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National Sleep Foundation's sleep time duration recommendations: methodology and results summary

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ABSTRACT

Objective: The objective was to conduct a scientifically rigorous update to the National Sleep Foundation's sleep duration recommendations.
Methods: The National Sleep Foundation convened an 18-member multidisciplinary expert panel, representing 12 stakeholder organizations, to evaluate scientific literature concerning sleep duration recommendations. We determined expert recommendations for sufficient sleep durations across the lifespan using the RAND/UCLA Appropriateness Method.
Results: The panel agreed that, for healthy individuals with normal sleep, the appropriate sleep duration for newborns is between 14 and 17 hours, infants between 12 and 15 hours, toddlers between 11 and 14 hours, preschoolers between 10 and 13 hours, and school-aged children between 9 and 11 hours. For teenagers, 8 to 10 hours was considered appropriate, 7 to 9 hours for young adults and adults, and 7 to 8 hours of sleep for older adults.
Conclusions: Sufficient sleep duration requirements vary across the lifespan and from person to person. The recommendations reported here represent guidelines for healthy individuals and those not suffering from a sleep disorder. Sleep durations outside the recommended range may be appropriate, but deviating far from the

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normal range is rare. Individuals who habitually sleep outside the normal range may be exhibiting signs or symptoms of serious health problems or, if done volitionally, may be compromising their health and well-being.
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Introduction

The National Sleep Foundation's (NSF's) mission is to improve health and well-being through sleep health education and advocacy. Notably, the NSF provides the public with the most up-to-date, scientifically rigorous sleep health recommendations. Millions of individuals each year seek guidance regarding sleep duration sufficiency from the NSF website. Additionally, the recommendations are widely cited and distributed by other organizations. To this end, the NSF convened a multidisciplinary expert panel, conducted a systematic literature review, and used the RAND/UCLA Appropriateness Method (RAM)[1] to formulate age-specific sleep duration recommendations.

Participants and methods

The NSF assembled a multidisciplinary expert panel comprised of both sleep experts and experts in other areas of medicine, physiology, and science. This approach provided varying perspectives regarding sleep duration. The 18-member expert panel included 12 representatives selected by stakeholder organizations and 6 sleep experts chosen by the NSF. Stakeholder organizations included the following: American Academy of Pediatrics, American Association of Anatomists, American College of Chest Physicians, American Congress of Obstetricians and Gynecologists, American Geriatrics Society, American Neurological Association, American Physiological Society, American

Table 1
Search terms for literature review.

Primary search terms	Age search terms	Outcome search terms
Sleep time	Infant	Performance
Sleep need	Children	Executive function
Sleep requirement	Child	Cognition
Health sleep	Pre-school child	Mood
Sleep schedule	Perschoolers	Learning
Sufficient sleep	Adolescent	Memory
Insufficient sleep	Teenager	Accidents
Sleep deprivation	Teen	Attention deficit
Sleep restriction	Adult	Academic performance
Short sleeper	Senior	Impulse control
Long sleeper	Elderly	Anxiety
	Developmental	Suicide
	Geriatric	Divorce
	Newborns	Health
	Toddlers	Mortality
	School-age children	Morbidity
		Hypertension
		Stroke
		Cerebrovascular insult
		Heart disease
		Myocardial infarct
		Coronary artery disease
		Diabetes
		Obesity
		Glucose intolerance
		Lipids
		Pain

Table 2
Expert panel recommended sleep durations.

Age	Recommended, h	May be appropriate, h	Not recommended, h
Newborns	14 to 17	11 to 13	Less than 11
0-3 mo		18 to 19	More than 19
Infants	12 to 15	10 to 11	Less than 10
4-11 mo		16 to 18	More than 18
Toddlers	11 to 14	9 to 10	Less than 9
1-2 y		15 to 16	More than 16
Preschoolers	10 to 13	8 to 9	Less than 8
3-5 y		14	More than 14
School-aged children	9 to 11	7 to 8	Less than 7
6-13 y		12	More than 12
Teenagers	8 to 10	7	Less than 7
14-17 y		11	More than 11
Young adults	7 to 9	6	Less than 6
18-25 y		10 to 11	More than 11
Adults	7 to 9	6	Less than 6
26-64 y		10	More than 10
Older adults	7 to 8	5 to 6	Less than 5
≥65 y		9	More than 9

Psychiatric Association, American Thoracic Society, Gerontological Society of America, Human Anatomy and Physiology Society, and Society for Research in Human Development.

