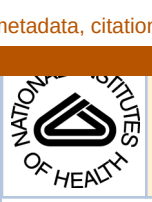

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Screening for Obstructive Sleep Apnea on the Internet: Randomized Trial

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Abstract

BACKGROUND—Obstructive sleep apnea is underdiagnosed. We conducted a pilot randomized controlled trial of an online intervention to promote obstructive sleep apnea screening among members of an Internet weight-loss community.

METHODS—Members of an Internet weight-loss community who have never been diagnosed with obstructive sleep apnea or discussed the condition with their healthcare provider were randomized to intervention (online risk assessment +feedback) or control. The primary outcome was discussing obstructive sleep apnea with a healthcare provider at 12 weeks.

RESULTS—Of 4700 members who were sent e-mail study announcements, 168 (97% were female, age 39.5 years [standard deviation 11.7], body mass index 30.3 [standard deviation 7.8]) were randomized to intervention (n = 84) or control (n = 84). Of 82 intervention subjects who completed the risk assessment, 50 (61%) were low risk and 32 (39%) were high risk for obstructive sleep apnea. Intervention subjects were more likely than control subjects to discuss obstructive sleep apnea with their healthcare provider within 12 weeks (11% [9/84] vs 2% [2/84]; *P* = .02; relative risk = 4.50; 95% confidence interval, 1.002–20.21). The number needed to treat was 12. High-risk intervention subjects were more likely than control subjects to discuss obstructive sleep apnea with their healthcare provider (19% [6/32] vs 2% [2/84]; *P* = .004; relative risk = 7.88; 95% confidence interval, 1.68–37.02). One high-risk intervention subject started treatment for obstructive sleep apnea.

CONCLUSION—An online screening intervention is feasible and likely effective in encouraging members of an Internet weight-loss community to discuss obstructive sleep apnea with their healthcare provider.

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Keywords

Internet; Obesity; Obstructive sleep apnea; Screening

Obstructive sleep apnea causes daytime sleepiness, neurocognitive dysfunction, motor vehicle accidents, cardiovascular disease, reduced quality of life, and increased health-care use.[1–4] Treatment of obstructive sleep apnea reduces the risk or severity of these conditions, but obstructive sleep apnea is underdiagnosed.[2,3]

Promoting obstructive sleep apnea screening with medical chart reminders[5] or physician education[6] is labor-intensive. Population-based screening interventions are needed.[2] Such a program could encourage high-risk individuals to discuss obstructive sleep apnea with their healthcare provider, who would decide whether referral for definitive testing is warranted.

Internet health communities offer new opportunities for health screening programs. Several Internet communities exist for overweight and obese individuals who are trying to lose weight. Because obesity is a strong risk factor for obstructive sleep apnea,[7,8] a screening intervention among members of Internet weight-loss communities may be an effective, low-cost approach.

Therefore, we developed an online screening intervention to identify members of an Internet weight-loss community at high risk for obstructive sleep apnea and encourage them to discuss obstructive sleep apnea with their healthcare provider. This study was a pilot randomized controlled trial to evaluate feasibility, estimate effect size, and test the hypothesis that the intervention would lead individuals to discuss obstructive sleep apnea with their healthcare provider within 12 weeks.

MATERIALS AND METHODS

We compared an obstructive sleep apnea screening intervention (risk assessment+ feedback) against control (no risk assessment or feedback) among members of an Internet weight-loss community. Intervention and assessment materials were SurveyMonkey (www.SurveyMonkey.com) web pages accessed by hyperlinks in e-mails.

Recruitment

SparkPeople (www.sparkpeople.com) is a free Internet weight-loss community. More than 250,000 members log in to the website monthly (David Heilmann, Chief Operating Officer, SparkPeople, May 2008), and it had the fourth most page views among health websites in June 2007.[9]

SparkPeople staff sent recruitment e-mails to 4700 randomly selected members who logged in to the website within the previous month. The e-mail included a hyperlink to study information, an eligibility screening questionnaire, and informed consent. Members were eligible if they were ≥18 years old and lived in the United States. They were excluded if they had a diagnosis of obstructive sleep apnea or had previously discussed obstructive sleep apnea with a healthcare provider. Distractor questions about diabetes and hypertension were included to mask the focus of the study but were not used to exclude from enrollment.

The consent form stated that we were studying how SparkPeople members communicate with their healthcare providers. The participants knew they might receive a questionnaire and information. After an individual gave initial consent and supplied an e-mail address, we sent an e-mail asking confirmation of interest in the study (“double opt-in”). This also

confirmed that we had a valid e-mail address. Recruitment occurred from July 1 to 8, 2008. The honorarium was a $10 Amazon.com gift certificate.

