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The National Sleep Foundation's Sleep Satisfaction Tool

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ABSTRACT

Objectives: The National Sleep Foundation (NSF) sought to test, refine, and add statistical rigor to its previously described provisional Sleep Satisfaction Tool (SST). The tool assesses the general population's sleep satisfaction.
Design: In 2017, NSF created a provisional tool through systematic literature review and an expert consensus panel process. This tool was expanded, refined, and tested through an open-ended survey, 2 rounds of cognitive testing, and a national survey of a random sample of Internet users (aged 18-90). Factor analysis and final consensus panel voting produced the robust SST.
Results: The exploratory, open-ended surveying for identifying additional factors important to the public led to question formulation around mind relaxation. Cognitive testing yielded significant refinement to question and response option formatting. Factor analysis of questions from field testing indicated loading on one construct identified as "sleep satisfaction." The final 9-item SST demonstrated strong reliability and internal validity with overall SST scores of 56/100 (higher scores indicating greater sleep satisfaction). Individual SST item mean scores ranged from 39 to 66, and overall SST scores varied substantially across demographic groups.
Conclusions: NSF used a series of development and validation tests on its provisional SST, producing a novel and reliable research tool that measures the general population's sleep satisfaction. The SST is a short, reliable, nonclinical assessment that expands the set of tools available to researchers that implements the individual, social, and environmental factors related to sleep satisfaction. Further research will explore refined scoring methods along with factor weighting and use within different populations.

Introduction

The body of research on the relationship between sleep and health is growing. Despite challenges with design and methodology, research demonstrates that sleep health is associated with stress, health, and life satisfaction[2,3] and affects economic well-being.[4,5] Numerous tools measure sleep *dissatisfaction* as part of an ongoing focus in clinical sleep medicine on sleep problems and pathologies. However, literature review confirms that there are no known validated instruments that measure the positive, satisfactory experiences of sleep within the general population. This lack of a purposefully designed and validated instrument limits exploration of sleep satisfaction among the general public.

As noted, existing sleep questionnaires focus more on the negative aspects of sleep. For example, the Pittsburgh Sleep Quality Index[6] focuses on behaviors that disrupt sleep, like pain or snoring. Other instruments screen for sleep disorders or measure their severity, including the Insomnia Severity Index.[7] Recent efforts to catalog patient experiences, like the Patient-Reported Outcomes Measurement Information System,[8] include questions about sleep disorders. However, most people do not have a clinical sleep disorder, and using clinical instruments in a general population is not appropriate. To fill the gap in measuring sleep health, the National Sleep

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Foundation (NSF) set out to create a tool for measuring the general population's sleep health.

A sleep satisfaction instrument would broaden the subjective measurement of sleep and augment findings that may otherwise distort true personal experience. NSF convened a sleep expert consensus panel (Panel) and conducted a systematic literature review to identify potential sleep satisfaction indicators.[1] The purpose of this study is to build on that work by developing, refining, and perfecting a general population sleep satisfaction measurement instrument. To achieve this aim, NSF assembled a task force including the Panel, public opinion, and cognitive testing experts, as well as NSF research staff (Taskforce). The Taskforce refined and thoroughly tested the Sleep Satisfaction Tool (SST), the first-of-its-kind instrument for gauging subjective sleep satisfaction in the general population.

Methods

NSF previously created a provisional tool for measuring sleep satisfaction[8] based on sleep satisfaction indicators identified in the published literature and through expert opinion. To properly refine the instrument through standard methods, NSF conducted an open-ended qualitative survey, cognitive testing, field testing, and statistical analyses along with significant input and oversight from the original Panel (Fig. 1).

Qualitative development

Sleep satisfaction indicators identified previously by the Panel were subsequently expanded using a probability-based online qualitative survey (n = 111) with the following open-ended questions:

1. What matters most in your getting a good night's sleep?
2. What things do you do, or have you done, to get a good night's sleep?
3. How do you know you got a good night's sleep?

SSRS of Glen Mills, PA, a market and survey research firm, fielded these questions and provided sampling and data collection services. Langer Research Associates performed the coding, tabulation, and statistical analyses.

