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Sleep myths: an expert-led study to identify false beliefs about sleep that impinge upon population sleep health practices

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ABSTRACT

Introduction: False beliefs about sleep can persist despite contradicting scientific evidence, potentially impairing population health. Identifying commonly held false beliefs lacking an evidence base ("myths") can inform efforts to promote population sleep health.
Method: We compiled a list of potential myths using Internet searches of popular press and scientific literature. We used a Delphi process with sleep experts (n = 10) from the fields of sleep medicine and research. Selection and refinement of myths by sleep experts proceeded in 3 phases, including focus groups (Phase 1); email-based feedback to edit, add, or remove myths (Phase 2); and closed-ended questionnaires (Phase 3) where experts rated myths on 2 dimensions, falseness and public health significance, using 5-point Likert scale from 1 ("not at all") to 5 ("extremely false").
Results: The current study identified 20 sleep myths. Mean expert ratings of falseness ranged from 5.00 (SD = 0.00) for the statement "during sleep the brain is not active" to 2.50 (SD = 1.07) for the statement "sleeping in during the weekends is a good way to ensure you get adequate sleep." Mean responses to public health significance ranged from 4.63 (SD = 0.74) for debunking the statement that "many adults need only 5 or less hours of sleep for general health" to 1.71 (SD = 0.49) for the statement that "remembering your dreams is a sign of a good night's sleep."
Conclusion: The current study identified commonly held sleep myths that have a limited or questionable evidence base. Ratings provided by experts suggest areas that may benefit from public health education to correct myths and promote healthy sleep.

Introduction

Sleep is increasingly recognized as fundamental to overall health, as reflected in position statements and reports by leading scientific, clinical, and governmental organizations in the United States and internationally.[1–6] In addition, research has examined genetic,[7,8] physiologic,[9,10] and environmental factors[11] that play a critical role in sleep-wake regulation. Despite these advances in knowledge, little attention has been paid to widely held beliefs about sleep in the public arena and whether these beliefs are consistent with the scientific evidence pertaining to how sleep actually impacts health and functioning. Although some widely held beliefs may promote behaviors that improve population health, those that are inconsistent with the evidence may actually degrade population-level sleep health.

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Beliefs can take many different forms. According to the Health Belief Model, health behaviors can be predicted by beliefs associated with risk susceptibility, risk severity, benefits to action, barriers to action, self-efficacy, and cues to action.[12] Although this prevailing framework predicts beliefs that are associated with health behavior, beliefs that lack an evidence base ("myths") can be perpetuated in our daily lives through various sources, such as peer- or media-related influences.[13] Prior research has identified the potential adverse public health consequences of myths regarding obesity,[14] cancer risk,[15] and smoking.[16] To our knowledge, no prior study has systematically ascertained potential myths about sleep.

Sleep deficiency (defined as inadequate sleep duration and/or poor sleep quality) is a public health issue.[17] Approximately one-third of adults in the United States report sleeping less than the recommended 7 hours nightly.[18] Further, approximately 30% of adults in the United States endorse insomnia symptoms, and 10% have received a clinical diagnosis.[19–21] Insufficient sleep duration and sleep difficulties carry economic burden, estimated to be over $411 billion annually.[22] In sleep medicine, little attention has been paid to sleep myths that may persist in the population despite availability of scientific evidence to the contrary. To understand the impact of sleep myths on the population, we first need to identify commonly held beliefs that are not supported by scientific evidence. The goal of this study was to identify myths about sleep.

Methods

We conducted Internet searches to identify articles in the popular press about potential sleep myths. Then, we engaged experts using the Delphi method[23] to identify those myths. We defined a *myth* as a belief held by individuals that lacks a strong evidence base or is contradicted by existing scientific evidence.[24] The Delphi method is a systematic protocol for collecting opinions from experts in a certain domain.[23] Using this method, experts were recruited and then engaged in a series of open-ended discussions followed by use of closed-ended questionnaires.[25]

Participants and procedure

A convenience sample of experts was identified using PubMed searches. To qualify as an expert for this study, each expert needed 20 articles published and cited in 20 or more other peer-reviewed publications with at least 1 of the following Medical Subject Headings: *sleep* and either *circadian rhythms*, *neuroscience*, or *psychiatry*. Twenty individuals who met these criteria were contacted. Among the experts contacted, 10 participated in the study (coauthors MG, SY, WT, OB, KK, SP, LH, DB, GJL, CC).

