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False beliefs about sleep and their associations with sleep-related behavior

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ABSTRACT

Objectives: Understanding the association between sleep-related beliefs and behaviors may be useful in improving sleep health in the general population. This study examines false beliefs about sleep and their associations with self-reported sleep and related behaviors.

Methods: Respondents in an online survey indicated the degree to which they agreed with 20 statements previously identified as sleep myths by experts in the field. A total sleep myths score was calculated for each participant, with higher scores reflecting greater false beliefs. Sociodemographic factors, behaviors, and knowledge related to sleep were also assessed.

Results: Total sample size was 1120 adults residing in the United States (51.5% female; *M* age = 47.22). Overall, belief in sleep myths was relatively common, with 10 of 20 false statements endorsed by at least 50% of the sample. Sleep myth scores varied by sociodemographic factors, including age, gender, socioeconomic indicators, and region of residence. Higher sleep myth scores were associated with greater inconsistency in bedtimes (odds ratio: 1.07 [1.04-1.09]), more frequent napping (odds ratio: 1.11 [1.09-1.14]), more in-bed activities (β = 0.35, $p < .001$), engaging in behaviors incompatible with sleep hygiene recommendations (β = 0.24, $p < .001$), and perceiving fewer consequences of insufficient sleep (β = −0.13, $p < .001$). Those endorsing more myths reported shorter sleep on non-worknights (β = −0.09, p = .01) but not on worknights.

Conclusions: Belief in sleep myths is related to sleep health behavior and may be a modifiable target for intervention.

Introduction

Sleep health is increasingly recognized as a critical aspect of overall wellness. Proposed definitions of sleep health emphasize its multidimensional nature, suggesting a composite of factors that can be measured on a continuum, as opposed to simply the absence of disordered sleep.[1,2] Determinants of sleep health include a broad range of physiological, socio-cultural, and psycho-behavioral factors.[3,4] In turn, several aspects of sleep health are believed to influence other domains of functioning, including physical and emotional health, cognitive performance, productivity, and safety.[5] Thus, improving sleep health at the population level may have wide-ranging health benefits.[1]

At least some aspects of sleep are under behavioral control, and health behavior theory may be helpful when considering how to change or improve sleep.[6] Beliefs are posited to play an integral role in many of the prominent health behavior theory models, although types of beliefs and their proposed mechanisms of influence vary across frameworks.[7] Regarding the role of beliefs in sleep, much of the literature has focused on characterizing maladaptive beliefs in insomnia or other sleep disorders.[8-11] Additional work has examined beliefs in the context of informing sleep health interventions or educational programs, especially among college students.[6,12,13]

False beliefs, sometimes referred to as misconceptions or myths, may also influence health behavior and decision-making.[14,15] False health beliefs may be propagated by a number of sources, including interpersonal communication and the media[14-16] and have been shown to be relevant in a variety of health domains, including sexual health,[17] vaccination behavior,[18] and management of chronic illness.[19] In a recent study examining false beliefs about sleep, Robbins et al[20] identified a list of *sleep myths* from the internet. Using the Delphi method, a panel of 10 sleep experts provided feedback on the wording, degree of falseness, and public health significance of each statement, resulting in a list of 20 sleep myths across 6 conceptual domains. The authors suggest that belief in these sleep myths could have adverse effects on sleep health and note that their findings may contribute to public health research and future intervention.

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While Robbins et al's study utilized expert feedback to identify false and potentially influential beliefs regarding sleep, a critical next step is to evaluate the degree to which sleep myths are endorsed by nonexperts, and to determine whether such beliefs relate to behavior. In the current study, we assess the degree to which sleep myths are endorsed in a large sample of US adults and examine whether these beliefs vary by sociodemographic factors. In addition, we test whether overall belief in sleep myths is associated with self-reports of sleep-related behaviors across several of the conceptual domains identified by Robbins et al.[20] Specifically, we hypothesize that individuals who report stronger beliefs in sleep myths will have less healthy sleep profiles in terms of sleep duration, sleep timing, and sleep hygiene.

Method

Participants

Participants were recruited via CloudResearch's Prime Panels,[21] an online platform that allows researchers to recruit from a pool of over 50 million individuals. All individuals complete a set of demographic questions prior to joining the panel.

In total, 1471 eligible panelists signed up for the study. Of those who began the survey, 294 failed the attention check and 57 did not complete the study, yielding a final sample size of 1120. Participants who completed the entire survey received compensation at the rate previously established by CloudResearch and its panel members (typically between US$1 and US$1.75 for a study of this length).