Baseline Assessment

Baseline assessment included age, gender, ethnicity/race, education, employment status, marital status, income, height, and weight. We asked if subjects had health insurance and a regular healthcare provider, defined as a physician, nurse practitioner, or physician assistant.

On the basis of the Health Belief Model,[10] 12 questions asked respondents the degree to which they agreed with statements about their susceptibility to obstructive sleep apnea, severity of obstructive sleep apnea, and benefits of and barriers to discussing obstructive sleep apnea with a healthcare provider. The Likert-type response scale was scored numerically (strongly agree = 5, agree = 4, neutral = 3, disagree = 2, and strongly disagree = 1) and analyzed as a continuous variable.

Randomization

We randomized subjects to intervention or control according to computer-generated randomization sequences for blocks of 10, each randomly assigning equal numbers of intervention and control subjects to achieve balanced group sizes. Subjects were enrolled in the order in which they responded to the confirmation questionnaire. Allocation was concealed from investigators at the time of enrollment. Subjects were not informed whether their group was intervention or control, nor were they informed of the study hypothesis.

Intervention

The goal of the intervention was to encourage high-risk individuals to discuss obstructive sleep apnea with a healthcare provider, who could decide whether to refer the individual for formal testing with polysomnography. The intervention had 2 steps: risk assessment and risk-tailored feedback.

To assess obstructive sleep apnea risk we used the Berlin Questionnaire, which includes items on snoring, daytime sleepiness, drowsy driving, hypertension, and obesity.[11] The Berlin Questionnaire is scored as high risk or low risk for obstructive sleep apnea. A high-risk score predicts obstructive sleep apnea (confirmed by polysomnography) with 86% sensitivity, 77% specificity, and 89% positive predictive value.[11]

We calculated Berlin Questionnaire scores with a spreadsheet and delivered the risk-tailored feedback presentations within 2 to 5 days. High-risk individuals were encouraged to talk to their healthcare provider about obstructive sleep apnea testing. The Health Belief Model served as the framework for the high-risk presentation.[10] Low-risk subjects were not explicitly encouraged to discuss obstructive sleep apnea with their healthcare provider. Detailed descriptions of the presentations are shown in Table 1.

Control

Control subjects did not undergo assessment of obstructive sleep apnea risk or receive an intervention. Because risk assessment alone may act as an intervention, we did not administer the risk assessment to the control group. We also wanted the control condition to represent “usual care” or what SparkPeople members would experience without the intervention. By comparing the intervention with usual care, we aimed to generate information that could help decide whether to offer the intervention to people in the usual care condition, which is all SparkPeople members. Usual care is an appropriate control condition for clinical trials designed to compare the effectiveness of a new system of care against the status quo.[12,13]

Follow-up Assessment

Follow-up assessments were performed 12 weeks after the risk-tailored presentations were delivered to the intervention group. Because assessments were online questionnaires, investigators were blinded to group allocation when the assessments were obtained.

The primary outcome was discussing obstructive sleep apnea with a healthcare provider as indicated by the answer to the question "Since you enrolled in this study, have you discussed obstructive sleep apnea with a healthcare provider?" (Yes/No). For those who did not discuss obstructive sleep apnea with a healthcare provider, we asked if they had plans to do so in the future. Other outcomes were referral for polysomnography, undergoing polysomnography, as well as diagnosis, offer of treatment, and starting treatment for obstructive sleep apnea (Yes/No). These outcomes were secondary because they can be influenced by factors beyond the reach of the intervention, such as the healthcare provider's knowledge of obstructive sleep apnea and availability of sleep laboratories. The Health Belief Model questions were administered at follow-up to measure change from baseline to follow-up.

Statistical Analysis

Without prior data to inform sample size, we enrolled all consented individuals. Categoric variables are compared with likelihood ratio chi-square, relative risk (RR), and 95% confidence interval (CI) around the RR. Continuous variables are presented as mean and standard deviation (SD) and compared with the *t* test. For the primary analysis, we compared intervention and control groups, with a 2-sided *P* value less than .05 considered significant. Because the intervention group included low-risk subjects whom we did *not* encourage to speak to their healthcare provider about obstructive sleep apnea, we performed pairwise comparisons of high-risk intervention subjects versus control subjects and of low-risk intervention subjects versus control subjects. For subgroup analysis, we applied Bonferroni's correction, with a 2-sided *P* value less than .025 (.05/2) considered significant. Analyses were performed on an intention-to-treat basis, so that subjects lost to follow-up were assumed not to have achieved the outcome. Analyses were performed with SPSS 16.0 for Windows (SPSS Inc, Chicago, Ill). The study was approved by the Committee for Protection of Human Subjects at the University of Texas Health Science Center at Houston.