Procedures for the current study included 3 phases (Fig. 1). Before the Delphi procedures, a search was conducted on a large online search engine in September 2016 using the terms *sleep* AND (*myth* OR *misconception* OR *misperception*). From this search activity, the search engine identified over 8000 Web sites. We used search tools to return 50 Web sites per page. We analyzed results on the first 5 pages (250 pages of content) to identify the most common sleep myths. Specifically, a research assistant downloaded the text from each article into a single document. Two independent coders reviewed this word document to categorize myths into categories (eg, myths about sleep hygiene, sleep duration, and bedroom environment). Then, the first and last authors (RR and GJL) reviewed this list and consolidated the myths to a shorter list of the 50 most common myths about sleep. We used this list for the first phase of the Delphi method. (See Tables 1 and 2.)

The first phase of the Delphi method included focus groups where experts were asked to provide rapid-fire feedback to the list of potential myths identified in the online searches. Experts were asked to provide feedback and reactions for each potential myth based on 2 criteria: (1) falseness, or the perceived strength of existing contradictory evidence to refute the myth statement, and 2) public health significance, or the degree to which myths would be problematic to public health if allowed to go unchallenged. This phase resulted in 20 pages of focus group data that were transcribed and analyzed using the constant comparative method of qualitative analysis, whereby transcripts were read critically several times to identify primary themes in available responses.[26] If a majority of experts (>50%, or> 5 experts) agreed that a statement was true and therefore not a myth, the statement was dropped. These activities resulted in a shorter list of 22 statements judged by most experts to be untrue or "myths."

In the second phase of the Delphi process, experts were provided the revised list of 22 potential myths. Experts were instructed to make edits to the statements for clarity. In addition, experts were asked to vote "keep" or "drop" for each potential myth using the 2 definitional criteria: (1) falseness and (2) public health significance. Myths that received a "drop" rating by the majority of experts (>50%, >5) were dropped at this stage. Results from this phase were also analyzed using the constant comparative method of qualitative analysis.[26] Potential myths that were marked "drop" by a majority of experts were eliminated from the analysis. In addition, all clarifications proposed for potential myths from experts were incorporated. Disagreement on edits was rare and resolved by the experts and first author via email. At this stage, experts identified 2 new potential myths believed to be missing from the initial list, resulting in a revised list of 24 potential myths.

In the third and final phase, experts rated potential myths using a closed-ended survey. Specifically, experts rated the potential myths on their degree of falseness and public health significance. In the case of truth/falseness, experts marked their response to the question "How false is each statement" on a scale from "Not at all false" (1),

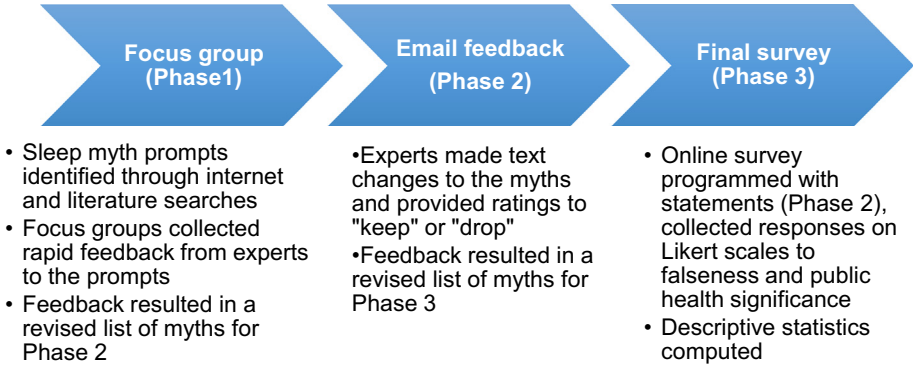

Fig. 1. Flowchart describing the Delphi phases to identify sleep myths.

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Table 1
Statements classified as myths displayed by conceptual domains with corresponding expert ratings on falseness and public health significance on scales from 1 (not at all) to 5 (extremely, n = 10)