Materials

Demographic questions

A mix of open-ended and multiple-choice questions assessed demographic characteristics, which are summarized in Table 1. While our sample was relatively diverse, there was an overrepresentation of highly educated participants residing in the Northeast, and an underrepresentation of Black and Hispanic participants, compared to the general US population.[22]

Sleep myth survey

We created a questionnaire using the 20 sleep myths identified by Robbins et al.[20] In that study, a myth was defined as a "belief held by individuals that lacks a strong evidence base or is contradicted by existing scientific evidence." To identify myths, a search of 250 websites was first conducted, followed by expert review. This process resulted in a list of 20 sleep myths spanning 6 conceptual domains: sleep duration, sleep timing, behaviors during sleep, daytime behaviors that relate to sleep, pre-sleep behaviors, and brain function and sleep ([20]; Table 2). While most of the myths pertained to knowledge regarding sleep habits that are partially amenable to behavior change (eg, "Watching television in bed is a good way to relax before bed"), some were more conceptual in nature (eg, "Adults sleep more as they get older"). In Robbins et al.'s study, 10 experts rated all statements on *falseness* and *public health significance* using a 5-point scale. In this study, we modified the response options by asking respondents to indicate the extent to which they agreed or disagreed with each statement, using a 4-point Likert scale ("strongly disagree" = 1 point to "strongly agree" = 4 points). We also reversed the wording of 5 statements so that they were accurate (eg, "During sleep the brain is active") to minimize potential response bias. These items were reverse-scored with responses of "strongly agree" receiving 1 point and "strongly disagree" receiving 4 points. We summed scores from each item to calculate a total sleep myths score. Scores could range from 20 to 80, with higher scores indicating stronger endorsement of sleep myths.

Sleep duration

Respondents were asked "On average, how many hours of sleep do you get on a night when you need to work the next day?" (worknight sleep duration) and "On average, how many hours of sleep do you get on a night when you do *not* need to work the next day?" (non-worknight sleep duration). Responses were selected using a slider scale, from 0 to 12 hours, with accuracy to one decimal point. There was also an option to select "12+ hours."

Sleep duration

To assess consistency of bedtimes from night to night, respondents were asked "On average, how stable or similar are your bedtimes from night to night, on nights when you need to work the next day?" Response options consisted of 11 choices. The first 8 choices were in 15-minute increments (eg, between 0 and 15 minutes, between 16 and 30 minutes), the next 2 choices in one-hour increments (eg, between 2 and 3 hours), and the final option being "over 4 hours." Bedtime consistency for worknights and non-worknights were assessed separately. Those who reported that their worknight bedtimes varied by 60 minutes or less per night were compared to those who reported that their worknight bedtimes varied by more than 60 minutes.

Sleep hygiene

To assess presleep behaviors, respondents indicated how frequently they engage in each of 8 activities in bed: read for fun (printed material), read for fun on an electronic device, online activities, do work, watch television, listen to music/podcast, talk on the phone, and eat/drink. An in-bed activities score was calculated by assigning points to the frequency of behaviors (0 = never; 1 = sometimes; 2 = often; 3 = regularly) and summing; higher scores reflect more frequent engagement in in-bed activities.

Respondents also indicated which strategies they use when they have difficulty sleeping, and how frequently they use each. We included 4 strategies that generally contradict sleep hygiene and stimulus control recommendations ("do something else in bed [eg, read, watch TV])," "do something related to work," "drink alcohol," and "have a snack") and 2 strategies that are generally in line with sleep hygiene and stimulus control recommendations ("relaxation exercises [eg, deep breathing, meditation]" and "get out of bed and do something else [eg, read, watch TV]").[23] Scores for strategies that are compatible and incompatible with sleep hygiene recommendations were calculated separately, by assigning points to the frequency of behaviors in each category (0 = never; 1 = occasionally; 2 = often) and summing. Finally, respondents indicated frequency of daytime naps ("on average, how frequently do you nap?"). Those who reported napping weekly or less were compared to those who reported napping more than once per week.

Sleep knowledge and interest

To assess general knowledge about the importance of sleep for health, we administered a modified version of the "Sleep and Health" subscale from the Sleep Practices and Attitudes Questionnaire (SPAQ; 24). The original questionnaire contains the stem, "If I don't get enough sleep, it can cause me to…," followed by 14 potential consequence items. To minimize response burden, we combined the "high blood pressure" and "raise cholesterol" items into a single statement and removed 2 additional items. Thus, our modified version included 11 items: "feel sleepy during the day," "fall asleep while driving," "gain weight," "develop heart disease," "develop high blood pressure or high cholesterol," "be more moody," "have less energy," "have a lower sex drive," "perform worse at work or school," "have problems remembering things or concentrating," and "develop diabetes." Respondents indicated the extent to which they agreed with each statement on a 5 point-scale, ranging from strongly disagree to

Table 1
Distribution of responses to demographic questions and mean myth score for each demographic category (n=1,120)