Cognitive testing

Using cognitive testing methods, Dr. D. Sunshine Hillygus interviewed individuals in Durham, NC, to inform refinement of the tool's items.[9,10] Cognitive testing is an evidence-based qualitative approach to improving survey questionnaires designed to assess the difficulty of questions for respondents, interpret "don't know" responses, and discover whether questions are confusing or call to mind different concepts than intended by the researcher. Cognitive interviewing involves administering the draft survey questions while collecting additional verbal information about the survey response to determine whether subjects understand the question, both consistently across the subjects and in the way intended by the researcher. We interviewed 13 individuals, split into 2 groups for 2 rounds of interviews, consistent with standard approaches to cognitive interviewing.[11] Eight individuals were interviewed in Round 1 (SST-v0). Interviews took approximately 60 minutes each and addressed interviewee understanding of each question and associated responses. The Taskforce reviewed the findings, adjusted a few questions, and then conducted 5 additional interviews (Round 2) using the revised items (SST-v1). In both rounds, 4 insight questions were included to assess device use before bedtime, overall health, stress, and life satisfaction.

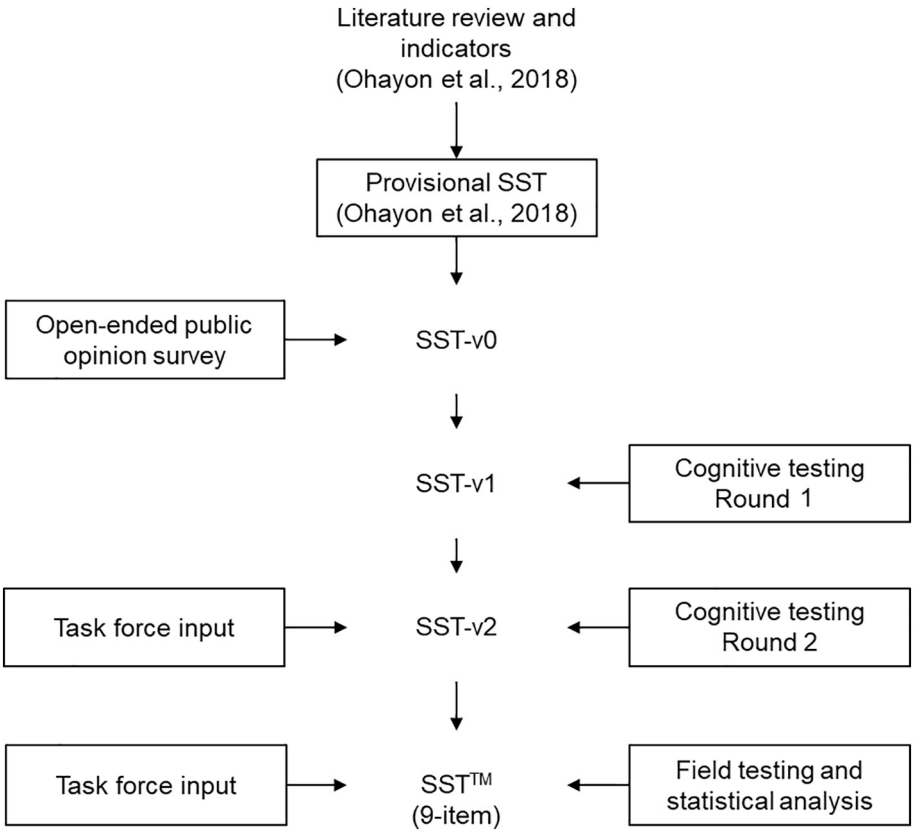

Fig. 1. Flow diagram of the construction and validation of the SST.

Cognitive interview respondents varied in life and sleep experiences, including whether they live with a partner, children, or pets; the number and age of children; sleep schedules due to occupation; type of residence; and locality (urban, suburban, or rural).

The interviewer used verbal probing techniques wherein, after eliciting a respondent's answer to a question, she followed up with additional questions about how that respondent understood the question. Some questions were also initially asked in an open-response format before providing respondents with answer choices. Examples of probing questions include:

1. In your own words, what do you think we meant by this word?
2. If you thought of this (X) as meaning something else (Y) how might that have changed your answer?
3. Was that question easy or hard to answer? Why?

Quantitative testing

After cognitive interviews, SSRS fielded a revised 14-item questionnaire (SST-v2) from December 11 to 15, 2017, among a probability-based national sample of Internet users (n = 534). The sample is weighted to Internet household benchmarks drawn from the SSRS Omnibus telephone survey.