Statement	Degree of falseness		Public health significance	
	M	SD	*M*	SD
1) Sleep duration				
1 Being able to fall asleep "anytime, anywhere" is a sign of a healthy sleep system.	4.75	0.46	4.00	0.93
2 Many adults need only 5 or less h of sleep for general health.	4.63	0.52	4.63	0.74
3 Your brain and body can learn to function just as well with less sleep.	4.63	1.06	4.14	0.90
4 Adults sleep more as they get older.	4.13	0.99	2.29	0.76
5 If you can get it, more sleep is always better.	3.25	1.28	2.86	0.90
6 One night of sleep deprivation will have lasting negative health consequences.	3.25	1.04	2.29	0.76
2) Sleep timing				
7 In terms of your health, it does not matter what time of day you sleep.	4.63	0.74	3.57	1.13
3) Behaviors during sleep				
8 Lying in bed with your eyes closed is almost as good as sleeping.	4.63	0.74	3.86	1.07
9 If you have difficulty falling asleep, it is best to stay in bed and try to fall back to sleep.	4.63	0.74	3.14	0.90
10 Although annoying for bed partners, loud snoring is mostly harmless.	4.25	0.89	4.25	0.89
11 A sound sleeper rarely moves at night.	3.88	0.64	1.83	0.41
4) Daytime behaviors that relate to sleep				
12 Hitting the snooze when you wake up is better than getting up when the alarm first goes off.	3.75	1.04	2.75	1.04
13 If you are having difficulties sleeping, taking a nap in the afternoon is a good way to get adequate sleep.	3.13	1.13	3.14	1.07
5) Presleep behaviors				
14 Alcohol before bed will improve your sleep.	4.13	0.35	4.00	0.76
15 For sleeping, it is better to have a warmer bedroom than a cooler bedroom.	3.88	1.13	2.75	1.04
16 Boredom can make you sleepy even if you got adequate sleep before.	3.75	1.04	2.71	1.11
17 Watching television in bed is a good way to relax before sleep.	3.50	0.93	3.14	1.35
18 Exercising within 4 h of bedtime will disturb your sleep.	3.25	1.04	2.43	0.53
6) Brain function and sleep				
19 During sleep, the brain is not active.	5.00	0.00	2.00	1.00
20 Remembering your dreams is a sign of a good night's sleep.	3.63	1.19	1.71	0.49

"A moderate amount false" (3), to "A great deal false" (5). In the case of public health significance, experts rated its importance, from a public health standpoint, on a scale from "Not at all" (1), "A moderate amount" (3), to "A great deal" (5). Descriptive statistics, including mean and standard deviation of expert ratings, were tabulated using SPSS (version 24.0; IBM Corporation, Armonk, NY). Mean expert rating above the scale midpoint on falseness (a mean response above 3, or neutral, which indicated agreement with falseness of the statement) was used as the threshold for establishing consensus that a statement or assertion was a myth.

Results

Delphi procedures resulted in classification of 20 of the statements as myths. Myths were categorized in the following domains: (1) sleep duration, (2) sleep timing, (3) behaviors during sleep, (4) daytime behaviors that relate to sleep, (5) presleep behaviors, and (6) brain function and sleep. Expert ratings as well as a summary of the evidence regarding the myths are outlined below. Myths are rank-ordered within each domain on ratings of falseness (from high falseness to low).

(1) Sleep duration

Myth: Being able to fall asleep "anytime, anywhere" is a sign of a healthy sleep system

Experts provided a rating of falseness for this myth "A great deal" (4.75 ± 0.46) and a rating of public health significance "A lot" (4.00 ± 0.93). Excessive daytime sleepiness, or the ability to fall asleep "anytime, anywhere," can result from sleep deficiency.[27] In other words, rather than being characteristic of "a good sleeper," being able to fall asleep "anytime, anywhere" may be indicative of a chronically sleep-deprived state. Excessive daytime sleepiness can also be one of the primary symptoms of obstructive sleep apnea (OSA).[28]Individuals who report OSA symptoms (eg, sleepiness) and are not treated for OSA are at high risk for adverse consequences, such as motor vehicle crashes.[29] Strong evidence refutes the myth that ability to fall asleep "anytime, anywhere" is a sign of healthy sleep but is instead likely a sign of an underlying sleep problem.

Myth: Many adults need only 5 or fewer hours of sleep for general health

Experts provided a rating of falseness for this myth "A great deal" (4.63 ± 0.52) and a rating of public health significance "A great deal" (4.63 ± 0.74). Habitual insufficient sleep (5 or fewer hours) is

Table 2
Statements *not* classified as myths with corresponding expert ratings of falseness and public health significance on scales from 1 (not at all) to 5 (extremely, n = 10)

Statement	Degree of falseness		Public health significance	
	M	SD	*M*	SD
1 Waking up in the middle of the night is a sign of poor sleep.	3.00	1.07	2.71	0.95
2 It is better to get up and exercise than sleep, even if it means cutting your sleep short.	3.00	0.76	2.57	0.53
3 Sleeping with a pet is comforting and improves sleep quality.	2.63	1.19	2.14	0.90
4 Sleeping in on weekends is a good way to ensure you get adequate sleep.	2.50	1.07	3.14	0.69

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associated with adverse outcomes related to cardiovascular, metabolic, mental, and immunological health.[1–3] Preliminary evidence suggests that there may be a short sleep phenotype, or some individuals can function well on with less than the recommended 7 hours of sleep (e.g. 5 hours).[30] Nevertheless, evidence of elevated chronic disease risk with short sleep duration supports a recommendation of 7 hours for most adults[1–3] and refutes this myth.