RESULTS

The 168 individuals randomized to control (n = 84) or intervention (n = 84) represented 3.6% of members who were sent the recruitment e-mail, 13.0% of those who opened the e-mail, 53.2% of those who started eligibility screening, and 64.1% of those who were eligible (Figure 1). Of the 82 intervention subjects who completed the Berlin Questionnaire, 50 (61%) were deemed low risk and 32 (39%) were deemed high risk for obstructive sleep apnea. Follow-up rates were similar for control (87%) and intervention (88%) groups, and within the intervention group, for low-risk (92%) and high-risk (88%) subgroups.

Subjects were primarily well-educated Caucasian women with a mean age of 39.5 years (SD 11.7) and body mass index 30.3 kg/m^2 (SD 7.8) from 40 US states. There were no significant differences between groups in demographics, body mass index, geographic distribution, or access to healthcare (Table 2).

Intervention subjects were more likely than control subjects to discuss obstructive sleep apnea with their healthcare provider within 12 weeks (11% [9/84] vs 2% [2/84]; *P* = .02; RR = 4.50; 95% CI, 1.002–20.21). The number needed to treat was 12. Among those who did not discuss obstructive sleep apnea with their healthcare provider, intervention subjects were more likely than control subjects to have plans to discuss obstructive sleep apnea with their

healthcare provider in the future (21% [16/75] vs 9% [7/82]; *P* = .02; RR = 2.50; 95% CI, 1.09–5.74).

In the subgroup analysis, high-risk intervention subjects were more likely than control subjects to discuss obstructive sleep apnea with their healthcare provider (19% [6/32] vs 2% [2/84]; *P* = .004; RR = 7.88; 95% CI, 1.68–37.02). Among those who did not discuss obstructive sleep apnea with their healthcare provider, high-risk intervention subjects were more likely than low-risk subjects and control subjects to have plans to discuss obstructive sleep apnea with their healthcare provider in the future: 46% (12/26) versus 9% (4/47) *P* < .001; RR = 5.42; 95% CI, 1.95 to 15.12 and 46% (12/26) vs 9% (7/82); *P* < .001; RR = 5.41; 95% CI, 2.38–12.29, respectively.

One high-risk intervention subject was referred for testing by the healthcare provider, underwent polysomnography, was diagnosed with obstructive sleep apnea, and started positive airway pressure treatment during the 12-week study.

There were no significant differences in change in Health Belief Model scores when comparing intervention with control subjects or when comparing subgroups. However, subjects who discussed obstructive sleep apnea with their healthcare provider had a greater increase in their agreement with the “I suspect that I may have obstructive sleep apnea” item compared with those who did not discuss obstructive sleep apnea with their healthcare provider (increase 1.20 [SD 1.40] vs increase 0.29 [SD 0.96]; difference = 0.91; 95% CI, 0.26–1.56; *P* =.006).

DISCUSSION

This pilot study demonstrated the feasibility and efficacy of an online obstructive sleep apnea screening intervention. Compared with the control group, subjects exposed to the intervention were more than 4 times more likely to discuss obstructive sleep apnea with their healthcare provider within 12 weeks. The effect was greater in high-risk intervention subjects, who were approximately 8 times more likely to discuss obstructive sleep apnea with their healthcare provider compared with controls. The results support our hypothesis that the intervention leads members of an Internet weight-loss community to discuss obstructive sleep apnea with their healthcare provider.

Strengths of the study include the randomized design and our definition of comparison groups. In other trials of online screening interventions, risk assessment was performed first, followed by randomization of high-risk individuals to various groups.[14,15] Our intervention group received risk assessment plus risk-tailored feedback, whereas our control group received neither (status quo). Thus, our results estimated the effect of the intervention among community members who had not yet undergone risk assessment. This finding, if confirmed, would be useful in deciding whether to implement the intervention as a whole among members of the community.

The population and health condition also were novel. Online screening interventions have targeted geographically defined populations, such as suicide risk and problem drinking in local university students,[14,16] colorectal cancer screening in Michigan,[15] and chlamydia screening in Maryland.[17] Ours is the first randomized trial to evaluate online screening for obstructive sleep apnea among members of an Internet community.