As before, respondents provided demographic information and answered additional insight questions. Respondents also answered the questions from the disordered sleep subindex of NSF's Sleep Health Index.[2]

Statistical approaches and analyses

After sample weighting, the Taskforce used SPSS Statistics Software (IBM Corporation, v. 20) to employ factor analysis on the 14 items of SST-v2 (Table 1A). The Panel selected the final 9 SST items based on these results, and responses to SST items were scored; 4-part variables were coded as 1 through 4, and 5-part variables as 1, 1.75, 2.50, 3.25, and 4. Response options were then transformed onto a 0-100 scale and averaged to produce the overall sleep satisfaction score. The disordered sleep subscale from the Sleep Health Index was scored according to the NSF scoring manual.

Univariate and bivariate analyses explored variable distribution and produced descriptive statistics. Responses were crossed with demographic variables and the insight questions to discern specific trends and identify group differences. Statistical significance of group differences was determined at the 90% and 95% confidence levels ($\alpha = .10$ and .05, respectively). We assessed construct validity through response correlation with overall health, stress, and life satisfaction.

The multivariate analyses included factor analysis on the final SST items and a test of internal consistency through Cronbach α determination. Lastly, we generated regression models predicting SST scores using ordinary least square regressions with standardized coefficient estimates.

Table 1A
Factor loadings of the final 9 items included in the SST after Panel vote using principal axis extraction

Factor loadings	
Sleep satisfaction	.86
Feeling refreshed	.79
Weekday sleep satisfaction	.72
Weekend sleep satisfaction	.69
Feeling energized	.69
Trouble falling asleep	.62
Achieving relaxed mental state	.61
Falling back asleep	.59
Waking up during the night	.32

Results

Qualitative study

Previous work identified sleep satisfaction indicators from a literature review and expert consensus voting. To explore elements that the general public associates with sleep satisfaction, a probability-based online sample (n = 111; 54 women, 57 men; 21-86 years of age, average 56.5 years) answered 3 open-ended questions about "a good night's sleep."

Room conditions (n = 62), comfort of the sleeping area (n = 51), uninterrupted sleep (n = 42), and total hours of sleep (n = 32) were the highest-frequency responses for question 1, "What matters most in your getting a good night's sleep?" (Supplementary Table 1A). For question 2, "What things do you do, or have you done, to get a good night's sleep?" the most frequent responses included adjustments to the environment like using a fan or opening a window (n = 30) (Supplementary Table 2). For question 3, "How do you know you got a good night's sleep?" the highest-frequency responses included feeling well rested/not feeling groggy upon waking (n = 42) and feeling energized in the morning (n = 39) (Supplementary Table 3). Generally, the open-ended results were consistent with the sleep satisfaction indicators previously determined by the expert panel but also indicated the importance of 1 additional factor, the ability to quiet the mind. This item was added to the tool for additional testing.

Cognitive testing

Based on the responses to the qualitative study's open-ended questions and a previously developed provisional questionnaire, the Taskforce performed cognitive testing and refinement on SST-v0 through interviews with a total of 13 individuals (6 women, 7 men; 28-62 years of age, average 41.2 years). Round 1 of cognitive testing suggested changes in question or answer set wording that the Taskforce reviewed and revised. Respondents' interpretation of the questions consistently matched the intent behind the questions, and they found response options to be appropriate. Sleep amounts on "work-days or weekdays" and "weekends or non-work days" were predictable areas causing respondents to pause and consider.

The Taskforce further assessed the resulting revised questionnaire (SST-v1) through a second round of cognitive testing. Notably, respondents struggled with an item querying waking up at night. Even after revisions in Round 1, some respondents framed waking up in terms of frequency, that is, how many nights per week, whereas others answered as intensity or frequency per night. No respondents reported difficulties for the item asking how easy or difficult it is to fall asleep after waking. Cognitive interviews confirmed the face validity and comprehensibility of the instrument. The Taskforce adopted the 14 items refined through cognitive interviews for field testing (SST-v2).

Field testing

An online probability-based national sample of Internet users (n = 534) responded to the SST-v2. Results have a margin of sampling error of 5.1 points for the full sample, including the design effect.

Psychometric properties

A factor analysis using of the SST-v2 indicated a single construct with loadings determined through principal axis extraction (with

Table 1B
Initial factor analysis revealed loading of the SST-v2 questions to a single factor ("sleep satisfaction"). The solution could not be rotated.