A systematic literature review was conducted by a nonvoting, independent review team led by John Herman, PhD, from the University of Texas Southwestern Medical Center at Dallas, with assistance from colleagues Chelsea Vaughn, PhD, and David Brown, PhD. They conducted the literature review using search terms and protocol agreed upon by the panel (see Table 1 for search terms). Inclusion criteria were (a) normal, nondisordered population; (b) published in a peer-reviewed journal; (c) human subjects; and (d) English language. The review focused on medical and scientific research regarding (1) sleep duration data, (2) effects of reduced or prolonged sleep duration, and (3) health consequences of too much or too little sleep. Articles were identified with searches of current indexed literature published from 2004 to 2014.

Fifty-eight searches using combinations of search terms related to sleep (eg, time, duration, and sufficiency), age groups (eg, newborn, adolescent), and outcomes (eg, performance, executive function, cognition) yielded 2412 articles. The review team identified 575 articles for full-text review. Of the 575 articles, 312 met our inclusion criteria. Pertinent information (eg, sample size, study design, results) from each article was extracted and included in the literature review materials. Articles were sorted based on

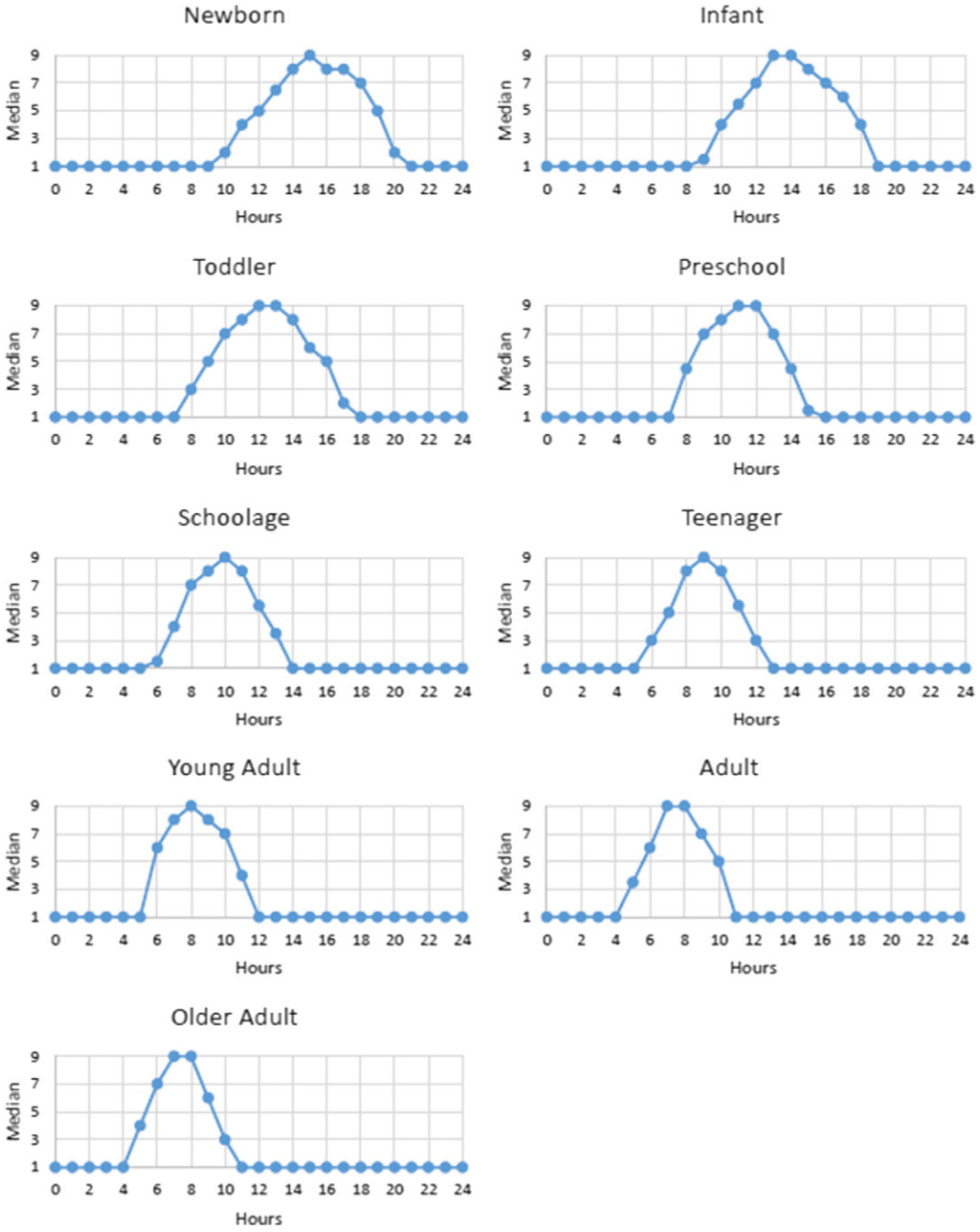

Fig. 1. Distribution of median expert panel scores.

the strength of the study and presented in descending order in a summary chart. Expert panel members received print and electronic versions of the literature.