Demographic questions and responses	Percentage (and number) of respondents	Mean (SD) myth score
Age[a]		
18-29	11.2% (n = 125)	47.25 (7.17)
30-39	22.4% (n = 251)	50.23 (6.71)
40-49	25.8% (n = 289)	49.66 (7.08)
50-59	15.6% (n = 175)	45.21 (5.34)
60-69	16.2% (n = 181)	43.64 (4.66)
70 or older	8.8% (n = 99)	44.03 (4.36)
Gender[b]		
Female	51.5% (n = 577)	45.44 (6.01)*
Male	48.5% (n = 543)	49.39 (6.88)*
Highest level of education		
High school or lower	14.3% (n = 160)	47.17 (5.43)*
Associate's degree or some college	28.0% (n = 314)	45.17 (5.13)*
Bachelor's degree	28.1% (n = 315)	46.38 (6.70)*
Master's degree	21.5% (n = 241)	49.65 (7.21)*
Doctoral/prof. degree	8.0% (n = 90)	52.52 (8.10)*
Race		
American Indian or Alaska Native	1.2% (n = 13)	49.92 (6.20)
Asian	7.1% (n = 80)	47.39 (5.02)
Black/African Amer.	5.5% (n = 62)	48.13 (6.47)
Native Hawaiian or other Pacific Islander	0.3% (n = 3)	49.00 (5.20)
White	84.3% (n = 944)	47.23 (6.90)
Other	0.2% (n = 2)	47.00 (4.24)
Do not wish to say	1.4% (n = 16)	49.13 (6.65)
Ethnicity		
Non-Hispanic	91.4% (n = 1,024)	47.07 (6.61)*
Hispanic	8.0% (n = 90)	50.67 (7.42)*
Employment status		
Full-time (35+ hrs/wk)	53.3% (n = 597)	49.05 (7.23)*
Retired	14.3% (n = 160)	43.82 (4.40)*
Unemployed, disabled, unpaid caregiver, or temporary leave	18.8% (n = 210)	45.72 (5.46)*
Part-time employment (1-34 hrs/wk)	13.7% (n = 153)	46.66 (6.29)*
Total household annual income		
Less than $5000	2.9% (n = 32)	48.50 (5.91)
$5000 - $11,999	2.9% (n = 32)	44.84 (4.59)
$12,000 - $15,999	2.8% (n = 31)	45.65 (6.45)
$16,000 - $24,999	6.3% (n = 70)	45.53 (4.84)
$25,000 - $34,999	9.2% (n = 103)	46.38 (5.43)
$35,000 - $49,999	12.6% (n = 141)	44.92 (5.49)
$50,000 - $74,999	17.0% (n = 190)	46.26 (7.13)
$75,000 - $99,999	11.8% (n = 132)	47.01 (6.66)
$100,000 - $149,999	18.2% (n = 204)	49.06 (7.31)
$150,000 or higher	13.7% (n = 153)	51.31 (6.83)
Don't know	2.9% (n = 32)	46.22 (5.33)
Geographic region[c]		
Midwest	17.3% (n = 194)	44.93 (5.82)*
Northeast	24.9% (n = 279)	48.86 (7.18)*
South	33.7% (n = 377)	46.96 (6.42)*
West	24.1% (n = 270)	48.08 (6.81)*

* $p < .001$ significant differences in total sleep myth scores between the categories in t-tests and analysis of variance

[a] $p < .001$. Age and income were assessed as continuous variables, and associations with total myth score were examined in linear regression models. Responses are grouped by category for summary purposes only.

[b] "Non-binary" and "Do not wish to say" were also presented as options, but these were not selected by any respondent.

[c] Geographic region designation based on US Census Bureau definitions. (https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf); Midwest: IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD, WI. Northeast: CT, ME, MA, NH, NJ, NY, PA, RI, VT. South: AL, AR, DE, DC, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV. West: AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA, WY. Our sample represented 48 states and the District of Columbia (no respondent from ND or WY).

strongly agree. In addition, respondents were asked to complete the following statement: "It is recommended that people of my age and gender get _____ hours of sleep per night, on average" using a slider scale from 0 to 12 hours, with accuracy to one decimal point.

We gauged general interest in the topic of sleep with 2 items. The first item asked, "What is your level of interest in learning more about sleep?" with options ranging from 1 ("Not interested") to 4 ("Very interested"). The second item inquired about use of sleep-related commercial products. Participants were asked to indicate which of the following products they have in their bedroom and how helpful each is to their sleep quality: weighted blankets, eye masks, blackout curtains, white noise machines, televisions, air purifiers, de/humidifiers, aromatherapy diffusers, and fans. A count of products used was examined in analyses.

Procedure

Data collection was completed in the spring of 2020 (April 21-May 5), with a total of 11 surveys posted on CloudResearch. Content was identical for all surveys, and the primary reason for having multiple surveys was to vary the timing of survey launch. Six surveys were launched on a weekday (2 in the morning, 2 in the afternoon, and 2 in the evening), and 4 were posted on a weekend (2 in the afternoon and 2 in the evening). For each pair of surveys launched at each time

Table 2
Sleep myth statements, distribution of responses, and mean (SD) score for each item