	Factor loadings			
	Factor 1	Factor 2	Factor 3	Factor 4
Sleep satisfaction (Q1)	.85	−.23	.02	.08
Refreshed (Q2)	.79	−.16	.06	−.03
Energized (Q3)	.68	−.15	.05	−.04
Mattress comfort (Q4a)	.39	.18	.43	−.09
Pillows comfort (Q4b)	.38	.12	.38	.02
Sheets comfort (Q4c)	.33	.30	.33	−.10
Bedroom temperature (Q5)	.22	.34	−.06	.10
Bedroom noise (Q6)	.06	.47	−.04	.39
Bedroom light (Q7)	.07	.30	−.15	.04
Trouble falling asleep (Q8)	.63	.19	−.22	.08
Waking up during the night (Q9)	.31	−.02	−.03	.22
Trouble falling back asleep (Q10)	.58	−.03	−.13	−.02
Weekday sleep satisfaction (Q11)	.70	−.16	−.02	.08
Weekend sleep satisfaction (Q12)	.67	−.17	−.07	.21
Trying to improve sleep (Q13)[a]				
Is improvement helping (Q13a)[a]				
Relaxed before bed (Q14)	.69	.31	−.30	−.44

[a] Not applicable. 13a did not go to all respondents. As such, it needed to be paired with 13 to create 1 variable. Determination of whether not trying to improve something belongs at the bottom of the scale (ie, not trying is worse than trying and it is not helping) or at the top (implying one does not need to try) is unclear. Both methods were explored. With not trying at the bottom of the scale, factor analysis yielded 2 factors. In this case, the combined variable 13 loaded at −.13 on the first factor and .25 on the second. With not trying at the top of the scale, this same variable loaded at .38 on the first factor and .12 on the second. Given this result, it encourages the assumption that not trying to improve one's sleep indicates better sleep satisfaction than trying to improve one's sleep and rating the change as helping a lot. However, because of the lack of clarity, this item was kept out of the factor analysis.

the extraction of 1 factor, the solution could not be rotated). Five of the items had factor loadings >0.65, and 3 additional items had factor loading values >0.5 (Table 1B). The Panel determined the composition of the final instrument (SST), ultimately voting to adopt a 9-item SST. The final tool has an overall factor loading of 0.86 and factor loadings >0.58 for all but 1 item (Table 1A). Based on lower factor loadings, the Taskforce decided to eliminate sleep environment and comfort questions. The SST responses were scored and distributed on a range from 0 to 100, with higher scores indicating higher sleep satisfaction. The SST demonstrated strong reliability as measured with Cronbach $\alpha = .87$, $R^2 = 0.50$.

SST results

The average SST score was 56 out of 100 (Fig. 2). Although the general population sample reported moderate satisfaction with sleep, there was a wide range in SST scores and in the scores of each individual question (Table 2). The total SST score varied based on demographic factors (Table 3). For example, women had a significantly lower SST score than men, and individuals aged 50-64 years old had higher scores than younger respondents. Rural respondents had reduced SST compared to suburban respondents, whereas married respondents had higher scores compared to single respondents. There were no significant differences in SST scores between education groups, racial groups, or income groups.

Validity

To assess the internal validity of the SST, additional questions asked about technology use before bed, overall health, overall stress, and overall life satisfaction. Respondents also answered questions from the Sleep Health Index subindex on disordered sleep, which included questions about taking sleep medications or discussing sleep problems with a medical professional. Questions from SST-v2 that were not included in the final SST, including those about sleep environment, were used to ensure a comprehensive analysis (Table 4).

The SST was significantly correlated with respondents' ratings of their overall health ($r = 0.40$, $P < .001$), stress ($r = -0.40$, $P < .001$), and life satisfaction ($r = 0.37$, $P < .001$), demonstrating