Myth: Your brain and body can learn to function just as well with less sleep

Experts provided a rating of falseness for this myth "A great deal" (4.63 ± 1.06) and a rating of public health significance "A lot" (4.14 ± 0.90). When sleep is restricted, self-reported levels of sleepiness increase for the first several days before starting to plateau, but objective measures of a person's inability to stay awake show a steady increase over time.[31] Several studies show that even after weeks of observation and tracking, reducing sleep leads to sustained decrements in performance.[32] Further, nightshift workers, who habitually sleep fewer hours than day workers, face higher morbidity due to breast cancer and all-cause mortality than day workers.[33] Overall, individuals might "adjust" to consistent sleep debt and/or circadian misalignment but do so at the risk of serious health consequences.[33] Consequently, evidence refutes the statement that the brain and body can adapt to function on less sleep.

Myth: Adults sleep more as they get older

Experts provided a rating of falseness for this myth "A great deal" (4.63 ± 0.52) and a rating of public health significance "A lot" (4.00 ± 0.93). Sleep duration varies across the lifespan.[34] A meta-analysis demonstrates that older adults get less sleep than younger adults.[35] The decline in sleep duration among older adults may be at least in part due to medical comorbidities.[36,37] Furthermore, it is not evident whether older adults in general need less sleep than do younger adults, only that they get less. Thus, evidence refutes the statement that healthy older adults get more sleep with age.

Myth: If you can get it, more sleep is always better

Experts provided a rating of falseness for this myth "A moderate amount" (3.25 ± 1.28) and a rating of public health significance "A moderate amount" (2.86 ± 0.90). Associations between mortality and long sleep (defined as ≥8 hours in several studies; longer in others)[38–40] and prospective cohort research have shown higher mortality among long sleepers even among individuals with good health status when first assessed.[41] However, because of a lack of experimental evidence of detrimental effects of long sleep duration, it has been argued that habitual long sleep may be a marker of other unreported chronic conditions rather than causally linked to ill health or early mortality.[1]

As noted in consensus reports, obtaining extra sleep is important for those recovering from sleep loss or healing from a medical condition; evidently, children need longer sleep for optimal behavioral development.[1,2] However, in contrast with short sleep, there is not clear experimental evidence that long sleep is related to health and mortality, and there is no consensus about habitual long sleep.[1,2] Earlier field experiments and more recent laboratory experiments[42–44] have generated conflicting results regarding positive and negative effects of long sleep on mood and cognition. Other laboratory studies have shown that, when provided with the opportunity for long sleep, participants sleep longer and eventually asymptotically experience longer than habitual sleep duration (>8 hours) and demonstrate more alertness than individuals on shorter sleep schedules.[45,46] Also, performance enhancements are observed among individuals instructed to sleep longer (>8 hours).[47] However, for individuals with insomnia, trying to compensate for lack of sleep by staying in bed longer can lead to a vicious cycle of further sleep fragmentation and more time lying awake struggling to stay asleep. Conversely, restriction of time in bed is one of the most effective behavioral treatments for insomnia. Thus, lower ratings from experts on falseness reflect the conflicting evidence in the field regarding long sleep duration.

Myth: One night of sleep deprivation will have lasting negative health consequences

Experts provided a rating of falseness for this myth "A moderate amount" (3.25 ± 1.04) and a rating of public health significance "A little" (2.29 ± 0.76). One night of sleep deprivation has some short-term adverse effects, although they likely resolve with recovery sleep. Meta-analysis has found sleep deprivation (eg, lack of sleep for at least 24 hours) leads to worse performance in several cognitive domains (eg, lapses in simple attention).[48] Another review examined the effects of sleep deprivation on cardiovascular and metabolic domains, demonstrating that sleep deprivation causes increased cardiovascular mortality.[49] Also, sleep deprivation can cause an increase in resting blood pressure.[49,50] However, experimental research shows performance on a cognitive task declines among individuals subjected to 2 nights of sleep deprivation, yet performance returns to predeprivation levels with sufficient sleep recovery.[51] Thus, evidence of adverse outcomes associated with sleep deprivation is strong. However, evidence from cognitive and performance measures suggests that sleep recovery following brief periods of sleep deprivation can return to baseline levels.

(2) Sleep timing

Myth: In terms of your health, it does not matter what time of day you sleep

Experts provided a rating of falseness for this myth "A great deal" (4.63 ± 0.74) and a rating of public health significance "A lot" (3.57 ± 1.13). Research on nightshift workers (individuals who work at night and sleep during the day) provides evidence regarding the implications of sleep timing for health. Nightshift workers, who experience circadian desynchronization, report less sleep and lower sleep quality than day workers[52] and are also at higher risk for long-term adverse health outcomes including depression,[53] diabetes,[54] and breast cancer.[33] Although it could be argued that sleep during the day is better than no sleep at all, the evidence from shift workers suggests that sleep timing is related to health, thereby refuting this myth.