Conceptual domain and statement	Strongly disagree (1)	Mostly disagree (2)	Mostly agree (3)	Strongly agree (4)	Mean (SD)
Conceptual domain: Brain function and sleep					
1. Being able to fall asleep "anytime, anywhere" is a sign of a healthy sleep system	12.9%	32.1%	40.8%	14.1%	2.6 (0.9)
2. Most adults need only 5 or fewer hours of sleep for general health	34.1%	40.2%	18.4%	7.3%	2.0 (0.9)
3. Your brain and body can learn to function just as well with less sleep	25.7%	41.0%	23.8%	9.6%	2.2 (0.9)
4. Adults sleep less as they get older[a]	10.4%	27.9%	45.2%	16.4%	2.3 (0.9)
5. If you can get it, more sleep is always better	3.1%	15.3%	48.2%	33.4%	3.1 (0.8)
6. One night of sleep deprivation will have lasting negative health consequences	12.1%	37.5%	35.1%	15.4%	2.5 (0.9)
Conceptual domain: Sleep timing					
7. In terms of your health, the time of day that you sleep matters[a]	3.7%	22.9%	51.7%	21.8%	2.1 (0.8)
Conceptual domain: Behaviors during sleep					
8. Lying in bed with your eyes closed is not as good as sleeping[a]	2.7%	14.2%	43.7%	39.5%	1.8 (0.8)
9. If you have difficulty falling asleep, it is best to stay in bed and try to fall back to sleep	7.2%	23.8%	49.0%	20.0%	2.8 (0.8)
10. Although annoying for bed partners, loud snoring is mostly harmless	27.4%	35.5%	23.8%	13.3%	2.2 (1.0)
11. A sound sleeper rarely moves at night	9.4%	33.2%	40.6%	16.8%	2.7 (0.9)
Conceptual domain: Daytime behaviors that relate to sleep					
12. Getting up when the alarm first goes off is better than hitting the snooze button[a]	2.8%	11.5%	50.8%	34.9%	1.8 (0.7)
13. If you are having difficulties sleeping, taking a nap in the afternoon is a good way to get adequate sleep	8.4%	29.2%	48.8%	13.7%	2.7 (0.8)
Conceptual domain: Pre-sleep behaviors					
14. Alcohol before bed will improve your sleep	39.1%	33.4%	19.2%	8.3%	2.0 (1.0)
15. For sleeping, it is better to have a warmer bedroom than a cooler bedroom	32.9%	35.2%	21.3%	10.7%	2.1 (1.0)
16. Boredom can make you sleepy even if you got adequate sleep before	2.9%	14.5%	57.6%	25.1%	3.1 (0.7)
17. Watching television in bed is a good way to relax before sleep	18.3%	29.4%	35.6%	16.7%	2.5 (1.0)
18. Exercising within 4 hours of bedtime will disturb your sleep	13.3%	36.8%	37.1%	12.9%	2.5 (0.9)
Conceptual domain: Brain function and sleep					
19. During sleep, the brain is active[a]	4.3%	9.9%	51.6%	34.2%	1.8 (0.8)
20. Remembering your dreams is a sign of a good night's sleep	7.1%	39.3%	39.1%	14.6%	2.6 (0.8)

Notes: Total number of respondents who completed this module of the survey = 1120.
[a] Reverse-scored items. These items were re-worded so that they were true rather than false statements. A lower mean score for these 5 items indicates stronger agreement with the true statement. Thus, for all items, a higher mean score reflects stronger belief in a myth. Please see Robbins et al[20] for experts' ratings of falseness and public health significance for each myth.

point, one survey was restricted to male respondents, and the other survey was restricted to female respondents, with the aim to ensure similar gender distribution.

The survey was entitled "*Sleep-related habits & beliefs,*" and the projected completion time was 20 minutes. After reviewing an information sheet and providing consent, respondents completed a brief demographic questionnaire. Instructions for the study were presented next. Participants were informed that the research aimed to understand sleep-related beliefs and practices and that they would answer questions about sleep-related topics, including their beliefs and behaviors. We also implemented a single-item instruction check, where respondents were to select the option that best summarized their task (ie, respond based on their general beliefs and typical behaviors). Data from respondents who failed the instruction check were excluded from analyses. Next, respondents completed the myth statements, the sleep-related measures described above, and additional questions not reported here. All procedures were approved by Villanova University's Institutional Review Board.

Analysis

We first examined demographic and related variables' relationships with total sleep myth scores, using *t* tests or analysis of variance for categorical variables and using correlation or linear regression for continuous variables. To examine income, equivalized income was calculated by dividing the mid-point of the selected income category by the square root of household size; the midpoint of the highest, open-ended category was estimated with a Pareto distribution.[25] We then used regression analysis to examine whether total sleep myth scores predicted sleep duration, sleep timing, sleep hygiene, and sleep knowledge. Hierarchical linear regression was used for continuous outcomes, and logistic regression was used for categorical outcomes. All tests were 2-tailed. We retained gender, age, education, income, employment status, geographic region, and ethnicity (Hispanic vs. non-Hispanic) as covariates due to their relationships with sleep myth scores, as well as their associations with sleep quantity and quality in previous studies.[4] Covariates were entered in the first step of each model. After reporting the link between sleep myths and sleep duration, subsequent analyses were also adjusted for worknight and non-worknight sleep duration in the first step. Total sleep myth score was entered in the final step.

In addition to our main analyses, we ran 2 sets of supplementary analyses. First, to try to control for potential response bias in the sleep myth questionnaire (ie, extreme responding), we collapsed the 4-point response scale (ranging from strongly disagree to strongly agree) into a dichotomous, 2-point scale in which agreement with a false statement received 1 point and disagreement with a false statement received 0 points. We then repeated all analyses with total sleep myth scores based on this dichotomous scoring.