To develop the sleep duration recommendations, the expert panel used a 2-round modified Delphi RAM to synthesize scientific evidence and expert opinion. Panelists graded every possible sleep time duration for appropriateness (ie, 0-24 hours). Response options were appropriate (ie, the expected health benefits exceed the expected negative consequences), inappropriate (ie, the expected negative consequences exceed the expected health benefits), or uncertain.

The appropriateness scale ranged from 1 to 9, with 1 representing "extremely inappropriate number of hours of sleep" and 9 representing "extremely appropriate number of hours of sleep." Panelists rated overall health as well as cognitive, physical, and emotional health. Panelists also noted whether scores were based on convincing scientific evidence, weaker scientific evidence, expert opinion, or their own experience.

The panel agreed to the following age categories:

- Newborn: 0-3 months
- Infant: 4-11 months
- Toddler: 1-2 years
- Preschooler: 3-5 years
- School-age: 6-13 years
- Teenager: 14-17 years
- Young adult: 18-25 years
- Adult: 26-64 years
- Older adult: ≥65 years

In total, the expert panel met 4 times over the course of 9 months and participated in 2 rounds of voting. Panelists performed the first-round vote independently. They received all 312 full-text articles, score sheets, and instructions by mail and electronically. Panelists were expected to use the provided literature to grade the appropriateness of every hour of sleep (ie, 0-24) for every age category (eg, how appropriate or inappropriate is *X* hours of sleep for a teenager?). A research assistant performed data entry, and a supervisor checked entries to ensure accuracy and completeness. A project team member followed up with panelists to resolve missing or discrepant scores.

The second vote occurred during an in-person meeting. Panelists received an individualized document showing the overall expert panel's first-round ratings, score distributions, and their own first-round votes. Panelists discussed the first-round ratings and the literature, focusing on areas of disagreement. Panelists voted at the conclusion of each age group discussion. When possible, consensus was reached; but no effort was made to eliminate disagreement.

Results

Sleep durations with median appropriateness scores ranging from 1-3 were classified as inappropriate, those in the 4-6 range were classified as uncertain, and those in the 7-9 range were classified as appropriate. Divergent opinion among panelists was defined as more than 20% (ie, 3 of 18 panel members) voting outside any 3-point range (ie, 1-3, 4-6, or 7-9) of the median. Also, all sleep durations rated "with disagreement," whatever the median, were classified as uncertain.

Each sleep duration was classified as one of the following:

- "Appropriate": panel median of 7-9, with agreement
- "May be appropriate for some people": panel median of ≥4 with disagreement
- "Unlikely to be appropriate": panel median of ≤3

The NSF's guidance will include recommended hours (ie, those hours that experts agree are appropriate for health and well-being), possibly acceptable hours (ie, those hours that may be appropriate for some individuals), and not recommended hours (ie, those hours that experts agree are not likely conducive for health and well-being).

Table 2 shows the expert panel's recommended sleep time durations. A graphic representation of sleep duration recommendations is illustrated in Figure 1.

Discussion

The NSF conducted a systematic literature review, convened an expert panel, and used quantitative techniques to summarize expert opinion concerning recommended sleep durations. We updated the NSF's age-related sleep duration recommendations based on these results. Importantly, the panel emphasized that some individuals might sleep longer or shorter than the recommended times with no adverse effects. However, individuals with sleep durations far outside the normal range may be engaging in volitional sleep restriction or have serious health problems. An individual who intentionally restricts sleep over a prolonged period may be compromising his or her health and well-being.

It is important to remember that this project focused on sleep duration. The literature, especially cohort and population studies, often do not distinguish between time in bed and actual sleep time. However, actual sleep time is typically less than time in bed, which biases data toward higher sleep duration estimates. By contrast, intervention studies using laboratory measured sleep time will typically produce shorter sleep durations. This data disparity is particularly important when interpreting laboratory-based findings.

Sleep and/or time-in-bed duration represents a major dimension for measuring sleep, but other indices do exist. Sleep's restorative properties undoubtedly also depend on sleep quality, sleep architecture, and the timing of sleep within the day. These factors, however, are more difficult to estimate from cohort studies that use self-reported data. More research is needed to evaluate sleep dimensions and measures.

The RAND appropriateness method is a well-recognized technique for systematically analyzing experts' interpretations of extant research. It provides a process by which conclusions can be reached using the best-available information when evidence-based medicine [2] methods fall short. To fill the gaps in our understanding, expert panelists reviewed the literature, deliberated, and voted on the appropriateness of each sleep time duration. Sleep, like diet and exercise, is a vital part of physical, cognitive, and emotional health. A full report of the results of the NSF sleep duration recommendation consensus panel will follow in the near future.

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