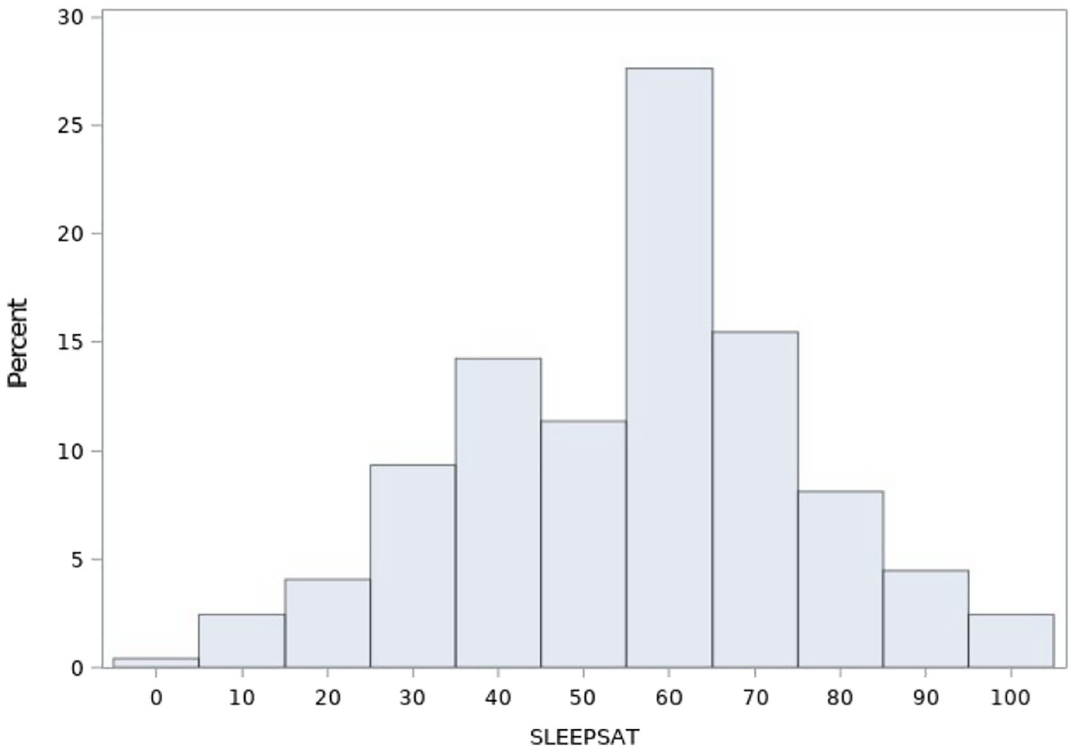

Fig. 2. Histogram showing the percent of respondents in each 10-point range of overall SST scores in the field-testing sample.

Table 2
Average SST question scores for the field-testing sample, scaled from 0 to 100

Sleep satisfaction item scores (0-100)	
SST	56
Waking up during the night	39
Weekday sleep satisfaction	54
Sleep satisfaction	56
Feeling refreshed	56
Achieving a relaxed mental state	56
Feeling energized	58
Falling back asleep	58
Trouble falling asleep	63
Weekend sleep satisfaction	66

convergent validity. Those who rated their overall health as excellent or very good had an SST score of 64 compared to 53 among those who say their health is good (the midpoint). Those who were extremely or very satisfied with their lives also scored significantly higher on the SST than those who were somewhat satisfied (64 vs 54). Respondents who described their personal stress level as very high or high had SST scores of 48 compared with 66 for those who rated their stress level as low or very low.

The SST was also significantly correlated with the disordered sleep subindex of the Sleep Health Index ($r = 0.39$, $P < .001$; note: a higher score on this subindex represents *less* disordered or problematic sleep). The average SST score was 44 for adults who have taken a sleep medication at least once in the past 7 days compared to 59 among others. SST score was 44 among those who have discussed sleep problems with a doctor compared to 61 among those who have not. SST scores were also lower (average score of 47) among those with a sleep disorder compared with 58 among others. Overall, sleep satisfaction was lower among adults who have taken a sleep medication in the past week, been diagnosed with a sleep disorder, or spoken with a doctor about sleep problems. SST scores were also significantly lower among individuals with uncomfortable mattresses, sheets, or pillows compared to those individuals with comfortable sleep environments (Table 4).

Regarding construct validity, trying to improve something about the way one sleeps also was related to sleep satisfaction. Those who were not trying to improve their sleep received an SST score of 62 compared to 51 among those who were trying to improve their sleep.

Table 3
SST mean scores and standard deviations for demographic groups. *P* values correspond to a statistically significant difference between the group comparisons determined through *t* tests.