Second, data were collected during the start of the COVID-19 pandemic in the United States, raising concerns about generalizability of the findings. We included a question asking, "Are you currently experiencing any out-of-the-ordinary events or issues that are impacting your sleep?" Participants could respond that their sleep was *improved* compared to usual (n = 222, 19.8%), *disrupted* compared to usual (n = 233, 20.8%), or typical (n = 602, 53.8%) (5.6% were missing data). After restricting the sample to only those who responded that their sleep was typical, we re-ran all analyses to determine if sleep myths and sleep-related behaviors were associated in this subgroup.

Results

Sample characteristics are shown in Table 1. Means for continuous sleep variables are shown in Table 3. Average sleep duration on worknights and non-worknights was 6.78 (standard deviation [SD] = 1.39) and 7.42 (SD = 1.61) hours, respectively. Regarding categorical outcome

Table 3
Means (SDs) of continuous sleep variable outcomes in full sample and by categories of total sleep myth scores

	Sleep variables							
Group	Worknight sleep (hours)	Non-worknight sleep (hours)	Activities in bed	Incompatible[a] sleep strategies	Compatible[a] sleep strategies	Sleep & health subscale of SPAQ[b]	Recommended hours of sleep	Sleep product use
Low[c] (31-43)	6.77 (1.30)	7.44 (1.47)	6.24 (5.02)	0.99 (1.13)	0.70 (0.84)	42.84 (6.78)	7.74 (0.64)	1.27 (1.19)
Med[c] (44-50)	6.65 (1.36)	7.33 (1.62)	7.63 (5.62)	1.02 (1.21)	0.55 (0.77)	39.35 (7.49)	7.59 (0.89)	1.12 (1.22)
High[c] (51-65)	6.94 (1.47)	7.50 (1.72)	13.47 (6.04)	1.96 (1.83)	0.86 (1.05)	39.45 (8.32)	7.58 (1.07)	2.68 (2.27)
Full sample	6.78 (1.39)	7.42 (1.61)	9.36 (6.44)	1.34 (1.50)	0.70 (0.91)	40.38 (7.75)	7.58 (1.07)	1.75 (1.87)

[a] Sleep strategies are categorized into behaviors that generally contradict (incompatible) or are in line with (compatible) stimulus control and sleep hygiene recommendations.
[b] Sleep Practices and Attitudes Questionnaire.[23]
[c] Unadjusted means shown here by tertiles of low, medium, and high total sleep myth scores for descriptive purposes only. Statistical analyses used total sleep myth scores as a continuous variable and were adjusted for covariates.

variables, 429 (38.3%) reported that their bedtimes varied by more than one hour from night-to-night, and 409 (37.6%) reported napping more than weekly. Just over half of the sample (56.9%) reported being "quite" or "very" interested in learning more about sleep.

Total sleep myth scores

Altogether, 1120 participants completed the sleep myths survey. Internal consistency of the scale was acceptable (Cronbach $\alpha = 0.71$). Total sleep myth scores ranged from 31 to 65, with a mean of 47.35 (SD = 6.74) (Fig. 1). Across all myths, the average belief score was 2.37 (SD = 0.34). Half of all myths received an average rating score of 2.5 or higher, reflecting agreement with the statement (Table 2). Of the 5 myths most strongly endorsed by this sample, 2 were rated as higher than the median in terms of public health significance by experts in Robbins et al[20]: "If you have difficulty falling asleep, it is best to stay in bed and try to fall back to sleep" and "If you are having difficulties sleeping, taking a nap in the afternoon is a good way to get adequate sleep."

Demographic differences in total sleep myth scores

Total sleep myth scores by demographic factors are shown in Table 1. Age was inversely associated with total sleep myth scores, indicating stronger endorsement of false statements among younger participants, ($r = -0.33$, $p < .001$). Men had higher scores than women (t (1118) = 10.25, $p < .001$), and those who identified as Hispanic scored higher than those identifying as non-Hispanic (t (1118) = −4.91, $p < .001$). There were no differences in sleep myth scores by self-identified race group, ($F6$, 1113 = 0.72, $p = .63$). After adjusting for age, gender, and Hispanic ethnicity, higher income was associated with higher sleep myth scores ($\beta = 0.10$, $p < .001$). Results for education showed a similar pattern ($F4$, 1112 = 20.55, $p < .001$), in which individuals with either a Master's or Doctorate/professional degree endorsed more myths than those with a Bachelor's degree, an Associate's degree or some college, or a high school diploma. Sleep myth scores varied by employment status ($F3$, 1113 = 6.04, $p < .001$), with those employed full-time endorsing more myths than the other groups, and the retired group endorsing the fewest myths. Sleep myth scores also varied by geographic region ($F3$, 1113 = 9.42, $p < .001$), with those in the Northeast and West scoring higher than those in the South, and those in the Midwest scoring the lowest.

Total sleep myth scores and sleep duration, timing, and hygiene

Sleep duration

After adjusting for age, gender, education, income, Hispanic ethnicity, employment status, and geographic region, sleep myth scores were not associated with worknight sleep duration ($\beta = 0.03$, $p = .37$). Those endorsing more myths reported shorter sleep on non-worknights ($\beta = -0.09$, $p = .01$, $R^2\Delta = 0.005$).