The study had limitations. The CIs were wide because of small sample size. Second, the Berlin Questionnaire may have misclassified some participants as high or low risk. However, acceptable sensitivity, specificity, and positive predictive value have been demonstrated.[11] Third, outcomes were self-reported because it is not practical to access

medical records of geographically dispersed members of an Internet community. Fourth, the short duration may not have given some subjects enough time to see their healthcare provider to discuss obstructive sleep apnea, much less be diagnosed and treated. Fifth, intervention and control subjects may have discussed the study with each other on SparkPeople forums. This would have caused underestimation of effect size. Finally, participants were mostly Caucasian women. However, initial research in this area is necessarily constrained to the population that currently participates in Internet weight-loss communities. Even so, the potential target population is large, given the size of SparkPeople and other Internet health communities. If efficacy is confirmed in a larger trial, then socioeconomic and cultural modifications can be tested for other groups.

Evaluation of participation rate depends on the denominator used to assess participation.[18] Only 3.6% of those who were sent the recruitment e-mail were enrolled. Because we had no prior relationship with community members, a single recruitment e-mail would not be expected to engender overwhelming interest. By policy, SparkPeople administrators do not burden members with repeat e-mails. However, approximately two thirds of those who were eligible were enrolled. Our sample was similar in age and gender to the overall SparkPeople membership (mean age 39 years and 88% were female) (David Heilmann, Chief Operating Officer, SparkPeople, January 2009). The ability to measure denominators is an advantage of recruiting through e-mail rather than website announcements.

Given the difficulty of promoting obstructive sleep apnea screening with physician-centered strategies,[5,6] this population-based intervention was inexpensive and easy to deliver. The cost of administering the Berlin Questionnaire and delivering presentations included salaries (≈$1500 in 1 month) and use of the online questionnaire software (≈$17 in 1 month). A similar intervention conducted by postal mail would likely be slower and more expensive. One intervention subject was diagnosed with obstructive sleep apnea and started treatment with positive airway pressure. Continuous positive airway pressure for obstructive sleep apnea is associated with incremental cost-effectiveness ratios of $3354 per quality-adjusted life-year gained from a third-party payer perspective and $314 per quality-adjusted life-year gained from a societal perspective, values that compare favorably to common medical therapies.[19]

An alternative strategy is to deploy an awareness campaign within the Internet community by posting obstructive sleep apnea presentations on the website. However, this mass media approach would not identify and target high-risk members or track individual-level responses.

Our intervention can be disseminated by automating recruitment, risk assessment, and presentation delivery. Costs would include computer programming (≈$5000), website hosting (≈$100/year), and online questionnaire software (≈$200/year). Offering the intervention to 10,000 instead of 84 individuals would incur little additional cost. The automated intervention could be expanded within and across Internet communities. The overall public health impact of a modestly effective yet widely disseminated intervention can be significant.[20]

However, further research is needed. Many Health Belief Model questions were not sensitive to the cognitive changes underlying the observed behavior change. This may have partly been due to ceiling and floor effects, because 7 items had mean baseline scores between 4 and 5 (ceiling) and 2 items had mean baseline scores between 1 and 2 (floor). However, an increasing perception of susceptibility to obstructive sleep apnea was associated with discussing obstructive sleep apnea with a healthcare provider. Better items might arise from qualitative studies of the intended target population. A larger, longer trial is

needed to confirm results and obtain a more precise estimate of effect size. A cost-effective analysis is warranted. Last, efforts are needed to adapt the intervention to other socioeconomic and cultural groups.

This study also demonstrated that a risk-tailored health behavior intervention can be implemented among members of an Internet community and that efficacy can be evaluated with a randomized trial. Our approach could be tested for other health conditions and Internet communities.

CONCLUSIONS

This pilot study demonstrated feasibility and provided preliminary evidence that a low-cost online intervention encourages members of an Internet weight-loss community to discuss obstructive sleep apnea with their healthcare provider. Further work is needed to clarify the theoretic underpinnings of the intervention, automate it, and confirm efficacy in a larger trial.

CLINICAL SIGNIFICANCE

- Members of Internet weight-loss communities are at high risk for obstructive sleep apnea.
- This online obstructive sleep apnea screening intervention was feasible and effective in encouraging members of an Internet weight-loss community to discuss obstructive sleep apnea with their healthcare providers.
- Advantages of this intervention include risk-tailored messaging, low cost, and potential for wide dissemination.

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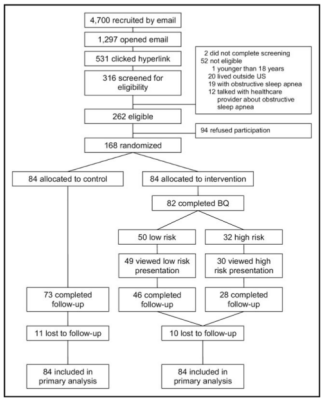

Figure 1.
Study flowchart. BQ = Berlin Questionnaire.