	SST			
	Score	SD	*P* value	Group comparison
Sex				
Male (n = 236)	59.3	18.8	<.001	
Female (n = 298)	53.6	19.7		
Age				
18-29 (n = 104)	52.1	20.1		
30-49 (n = 166)	54.7	18.7	.225	(18-29 vs 30-49)
50-64 (n = 142)	59.8	18.5	.015	(30-49 vs 50-64)
65+ (n = 121)	61.8	19.8	.49	(50-64 vs 65+)
Education				
College grad (n = 253)	58.4	18.8		
Non–college grad (n = 280)	55.1	19.8	.064	
Income				
<50 K (n = 205)	55.7	20.8		
50-100 K (n = 176)	56.6	19.3	.677	(<50 K vs 50-100 K)
100+ K (n = 113)	57.7	17.1	.653	(50-100 K vs 100+ K)
Race[a]				
White (n = 368)	55.6	19.9		
Nonwhite (n = 158)	56.8	18	.462	
Metro status				
Urban (n = 182)	55.8	18.2		
Suburban (n = 223)	58.3	19.7	.173	(Urban vs suburban)
Rural (n = 117)	52.9	20.6	.02	(Suburban vs rural)
Marital status				
Married (n = 257)	58.7	19.3		
Single (n = 177)	54.1	19.7	.012	(Married vs single)
Separated/divorced/ widowed (n = 99)	55.6	18.9	.531	(Single vs separated/ divorced/widowed)

[a] Race was grouped into 2 main groups given limitations in sample size. Unweighted, 70% White, 9% Black, 15% Hispanic, 2% Asian, 1% Native American/American Indian/Alaska Native, 1% Native Hawaiian/Pacific Islander, 0.2% other, and 2% mixed. Unweighted among non-Whites, 28% Black, 48% Hispanic, 8% Asian, 4% Native American/American Indian/Alaska Native, 2% Native Hawaiian/Pacific Islander, 1% other, and 8% mixed.

Table 4
SST mean scores and standard deviations for insight cross-variables. *P* values correspond to a statistically significant difference between the group comparisons (determined through *t* tests). Note that lower scores on the Sleep Health Index disordered sleep subindex indicate greater disordered sleep.

	SST			
	Score	SD	*P* value	Group comparison
Mattress				
Comfortable (n = 431)	58.2	19		
Uncomfortable (n = 102)	49.6	19.7	<.001	
Sheets				
Comfortable (n = 492)	57.3	19.4		
Uncomfortable (n = 40)	47.3	17	<.001[a]	
Pillows				
Comfortable (n = 435)	58.5	18.9		
Uncomfortable (n = 99)	47.3	19.2	<.001	
Device use before bed				
More often (n = 366)	55.3	18.9		
Occasionally or less often (n = 168)	58.8	20.5	.055	
Overall health				
Excellent/very good (n = 241)	63.8	18		
Good (n = 231)	53	17.1	<.001	(Excellent/very good vs good)
Not so good/poor (n = 62)	41.8	20.8	<.001[a]	(Good vs not so good/ poor)
Stress				
High (n = 191)	47.9	19.9		
Moderate (n = 229)	59.9	15.8	<.001	(High vs moderate)
Low (n = 114)	66.5	18.8	.001	(Moderate vs low)
Life overall				
More satisfied (n = 242)	63.7	16.8		
Somewhat satisfied (n = 207)	53.9	17.7	<.001	(More vs somewhat satisfied)
Less satisfied (n = 85)	44	21.6	<.001[a]	(Somewhat vs less satisfied)
Sleep Health Index disordered sleep subindex				
Subindex = 100 (n = 314)	61.9	16.8		
Subindex = 63-99 (n = 119)	52.1	20.2	<.001	(Least disordered sleep vs middle group)
Subindex = 0-62 (n = 101)	42	18.8	<.001	(Middle group vs most disordered sleep)

[a] Analysis limited because of sample size.

Regression analysis

To further characterize the utility of the SST, we conducted a regression on demographic and other variables, including items that do not appear in the final SST (Table 5). In our regression modeling (adjusted $R^2 = 0.41$), several factors were significant predictors of overall SST scores. Disordered sleep, as measured by the disordered sleep subindex of the Sleep Health Index, was a significant predicting variable ($\beta = .27$), as were pillow comfort ($\beta = .17$), overall stress ($\beta = -.17$), and overall health ($\beta = .20$; all: $P < .001$). Age ($\beta = .15$), sex (being female; $\beta = -.10$), and life satisfaction ($\beta = .12$)

Table 5
Item β values and statistical significance from regression model predicting SST scores