Sleep timing

After adjusting for covariates and sleep duration, those with higher sleep myth scores were more likely to report that their bedtimes typically vary by over 60 minutes per night (odds ratio [OR]: 1.07, 95% confidence interval [CI]: 1.04-1.09, $p < .001$; Fig. 2).

Sleep hygiene

After adjusting for covariates and sleep duration, higher sleep myth scores were associated with performing more activities in bed ($\beta = 0.35$, $p < .001$, $R^2\Delta = 0.09$), as well as with more frequent use of strategies incompatible with sleep hygiene and stimulus control guidelines when having difficulty sleeping ($\beta = 0.24$, $p < .001$, $R^2\Delta = 0.04$). Sleep myth scores were not related to using strategies compatible with sleep-hygiene and stimulus control guidelines, such

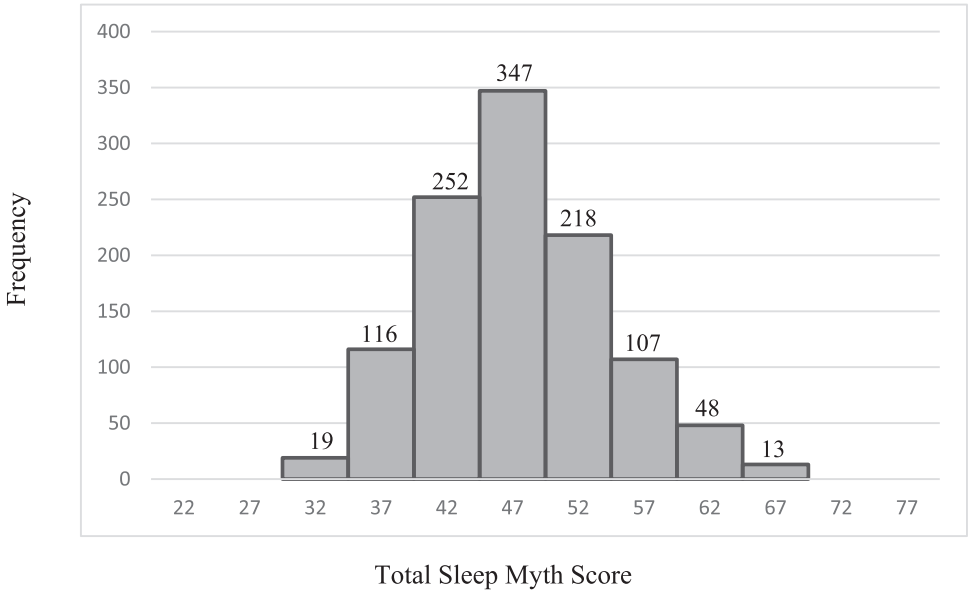

Fig. 1. Histogram of total sleep myth scores in the sample of participants (n = 1120). Higher scores reflect stronger endorsement of sleep myths.

as relaxation or getting out of bed to do something else when experiencing sleep difficulty (β = 0.05, p = .19). After adjusting for covariates and sleep duration, higher sleep myth scores were associated with napping more frequently than weekly (OR: 1.11, 95% CI: 1.09-1.14, $p < .001$; Fig. 2).

Sleep knowledge and interest

After adjusting for covariates and sleep duration, higher sleep myth scores were associated with lower scores on the SPAQ Sleep and Health subscale ($\beta = -0.13$, $p < .001$, $R^2\Delta = 0.01$), indicating that endorsing more sleep myths was related to perceiving fewer consequences of insufficient sleep. Consistent with this, higher sleep myth scores were related to lower estimates of recommended hours of nightly sleep for persons of the same age and gender ($\beta = -0.08$, $p = .02$, $R^2\Delta = 0.01$). Those with higher sleep myth scores also reported using more sleep-related products ($\beta = 0.26$, $p < .001$, $R^2\Delta = 0.05$) and were more likely to state that they were "quite" or "very interested" in learning about sleep vs. "mildly" or "not interested" (OR: 1.03, 95% CI: 1.01-1.06, $p = .01$; Fig. 2).

Supplementary analyses

In analyses that used dichotomous scoring to calculate total sleep myth scores, patterns of results were identical to those reported above. A second set of analyses excluded participants who reported that their sleep at the time of the survey was improved or disrupted compared to their usual patterns and was restricted to only those