(3) Behaviors during sleep

Myth: Lying in bed with your eyes closed is almost as good as sleeping

Experts provided a rating of falseness for this myth "A great deal" (4.63 ± 0.74) and a rating of public health significance "A lot" (3.86 ± 1.07). Endocrine, cardiovascular, metabolic, and cognitive function are markedly different during wakefulness than non-rapid eye movement (REM) sleep. Cognition is a prime example, as brain activity during sleep takes on a very different pattern compared with activity in the awake brain.[55–57] Sleep and arousal regulatory centers in the brain function as a sort of "on-off" switch, whereby one is either sleeping or awake with little overlap.[58] Also, a sharp nocturnal "dip" in core body temperature is much larger when individuals are asleep compared to when they lie quietly awake in bed, providing further evidence that sleep differs from lying down with eyes closed.[59] Thus, available evidence showing that cognitive activity when a person is sleeping is distinctly different from wake with eyes closed refutes this myth.

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Myth: If you have difficulty falling asleep, it is best to stay in bed and try to fall back to sleep

Experts provided a rating of falseness for this myth "A great deal" (4.63 ± 0.74) and a rating of public health significance "A moderate amount" (3.14 ± 0.90). Individuals who experience difficulty falling asleep are instructed to follow what is termed *stimulus control therapy*.[60] Although it seems counterintuitive, in stimulus control therapy, individuals experiencing difficulty falling asleep are instructed to leave their bed, avoid blue light, and return to bed only when they are tired. Individuals who follow these instructions demonstrate significant improvements, such as lower time to fall asleep.[61] Meta-analysis also shows stimulus control therapy improves one's ability to fall asleep and overall sleep quality.[62] Thus, available evidence and high ratings on falseness from experts refute this myth.

Myth: Although annoying for bed partners, loud snoring is mostly harmless

Experts provided a rating of falseness for this myth "A lot" (4.25 ± 0.89) and a rating of public health significance "A lot" (4.25 ± 0.89). Snoring is caused by turbulent airflow due to partial obstruction of the upper airway during sleep. One large, cross-sectional study of US adults found that 52.8% reported snoring and that snoring was associated with adverse health outcomes in its own right.[63] Furthermore, snoring is a primary symptom of OSA that, when untreated, places individuals at elevated risk for adverse cardiovascular events.[5] Thus, loud or bothersome snoring may be an indication that one needs to consult with a health care provider.

Myth: A sound sleeper rarely moves at night

Experts provided a rating of falseness for this myth "A lot" (3.88 ± 0.64) and a rating of public health significance "A little" (1.83 ± 0.41). Occasional movement has been documented as a normal part of sleep.[64] The number of movements during sleep varies across the lifespan, with the fewest occurring during sleep among those between ages 18 and 30.[9] However, unless prolonged and chronic, small movements and cortical arousals during sleep may be a part of normal sleep.

(4) Daytime behaviors that relate to sleep

Myth: Hitting the snooze when you wake up is better than getting up when the alarm first goes off

Experts provided a rating of falseness for this myth "A lot" (3.75 ± 1.04) and a rating of public health significance "A moderate amount" (2.75 ± 1.04). Although little research has directly examined effects of alarms in interrupting sleep and the role of "snoozing" in between alarm sounds, sleep disruptions are not optimal. Sleep fragmentations, such as those caused by a snooze bar, are associated with adverse outcomes, including decreased mental flexibility and subjective mood.[65] Thus, evidence suggests it may be best to set the alarm when one needs to get up instead of setting multiple alarms that might interrupt sleep.

Myth: If you are having difficulties sleeping at night, taking a nap in the afternoon is a good way to get adequate sleep

Experts provided a rating of falseness for this myth "A moderate amount" (3.13 ± 1.13) and a rating of public health significance "A moderate amount" (3.14 ± 1.07). Research shows that a "siesta," or midafternoon nap, is common in some cultures.[66,67] Napping can also be used to supplement insufficient nocturnal sleep. However, habitual napping can be associated with adverse health outcomes.[68] Napping is discouraged among those with insomnia, as it may reduce homeostatic sleep drive, perpetuate nighttime insomnia, and present health consequences.[57,67] The evidence that napping can perpetuate insomnia along with expert scores casts doubt on a recommendation that individuals who experience difficulty sleeping at night should nap.