Predicting SST scores, OLS regression	
Age	.15**
Female	−.10**
Urban	−.06
Rural	−.08*
Black	.07
Hispanic	.07
Other race	.06
Full-time employed	.02
Education	.01
Income	−.06
Parent	.00
Device use before bed	−.02
Disordered sleep	.27***
Bedroom: temperature	.02
Bedroom: too quiet	.04
Bedroom: too noisy	−.04
Bedroom: light	.03
Mattress comfort	.10*
Pillows comfort	.17***
Sheets comfort	.01
Life satisfaction	.12**
Overall stress	−.17***
Overall health	.20***
Adjusted R^2	***.41***

Variable details including reference categories are as follows:
Age: continuous (ranging from 18 to 90 years old); female: sex (female vs male); urban: metro status (urban vs suburban and rural); rural: metro status (rural vs urban and suburban); Black: race (Black vs not Black); Hispanic: race (Hispanic vs not Hispanic); other race: race (Asian/Chinese/Japanese, Native American/American Indian/Alaska Native, Native Hawaiian and other Pacific Islander, other race, mixed vs not); full-time employed: employment status (employed full-time vs not); education: 8 categories—less than high school, high school incomplete, high school graduate, some college–no degree, 2-year associate degree, 4-year college degree, some postgrad or professional–no degree, postgrad or professional degree; income: 3 categories—less than $50 K, $50-<$100 K, $100+ K; parents: parental status (parent vs not); device use before bed: continuous (never, rarely, occasionally, somewhat often, very often); disordered sleep index: index ranging from 0 to 100 (as it is scored for the Sleep Health Index); bedroom temperature: 3 categories—much too hot or cold, somewhat too hot or cold, about right; bedroom: too quiet (too quiet vs not); bedroom: too noisy (too noisy vs not); bedroom: light: 3 categories–much too bright or dark, somewhat too bright or dark, about right; mattress comfort: 4 categories—not comfortable at all, not so comfortable, somewhat comfortable, very comfortable; pillows comfort: 4 categories—not comfortable at all, not so comfortable, somewhat comfortable, very comfortable; sheets comfort: 4 categories—not comfortable at all, not so comfortable, somewhat comfortable, very comfortable; life satisfaction: 5 categories—not satisfied at all, not so satisfied, somewhat satisfied, very satisfied, extremely satisfied; overall stress: 5 categories—very low, low, moderate, high, very high; overall health: 5 categories—poor, not so good, good, very good, excellent.
*** $P < .001$
** $P < .01$.
* $P < .05$.

were significant predictors as well (all: $P < .01$). Other significant predictors of sleep satisfaction included living in a rural environment ($\beta = -.08$) and mattress comfort ($\beta = .10$).

Discussion

The SST fills a major unmet need for a robust instrument to measure one's opinions of his or her sleep satisfaction. Using a qualitative study and previous findings from an expert panel assembled by the NSF,[8] a taskforce compiled common sleep satisfaction indicators. These indicators were used to assemble the initial SST for cognitive and quantitative testing. Through factor analysis and review from an expert panel, 9 items were identified for the final SST, which displayed excellent internal validity and loaded onto a single factor.

The SST has strong reliability and internal validity, as measured through analysis of cross-variables. For example, overall health and life satisfaction positively correlated with sleep satisfaction, whereas greater stress predicted lower sleep satisfaction. Although we did not measure the SST alongside mood or sleep dysfunction scales, we conducted correlation and regression analyses with self-reported assessments of overall health, stress, and satisfaction with life. We also observed correlations between the SST and the disordered sleep subindex of the Sleep Health Index.[2] Those who reported better overall health, lower stress levels, and higher life satisfaction achieved higher SST scores. Individuals with sleep disorders or who recently used sleep medication or discussed sleep problems with a doctor had significantly lower SST scores than those who had not. Respondents trying to improve sleep also had lower SST scores than those who were not. Taken together, these results confirm SST's strong psychometric properties.

The SST measures a previously unexamined facet of sleep health and offers unique insight into the sleep of the general population. For example, despite literature that presents decreasing sleep[12] and changes to sleep architecture with age,[13] SST scores of older adults were higher than younger adults, and age was a positive predictor of sleep satisfaction. On the other hand, women, single respondents, and rural-dwelling respondents had lower sleep satisfaction than men, married respondents, and suburban-dwelling respondents, respectively. It is unclear if the sex difference in sleep satisfaction is due to an increased prevalence in disordered sleep[14] or nonsleep factors. The SST may enable additional studies of the general population, where nonsleep factors may significantly affect sleep satisfaction and sleep health overall.