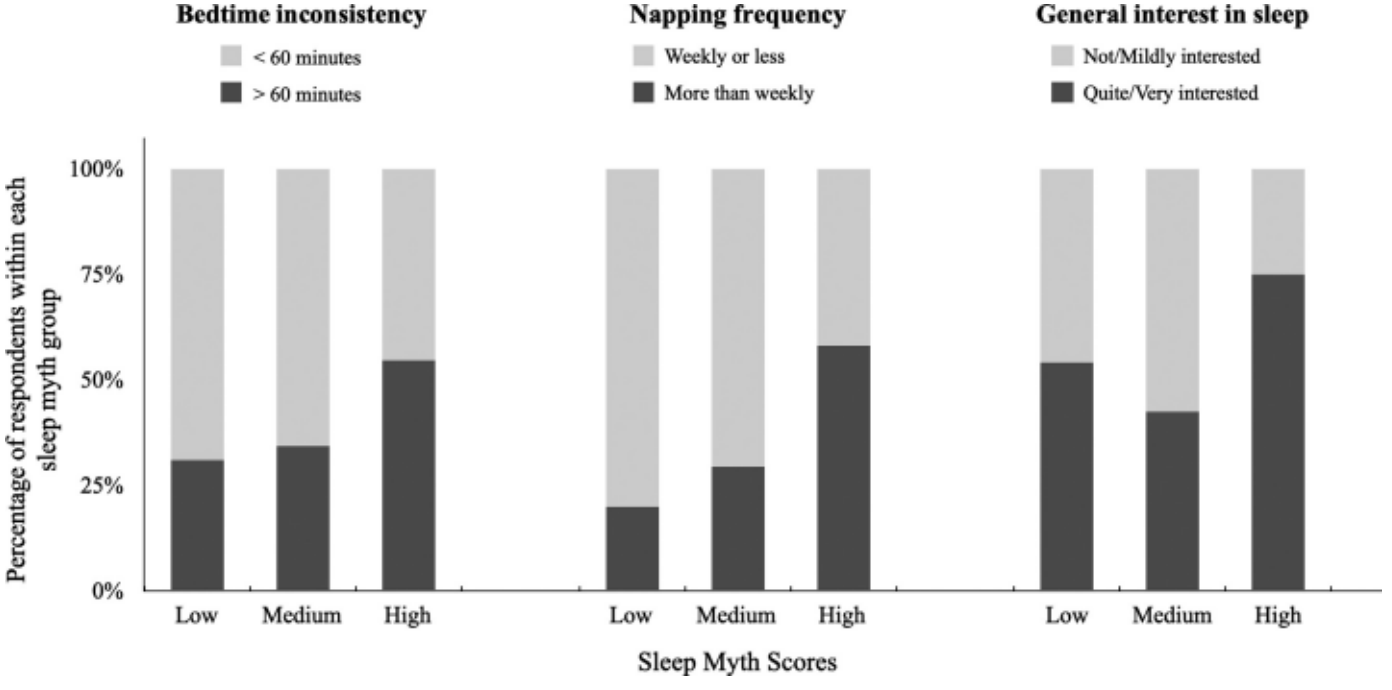

Fig. 2. Categorical sleep variable outcomes by categories of total sleep myth scores.

who reported typical sleep. In this subsample, 3 of the findings reported above were reduced to non-significance. Specifically, sleep myth scores were no longer associated with non-worknight sleep duration (β = −0.04, p = .31), interest in learning about sleep (OR: 1.01, p = .55), nor recommended sleep hours (β = −0.03, p = .47). All other associations reported above remained significant.

Discussion

The first goal of this study was to quantify belief in sleep myths among the general public. Belief in sleep myths was relatively common, with 10 out of 20 incorrect statements endorsed by 50% or more of sample participants. These "popular" myths spanned all 6 of the conceptual domains identified by Robbins et al,[20] including sleep duration, sleep timing, brain function and sleep, and daytime, pre-sleep, and sleep behaviors. Thus, these findings build on the work of Robbins et al[20] by showing that many statements regarded as sleep myths by experts are endorsed by non-experts. Belief in sleep myths varied by demographic factors, with younger individuals, men, those of Hispanic ethnicity, those living in the Northeast and West, and those reporting full-time employment, more years of education, and higher incomes endorsing more myths.

An additional goal was to examine if belief in sleep myths was associated with sleep-related behaviors. Participants endorsing more sleep myths across multiple domains were more likely to report greater variability in bedtimes and more frequent daytime napping. Those endorsing more myths also reported more frequent engagement in behaviors inconsistent with sleep hygiene guidelines, specifically: performing more in-bed activities before going to sleep, and using alcohol, snacking, doing work, or engaging in other activities in bed when having trouble sleeping. Thus, stronger belief in myths was generally linked to a less healthy behavioral sleep profile. Belief in sleep myths was not related to worknight sleep duration but was inversely related to sleep duration on non-worknights. It should be noted, however, that we were unable to quantify typical number of worknights per week, and just over one-third of participants reported being retired or otherwise unemployed. Therefore, there was likely substantial variability in the ratio of worknights vs. non-worknights across the sample.

Although the statements measured in this study were identified as beliefs, there is conceptual overlap with research examining sleep knowledge. Prior work has shown that knowledge of sleep hygiene recommendations is generally related to healthier sleep practices and, in some cases, better sleep quality,[26,27] although overall data are mixed.[28] Indeed, participants in the current study who endorsed more sleep myths perceived fewer health and functional consequences of insufficient sleep as measured by the SPAQ[24] and provided lower estimates for sleep duration recommendations, consistent with less overall knowledge on the topic. Higher sleep myth scores were also associated with greater interest in the topic of sleep in general and increased use of sleep products. One possible explanation for these findings may be that individuals who are more interested in sleep seek out more sleep-related products and information, perhaps without regard to source credibility. While the internet is an increasingly used resource for health information, including sleep-related information,[29,30] researchers have raised concerns regarding website accuracy and reliability.[31,32] It may also be challenging for consumers to effectively evaluate and interpret multiple streams of evidence. For instance, the statements used in this study were originally identified via websites that labelled them as sleep myths or misperceptions.[20] However, the effectiveness of providing corrective information regarding unsupported health claims varies, and, at times, can even be counterproductive.[33,34] Therefore, it is possible that mere exposure to sleep myths influenced their endorsement in the current study. Another line of research has shown that holding dysfunctional or inaccurate beliefs about sleep is associated with vulnerability to sleep problems, such as insomnia.[8,9,11] Once individuals start to experience sleep problems, they may be more likely to adopt habits such as increased napping in an attempt to compensate for sleep loss. These same individuals may also seek out more sleep-related products and information as they try to improve their sleep. Altogether, these results underscore the importance of accessibility to clear, evidence-based health information.

