, resulting from exposure to the TASHE intervention, is encouraging. Specifically, higher beliefs about treatment efficacy may increase willingness to adhere to recommended OSA care (eg, PAP). Moreover, results strongly suggest that blacks with greater self-efficacy would likely engage in OSA help-seeking behavior such as attending scheduled sleep clinic visits[13] or adhering to recommended OSA evaluation and treatment.[51] Indeed, in a previous trial among blacks with metabolic syndrome and OSA (MetSO), we observed that blacks exposed to a tailored educational intervention delivered by trained health educators were more likely to adhere to scheduled OSA clinic visits and tended to follow through with scheduled OSA evaluations and treatments.[15] That participants in the TASHE intervention and those in the previous MetSO trial share similar demographic and clinical characteristics suggests a strong likelihood that participants in the current study would also likely adhere to recommended OSA care. We are currently conducting a follow-up study to determine whether, in effect, blacks exposed to the TASHE materials were more likely to seek care for OSA over the long term. Findings from this study are potentially generalizable to other New York City communities or other US cities, or communities that mirror similar demographic characteristics.

Although results of this RCT support the effectiveness of the TASHE tool in improving self-efficacy among blacks, the intervention had no significant effect on health literacy assessed with SAHLS, a recently validated scale assessing health literacy regarding OSA symptoms and treatment in a diverse sample.[30] Since the intervention was effective in improving self-efficacy, it may be that SAHLS might not be sensitive enough to show effects of the TASHE intervention. Additional validation studies may be necessary to ensure this measure has adequate sensitivity to reflect OSA health literacy levels among racially/ethnically diverse populations. Likewise, the intervention did not have significant effects on OSA knowledge and beliefs. It is worth noting that previous studies have shown mixed results regarding effects of behavioral interventions using these scales.[52] These instruments were not developed and validated using individuals from diverse racial and ethnic samples,[34] raising some doubt as to their usefulness as robust measures of OSA knowledge and beliefs in diverse samples. Notwithstanding this finding, the observed trends were in the direction of improvement associated with the intervention exposure.

While our study included follow-up at 2 and 6 months, we did not find significant effects of the intervention at 6 months, suggesting that the initial gains in self-efficacy may have waned over time. It seems that the exposure to the intervention materials may need to be longer to achieve a sustained, positive effect. This suggests that there may be a limited window of opportunity to achieve behavioral change leading to desired OSA outcomes. Of interest, we noted a significant effect on sleep hygiene scores at 6 months but not during the initial 2-month follow-up assessment. This suggests that improvement in sleep hygiene may require a longer exposure dose to show a meaningful response. It is also necessary to consider the finding of no significant effects at 6 months, which may also be a function of our inability to capture data precisely at the expected 6-month time point due to the significant barriers associated with field-based studies.

Limitations

A few limitations are worth noting, which might improve future behavioral sleep interventions. First, the OSA variables (eg, whether individuals had actually received an OSA diagnosis) were all derived from self-reported data rather than objective data. Second, we did not assess whether the TASHE tool led to specific help-seeking behaviors, such as speaking to a health care provider about OSA care. We are currently conducting a follow-up study to address this issue of help-seeking behavior on a long-term basis. Third, approximately 30% of the participants were lost to follow-up at 6 months due to several factors, including changes in phone numbers or place of residence or loss of interest in remaining involved in the study during the follow-up period. Finally, it was difficult to verify the specific duration exposure to study materials, such as how frequently participants visited the website to review the tailored materials and how long they were exposed to various aspects of the available content (texts or videos). Future research should consider incorporation of potential methods to eliminate these limitations to improve efficacy and generalizability of these findings.

CONCLUSIONS

Consistent with the National Institutes of Health Sleep Disorders Research Plan, which calls for research to promote sleep health nationally, we developed and tested the effectiveness of the TASHE to address specific health needs of blacks at risk of OSA. To our knowledge, the TASHE tool is the first intervention that demonstrated its effectiveness in delivering culturally and linguistically tailored sleep messages to blacks to improve OSA self-efficacy. We note that the involvement of community health champions was critical to achieving the

recruitment and retention goals, as these individuals are better integrated in the affairs of their respective communities. It is of great interest to explore whether the TASHE informational materials would need to be tailored to address specific concerns of individuals in other minority communities at risk of OSA. Finally, there is a pressing need to develop more accurate measures to assess psychosocial factors that affect OSA help-seeking behavior in diverse populations.

ABBREVIATIONS

ABS, Apnea Belief Scale
AKT, Apnea Knowledge Test
ANOVA, analysis of variance
CI, confidence interval
OSA, obstructive sleep apnea
PAP, positive airway pressure
RCT, randomized controlled trial
SAHLS, Sleep Apnea Health Literacy Scale
SEMSA, Self-Efficacy Measure for Sleep Apnea
SHI, Sleep Hygiene Inventory
TASHE, Tailored Approach to Sleep Health Education

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DISCLOSURE STATEMENT

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