The SST, as currently designed, has several strengths as an instrument. Psychometrically, the SST loads on a single factor, and the questions generally have high loading factors. The SST is reliable, valid, and brief and can be scaled to a total numerical score of 100, allowing researchers to track sleep satisfaction in a large population over time. The instrument does not include measures of sleep environment but enables a broader examination of the factors that affect sleep satisfaction. For example, both mattress comfort and pillow comfort were significant predictors of sleep satisfaction, underscoring the importance of environment for sleep satisfaction.[15,16] We found weekday sleep satisfaction to be lower than weekend sleep satisfaction, suggesting an area where targeted policies around school or work schedules may improve the nation's satisfaction with sleep. Translation of the SST and testing in distinct subpopulations or countries outside of the United States may reveal diverse insights into sleep satisfaction.

The NSF created the SST to be a subjective measure of sleep within the general population. Developed through a series of rigorous refinement and analytical processes, the SST is a first-of-its-kind instrument with multiple potential applications. Further use and additional validation testing of the SST can strengthen the instrument, perhaps by including alterations to the scoring system, balancing item weights, testing in different populations, or comparing to other established sleep assessment scales. The SST may also be used to measure the overall sleep satisfaction in individuals with chronic health conditions, including sleep disorders. Administration of the SST alongside clinical sleep instruments may define SST score ranges that are predictive for sleep or health problems and establish the sensitivity of the SST to conditions that affect sleep satisfaction. Characterizing healthy individuals who have low sleep satisfaction may help elucidate the personal and environmental factors that contribute to subjective sleep perception. One limitation of the SST is the reliance on subjective self-report. However, this limitation is also one of its greatest strengths. The SST is an important supplement to the more clinically focused tools assessing various sleep pathologies by providing insight into an individual's personal sleep experience. Finally, researchers can use SST alongside other measures of sleep and activity, ranging from EEG to consumer actigraphy devices. This combined approach enables a deeper understanding of sleep in the general population.

Conclusion

The SST provides a useful, reliable, and substantive measure of individuals' sleep satisfaction. The SST measures a previously unexplored domain of sleep and well-being, and the SST can be used across the general population to understand sleep satisfaction correlates and predictors. Based on a question from the SST, just about 6 of 10 Americans are somewhat or very satisfied with their sleep. The prevalence of indicators, including the low average satisfaction score of waking up during the night (39), may depress the overall sleep satisfaction score (56). However, these preliminary findings suggest that there is clearly room for improving the overall sleep satisfaction of the country. Given that only a slim majority of respondents were satisfied with their sleep, there is a clear need for public health and policy initiatives with the goal of improving sleep health and thus satisfaction. The SST enables future studies exploring how to achieve a more satisfying night of sleep every night.

Disclosures

C.F. and G.L. provided consultation and data analysis for this project. D.S.H was also a consultant for this project. The National Sleep Foundation (NSF), a 501(c)3 charitable and scientific organization, was the sole funder of this project.

All other authors have no disclosures.

Appendix A

Sleep Satisfaction Tool

This survey is about your satisfaction with your sleep. Please read and think about each question before answering.

1. How satisfied are you with your sleep overall? (response: 4-point satisfaction scale)
2. Generally speaking, when you wake up in the morning, how refreshed do you feel? (response: 4-point refreshed scale)
3. Based on how well you sleep, how energized do you generally feel as you go about your day? (response: 4-point energized scale)
4. How much trouble do you generally have falling asleep, if any? (response: 4-point amount description scale)
5. How often do you wake up during the night for any reason? (response: 5-point frequency scale)
6. If you wake up after falling asleep, is it generally easy or difficult to fall back asleep? (response: 4-point difficulty scale)
7. In general, how satisfied are you with the amount of sleep you get on work-days or weekdays? (response: 4-point satisfaction scale)
8. In general, how satisfied are you with the amount of sleep you get on weekends or non-work days? (response: 4-point satisfaction scale)
9. How easy or difficult is it for you to achieve a relaxed mental state before going to bed — is this… (response: 4-point difficulty scale)

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleh.2018.10.003.

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