(5) Presleep behaviors

Myth: Alcohol before bed will improve your sleep

Experts provided a rating of falseness for this myth "A lot" (4.13 ± 0.35) and a rating of public health significance "A lot" (4.00 ± 0.76). Folklore makes reference to a "nightcap" or serving of alcohol consumed as part of the bedtime routine.[70] The literature on sleep and alcohol shows alcohol consumed close to bedtime reduces sleep latency but subsequently causes sleep disturbances in the second half of the night. Across a number of different studies and doses, overall, alcohol has a negative overall impact on sleep, delaying the onset of REM sleep.[71] Alcohol consumption has also been found to worsen sleep apnea symptoms.[72] Thus, evidence is relatively strong to refute this myth.

Myths: For sleeping, it is better to have a warmer bedroom than a cooler bedroom

Experts provided a rating of falseness for this myth "A lot" (3.88 ± 1.13) and a rating of public health significance "A little" (2.75 ± 1.04). Cross-sectional evidence showed a warm environment (specifically, a reported "hot and stuffy" bedroom) is associated with poor sleep.[73] Another cross-sectional study of self-reported environmental barriers to sleep showed that "too high a temperature" was a limiting factor for sleep health.[74] Consequently, a temperature between 65°F and 70°F is often recommended for sleep.[75] Taken together, there is moderate evidence to refute this myth.

Myth: Boredom can make you sleepy even if you got adequate sleep before

Experts provided a rating of falseness for this myth "A lot" (3.75 ± 1.04) and a rating of public health significance "A moderate amount" (2.71 ± 1.11). It is sometimes said that boring activities, such as a dry lecture or meeting, could induce sleepiness. However, participants who underwent 60 hours of forced bed rest, arguably total boredom, slept longer than 7 hours in a given 24-hour cycle but did not sleep the entire time.[45,46,76] Other evidence from cross-sectional surveys among older adults shows individuals with hobbies and lower reported boredom have better sleep quality.[77] Thus, boredom may reveal underlying sleepiness, but boredom alone does not *cause* sleepiness.

Myth: Watching television in bed is a good way to relax before sleep

Experts provided a rating of falseness for this myth "A moderate amount" (3.50 ± 0.93) and a rating of public health significance "A moderate amount" (3.14 ± 1.35). Routines before bed can include television watching, as one survey of adults in the United States found that 50% of respondents reported television watching in the 30-minute period leading up to bedtime.[72] Time-use data from US adults also revealed late-night television watching to be more common among short sleepers.[79] Also, experimental evidence shows presleep arousal mediates the relationship between television viewing and sleep difficulties.[80] Thus, television viewing may not be an optimal prebed activity for relaxation before bed.

Myth: Exercising within 4 hours of bedtime will disturb your sleep

Experts provided a rating of falseness for this myth "A moderate amount" (3.25 ± 1.04) and a rating of public health significance "A moderate amount" (2.43 ± 0.53). Exercise and sleep appear to be mutually beneficial, as one meta-analysis showed small to moderate improvements in sleep-related variables with consistent physical

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activity.[81] According to survey data from US adults, nighttime exercise was not associated with sleep disturbance for the majority of individuals.[82] Other experimental evidence shows no impairment in sleep following vigorous nighttime exercise.[81,83,84] Thus, low ratings of falseness and conflicting evidence preclude a definitive conclusion that this statement is indeed a myth.

(6) Brain function and sleep

Myth: During sleep, the brain is not active

Experts provided a rating of falseness for this myth "A great deal" (5.00 ± 0.00) and a rating of public health significance "A little" (2.00 ± 1.19). Although it may appear to an observer that the brain is passive during sleep, research indicates otherwise. The characteristic neuronal activity in the thalamus and brainstem of the awake EEG begins to slow and brain waves become larger in amplitude.[58] Then, sleep is periodically marked during REM sleep by activity, including eye movement, loss of muscle tone, and rapid firing of neurons.[85,86] Finally, sleep plays an important role in clearance of neurotoxic waste from the brain.[87] Thus, strong evidence refutes the myth that the brain is passive during sleep.

Myth: Remembering your dreams is a sign of a good night's sleep

Experts provided a rating of falseness for this myth "A lot" (3.63 ± 1.190) and a rating of public health significance "A little" (1.71 ± 0.49). Diaries comparing sleep duration and dream recall show an association between sleep duration and dreaming.[88] This research suggests that longer sleep duration, which would provide opportunity for more and longer REM episodes, is a marker of a good night's sleep. However, dream recall in sleep research can be conducted with dream diaries but also by awakening participants from REM sleep when the majority of dreaming takes place.[89,90] Thus, the challenges associated with dream research (eg, awakening from REM and dream diaries) and the minimal number of studies examining the relationship between sleep health and dreaming refute this myth.