Table 1

Content of Presentations Viewed by Low-Risk and High-Risk Intervention Subjects

Presentation for Intervention Subjects at Low Risk for Obstructive Sleep Apnea	Presentation for Intervention Subjects at High Risk for Obstructive Sleep Apnea
Text:	Text:
You have recently completed the online Berlin Questionnaire to estimate your risk of having obstructive sleep apnea. The questionnaire identifies people as either high risk or low risk. According to your answers, you are at *low risk* for having obstructive sleep apnea (OSA). If you are concerned about OSA or have questions, please talk to a healthcare provider. You also can find more information about obstructive sleep apnea at this website: Medline Plus: Sleep Apnea (*hyperlink*)'	You have recently completed the online Berlin Questionnaire to estimate your risk of having obstructive sleep apnea. The questionnaire identifies people as either high risk or low risk. According to your answers, you are at *high risk* for having obstructive sleep apnea (OSA). OSA occurs when there is an obstruction (blockage) of airflow into your lungs during sleep. This can lead to problems such as heart disease, daytime sleeplessness, and other unpleasant symptoms. OSA can only be diagnosed with a special test arranged by a health care provider. Learn more about OSA and what you can do about it by clicking "Next." (*hyperlink*)' The "Next" hyperlink led to a presentation based on the Health Belief Model (HBM). To increase perceived susceptibility to OSA, we emphasized that they are at high risk of having OSA. To address consequences of OSA, we stated that untreated OSA can lead to sleepiness, hypertension, heart disease, stroke, and a variety of symptoms. To highlight the benefits of discussing OSA with their healthcare provider, we described how the healthcare provider can arrange for OSA testing, and that treatment of OSA can improve sleep, health, and quality of life. To address barriers to discussing OSA with their healthcare provider, we generated a letter to a healthcare provider for the subject to print and bring to their healthcare provider as an aid to discussing OSA. (The letter was e-mailed to the subjects after they viewed the presentation.) The high-risk presentation also included hyperlinks to the MedlinePlus OSA website and OSA-themed discussion forums on the SparkPeople website.

Table 2

Characteristics of 168 Members of the Internet Weight-Loss Community[a]

	Control (n = 84)	Intervention (n = 84)
Age, mean (SD)	39.5 (11.7)	39.6 (11.7)
Gender, n (%) female	81 (96)	82 (98)
Ethnicity, n (%) Hispanic	4 (5)	3 (4)
Race, n (%)		
White	75 (89)	77 (92)
Black	6 (7)	4 (5)
Asian	1 (1)	1 (1)
Multiracial	2 (2)	2 (2)
Highest education completed, n (%)		
Graduate or professional school	21 (25)	16 (19)
College	42 (50)	46 (55)
High school	21 (25)	21 (25)
Marital status, n (%)		
Married	54 (64)	50 (60)
Divorced	7 (8)	8 (10)
Separated	5 (6)	1 (1)
Widowed	1 (1)	2 (2)
Living with partner	3 (4)	6 (7)
Never married	14 (17)	16 (19)
Employment status, n (%)		
Full-time	48 (57)	51 (61)
Part-time	14 (17)	10 (12)
Student	6 (7)	6 (7)
Homemaker	10 (12)	10 (12)
Retired	4 (5)	3 (4)
Unemployed	0	2 (2)
Unable to work	2 (2)	1 (1)
Annual household income, n (%)		
<$10,000	1 (1)	5 (6)
$10,000–$19,999	4 (5)	2 (2)
$20,000–$29,999	7 (8)	6 (7)
$30,000–$39,999	9 (11)	9 (11)
$40,000–$49,999	15 (18)	7 (8)
$50,000–$59,999	5 (6)	14 (17)
$60,000–$69,999	7 (8)	9 (11)
$70,000–$79,999	7 (8)	7 (8)
≥$80,000	27 (32)	23 (27)
BMI, mean ± SD	30.1 (8.1)	30.5 (7.4)
BMI categories, n (%)		

	Control (n = 84)	Intervention (n = 84)
<25.0	26 (31)	21 (25)
25.0–29.9	24 (29)	24 (29)
≥30.0	34 (41)	39 (46)
Health insurance, n (%) yes	79 (94)	77 (92)
Regular healthcare provider, n (%) yes	77 (92)	79 (94)

BMI = body mass index; SD = standard deviation.

[a]For some variables, column totals not equal to 84 because of missing data.