When considered in the context of health behavior theory, the results of this study could inform interventions aimed at improving sleep health on multiple levels. For example, these data may be relevant for health care providers, social media campaigns aimed at disseminating accurate health information,[16,30] and population-level interventions targeting sleep, which remain rare compared to large scale interventions focused on other health behaviors.[1,20] Although several studies have shown that sleep education programs can lead to improved sleep, it is important to note that an increase in knowledge alone is often insufficient to enact behavioral change.[6] Thus, this information may be used in combination with other components of health behavior theory, such as addressing individual perceptions, efficacy, and readiness, to generate behavior change.[6,35] Noting the content of the most commonly endorsed myths, and considering how to best address them, may be helpful in achieving the largest impact. For example, large-scale interventions aimed at correcting misperceptions about the negative impact of daytime sleepiness, which were relatively common in this sample, could potentially lead to more screening for disorders such as sleep apnea. Other myths endorsed by most of this sample and rated high on potential public health impact in Robbins et al's[20] study revolved around actions taken in response to sleep difficulties, specifically eliminating afternoon naps and leaving bed when having trouble sleeping. These recommendations stem largely from stimulus control guidelines, which may be counterintuitive. Therefore, myths such as these may be best addressed in conjunction with a health professional who can explain their rationale and help with implementation of alternative strategies, especially in those at risk for sleep disorders.

Relatedly, the sleep myths we measured vary in their degree of inaccuracy,[20] and the potential consequences of endorsing some of the statements may be nuanced. For example, taking an occasional nap in the afternoon may not be problematic for someone without chronic sleep difficulties, and getting more sleep may indeed be a healthy behavior for many individuals. Our study was unable to assess origins of the false beliefs, which may provide an interesting avenue for future work. Research that evaluates the relationships among source of beliefs, persistence of those beliefs, and resultant behaviors will have important implications in developing targeted interventions.

The current study has several limitations. Since we were interested in assessing several behaviors for which validated measures do not exist (eg, sleep product use), we created some of the questionnaires used in this study. The psychometric properties of these questionnaires are unknown, and direct comparison with previous research is limited. Nonetheless, it is reassuring that our measures correlated with each other, and with a previously validated measure (ie, the SPAQ), in the expected manner. In addition, we focused on participants' cumulative beliefs in sleep myths spanning an array of topics rather than examining domain-specific beliefs, partially because our behavioral measures did not adequately capture all of the domains identified by Robbins et al.[20] Thus, future research may want to investigate the relation between domain-specific beliefs and behaviors in a more targeted manner (eg, are napping beliefs associated with napping behaviors?).

Although our study provides interesting insight into the associations between false belief endorsements and sleep-related behaviors, its cross-sectional nature limits our ability to draw causal

conclusions, and the long-term stability of these beliefs is unknown. Experimental work aimed at changing these beliefs will be critical to determining their utility in affecting behavior change. Most of the observed effects were small, and sleep myths appear to account for a very small portion of variance in the behaviors measured. It should also be noted that our data were collected during the start of the COVID-19 pandemic in the United States, which may have implications for generalizability. Specifically, given the well-established association between stress and sleep, respondents' sleep-related behaviors might have been affected. We attempted to minimize such influence by restricting our analyses to those who reported that their sleep was typical (54% of the sample), and we found that most associations between sleep myths and behaviors remained in this subgroup.

Finally, there are potential limitations associated with online data collection. Some of these include: (a) some of the respondents may not be naïve to common research material and may exert an undue influence over the results,[36] (b) lack of control over testing environment, [37] and (c) demographic misrepresentation.[38] However, since the materials used in our study are either original or from a recently published paper,[20] it is unlikely that respondents would have previously encountered the material. Although testing conditions can be variable across respondents, we included checks to verify respondent engagement. While the general concern for demographic misrepresentation has been raised, there is growing evidence to suggest that such behavior is unlikely to occur when demographic characteristics are not used to determine participation eligibility.[38-40]

In conclusion, the current study demonstrates that many sleep myths are believed to be true by nonexperts. Endorsement of sleep myths may vary by demographic factors and relate to other domains of sleep knowledge. Belief in sleep myths is also associated with a variety of sleep health behaviors. These findings add to the literature linking health beliefs to behavior and may have implications for health behavior models of sleep. With an increase in self-reported sleep difficulties among US adults in recent years,[41] these findings may also inform interventions targeting sleep health at the population level.

Declaration of conflict of interest

The authors have no conflicts of interest to declare.

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