Statements not classified as myths

Four statements identified in the Delphi approach as potential myths were dropped in the final phase of the procedure because they did not meet definitional criteria for falseness. The average expert rating of falseness to the statement "Sleeping in on weekends is a good way to ensure you get adequate sleep" was 2.50 ± 1.07. Second, regarding the statement "Waking up in the middle of the night is a sign of poor sleep," the average rating of falseness was 3.00 ± 1.07. Third, the statement "Sleeping with a pet is comforting and improves sleep quality" received an average expert rating of 2.63 ± 1.19. Finally, the statement "It is better to sleep in, compared to getting up and exercising" received an average falseness rating of 3.00 ± 0.76.

Discussion

Myths about sleep that go unaddressed at the population level may result in maladaptive health behavior patterns. Dominant theories of behavior change posit that beliefs are important for they predict behavioral intentions, which in turn predict health-related behaviors.[91] Using the Delphi approach, we engaged experts to develop a list of beliefs about sleep that are promulgated in the media, which represent sleep myths, or statements and suggestions that are not supported by scientific evidence. Our findings offer utility to educational efforts to improve sleep health in the population.

Myths about sleep identified in this study span conceptual domains, including sleep behavior (eg, "Lying in bed with your eyes closed is almost as good as sleeping"), as well as sleep timing, sleep duration, behaviors relating to sleep, behaviors close to bedtime, and brain function. It is important to note that every myth with the exception of one ("During sleep, the brain is not active") yielded some uncertainty about falseness among experts (eg, ratings below the scale midpoint).

The disagreement about falseness of each statement between experts in the current study is intriguing. The disagreement among experts in our study could have been due to the different areas of knowledge and expertise among the experts, which may lend different perspectives on the topics addressed by the myths in this study. Alternatively, the disagreement could suggest the need for more research on the topics relating to the myths that received more varied expert responses. In this manner, the myths that received varied responses from experts may represent an agenda for additional future research to confirm or refute each myth.

Several myths identified suggest there may be beliefs in the general population that human beings can adapt to insufficient sleep. For instance, consider the myths "Many adults need only 5 hours or less of sleep for general health" and "Your brain and body can learn to function just as well with less sleep." These beliefs could be perpetuated through a variety of sources, ranging from media to social influences. No matter their source, if believed to be true, perceptions that sleep is not important may have adverse effects on individual intention to obtain recommended sleep. Also, several beliefs suggest important targets for sleep health education campaigns and other communication-based efforts to change unfounded beliefs. For instance, the belief "if you have difficulty falling asleep, it is best to stay in bed and try to fall back asleep" could be altered with an educational campaign or initiative to promote awareness about stimulus control therapy or leaving the bedroom during periods of sleep onset difficulty, avoiding blue light exposure, and returning to the bed when tired.

Experts in the fields of sleep, circadian rhythms, and neuroscience offered judgments regarding the myths that potentially hinder population health. Furthermore, experts indicated the public health significance of myths and, in so doing, set an agenda for future research that may seek to promote evidence-based beliefs and ultimately evidence-based population sleep health practices.

Limitations

The sample of experts identified was based on convenience sampling based on peer-reviewed publications from PubMed searches. A larger sample of experts in the fields of sleep medicine, circadian rhythms, and related fields of neuroscience and psychiatry may have yielded somewhat different results. In addition, the evidence to refute the myths varied in "strength" so that some myths could be refuted by meta-analyses or clinical trials. Other myths had less available data or weaker level of evidence such as cross-sectional survey data. Other myths may have been tangentially addressed in the scientific literature. In addition, although this study used rigorous procedures to engage experts in identifying sleep myths, many of the statements were qualified by at least 1 expert disagreeing regarding its falseness. The vague statements and unqualified/underspecified lay language lend themselves to a variety of interpretations. Thus, it should be noted that the classification as a myth is qualified by varied ratings across the experts of a variety of statements that could be better crafted to be more clearly myth, or clearly evidence-based statements on that general topic. Furthermore, a number of sleep myths may have not been identified in a search using *Myth*, but instead additional statements may exist that lack supporting scientific evidence may instead be promulgated as truth. Finally, the Delphi method presents a limitation in that once myths are selected through the various steps outlined in this method, they are difficult to amend. Certainly, a larger panel of experts may have afforded the design of a

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broader array of myths or linguistic changes to improve comprehensibility of the myths articulated in this study. Obtaining expert input on statements that lack evidence (myths) is the first step before future research may examine actual prevalence of myths in the population or associations with health outcomes.

Implications

Beliefs are associated with behaviors. Thus, altering health-related beliefs that are untrue is one promising strategy for promoting population health.[14] Beliefs are cognitive constructs and are prone to change over time through experience and influence from peers and news sources.[13] Public health campaigns can reach a large number of individuals to promote awareness about health practices and change beliefs and behaviors.

Public health campaigns have been undertaken in domains such as smoking cessation and highway safety.[92,93] The statements identified by experts in the current study represent potential future directions for public health campaigns and efforts that seek to address untrue beliefs about sleep, promote awareness of the importance of sleep, and bolster intentions in the population to engage in healthful sleep practices.

Results of the current study also have implications in family contexts. For instance, a snoring bed partner could disrupt a partner's sleep or other individuals in the household. In addition, promoting awareness about problematic snoring among spouses and the need to seek treatment for potential sleep apnea could be a potentially promising direction for future interventions.

The myths about sleep identified in the current study represent a sampling of the potentially numerous untrue beliefs in the population regarding sleep health. Although we recruited and engaged sleep experts in identifying sleep health beliefs, future work could engage the general public to explore the prevalence of identified myths at the population level. In so doing, future research may develop an agenda for public health communication and education that seeks to change population-level beliefs that are not supported by scientific evidence regarding sleep health.

Conclusion

Beliefs may be broadly categorized as those that promote or those that degrade healthful sleep practices. In this study, we focused on potential myths, one category of beliefs that have potential adverse effects on population sleep health. We used a systematic method for engaging experts in iterative rounds of open-ended, followed by closed-ended, feedback. We identified a list of 20 myths categorized into 6 dimensions of sleep. The results provide a working framework for public health research and practice to address sleep beliefs that are not substantiated by scientific evidence, in the hope of ultimately promoting healthful sleep practices.

Conflict of interest

Dr. Hale serves on the Board of Directors of the National Sleep Foundation and receives an honorarium for her role as Editor-in-Chief of this journal.

Dr. Patel has received grant funding through his institution from the American Sleep Medicine Foundation, Bayer Pharmaceuticals, and Philips Respironics, personal consulting fees from the American Academy of Sleep Medicine, and serves on the Board of Directors of the American Thoracic Society and Breathe Pennsylvania.

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Dr. Buysse reports personal fees from BeHealth, personal fees from Emmi Solutions, personal fees from American Academy of Physician Assistants, personal fees from Bayer, personal fees from CME Institute, personal fees from Ebb Therapeutics, outside the submitted work; In addition, Dr. Buysse has a patent Copyright pending. Dr. Buysse reports personal fees from BeHealth, personal fees from Emmi Solutions, personal fees from American Academy of Physician Assistants, personal fees from Bayer, personal fees from CME Institute, personal fees from Ebb Therapeutics, outside the submitted work; In addition, Dr. Buysse has a patent Copyright issued. Dr. Czeisler reports grants from Cephalon Inc., Jazz Pharmaceuticals Plc., Inc., National Football League Charities, Optum, Philips Respironics, Inc., Regeneron Pharmaceuticals, ResMed Foundation, San Francisco Bar Pilots, Sanofi S.A., Sanofi-Aventis, Inc, Schneider Inc., Sepracor, Inc, Mary Ann & Stanley Snider via Combined Jewish Philanthropies, Sysco, Takeda Pharmaceuticals, Teva Pharmaceuticals Industries, Ltd., and Wake Up Narcolepsy; and personal fees from Bose Corporation, Boston Celtics, Boston Red Sox, Cephalon, Inc., Columbia River Bar Pilots, Ganésco Inc., Institute of Digital Media and Child Development, Klarman Family Foundation, Samsung Electronics, Quest Diagnostics, Inc, Teva Pharma Australia, Vanda Pharmaceuticals, Washington State Board of Pilotage Commissioners, Zurich Insurance Company, Ltd. In addition, Dr. Czeisler holds a number of process patents in the field of sleep/circadian rhythms (e.g., photic resetting of the human circadian pacemaker), and holds an equity interest in Vanda Pharmaceuticals, Inc. Since 1985, Dr. Czeisler has also served as an expert on various legal and technical cases related to sleep and/or circadian rhythms including those involving the following commercial entities: Casper Sleep Inc., Comair/Delta Airlines, Complete General Construction Company, FedEx, Greyhound, HG Energy LLC, Purdue Pharma, LP, South Carolina Central Railroad Co., Steel Warehouse Inc., Stric-Lan Companies LLC, Texas Premier Resource LLC and United Parcel Service (UPS). Dr. Czeisler receives royalties from the New England Journal of Medicine; McGraw Hill; Houghton Mifflin Harcourt/Penguin; and Philips Respironics, Inc. for the Actiwatch-2 and Actiwatch-Spectrum devices. Dr. Czeisler's interests were reviewed and managed by Brigham and Women's Hospital and Partners HealthCare in accordance with their conflict of interest policies.

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