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Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society on the Recommended Amount of Sleep for a Healthy Adult: Methodology and Discussion

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The American Academy of Sleep Medicine and Sleep Research Society recently released a Consensus Statement regarding the recommended amount of sleep to promote optimal health in adults. This paper describes the methodology, background literature, voting process, and voting results for the consensus statement. In addition, we address important assumptions and challenges encountered during the consensus process. Finally, we outline future directions that will advance our understanding of sleep need and place sleep duration in the broader context of sleep health.

Keywords: sleep duration, consensus, recommendation, adult, health

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1.0 INTRODUCTION

Sleep is vital to human health, necessary for life,[1,2] and it serves critical roles in brain functions including neurobehavioral, cognitive and safety-related performance,[3–13] memory consolidation,[14,15] mood regulation,[16,17] nociception[18,19] and clearance of brain metabolites.[20,21] Sleep is also critically involved in systemic physiology, including metabolism,[22–26] appetite regulation,[27,28] immune and hormone function,[29–33] and cardiovascular systems.[34–37] Sleep duration is associated with mortality risk[38–40] and with illnesses ranging from cardiovascular[41] and cerebrovascular[42] disease to obesity,[43] diabetes,[44] cancer,[45,46] and depression.[47]

These observations raise a critical question: How much sleep is needed for optimal health?

Sleep duration shows substantial intra- and inter-individual variation. Twin studies show sleep duration heritability between 31% and 55%, suggesting substantial genetic influences on sleep need.[23,48,49] Environmental factors, such as occupational duties and commute time, family responsibilities, and social and recreational opportunities, can lead to substantial discrepancies between the amount of sleep needed and the amount of sleep obtained.[50] A recent Centers for Disease Control and Prevention (CDC) analysis shows that between 1985 and 2012 mean sleep duration decreased and the percentage of adults sleeping ≤ 6 hours in a 24-hour period increased. This trend represents a near doubling in the number of U.S. adults sleeping ≤ 6 hours in a 24-hour period from 38.6 million to 70.1 million.[51] The CDC presently considers this progressive decline in sleep duration a public health epidemic.[52]

In 2013, the American Academy of Sleep Medicine and Sleep Research Society received a one year grant, renewable annually for up to five years, from the CDC entitled the "National Healthy Sleep Awareness Project." This Project addresses the four sleep health objectives from Healthy People 2020,[53] a U.S. Department of Health and Human Services initiative to improve the nation's health. Objective four is to "increase the proportion of adults who get sufficient sleep." In the course of stakeholder discussions on this objective it became evident that the fields of sleep research and sleep medicine lack a clear recommendation regarding what constitutes "sufficient" sleep. The absence of such guidance has wide ranging implications for personal and public health. Sleep restriction is the most common cause of sleepiness in society, yet clinicians struggle to tell their adult patients how much sleep is necessary to improve alertness. Public policy initiatives addressing operator fatigue and transportation safety are likewise hindered by the absence of evidence-based guidance regarding healthy habitual sleep duration in adults. The sleep medicine and research community stresses the importance of sleep for health, but this message is likewise undermined by the lack of consensus regarding healthy sleep duration in adults. The absence of such a consensus ultimately weakens the message that sleep is essential for health. Thus, clinical, public policy, and public health activities would all benefit from a consensus recommendation addressing the amount of sleep necessary to support optimal health and functioning in an adult.

A panel of 15 experts in sleep medicine and sleep research used a modified RAND Appropriateness Method[54] to develop an evidence based recommendation statement regarding the sleep duration that promotes optimal health in adults aged 18 to 60 years.[55] Sleep duration is the subject of the recommendation statement, but other sleep measures also impact health. Sleep timing, self-reported sleep quality, day-to-day variability in sleep duration, napping, and sleep disorders all influence health outcomes in cross-sectional and/or longitudinal studies.[56,57] At present, however, sleep duration is the most widely-studied, best-supported, and most straightforward sleep measure to address in relation to health. This supporting manuscript further describes the process, rationale, and discussion that resulted in this evidence-based sleep duration recommendation statement.

2.0 METHODS

The American Academy of Sleep Medicine (AASM)/Sleep Research Society (SRS) Sleep Duration Consensus Conference used a modified RAND Appropriateness Method (RAM)[54] to establish consensus for the amount of sleep needed to promote optimal health in adults.

2.1 Expert Panel Selection

In accordance with recommendations of the RAM, the Sleep Duration Consensus Conference panel comprised 15 members, including a moderator (who was also a member of both the Board of Directors of the American Academy of Sleep Medicine and the National Healthy Sleep Awareness Project Strategic Planning Group). All panel members are experts in sleep medicine and/or sleep science. The panel consisted of members of the AASM and/or the SRS who were recommended by the Board of Directors of these respective organizations.

Panel members were sent a formal letter of invitation from the AASM and SRS, and were required to complete Conflict of Interest disclosures before being officially accepted. To avoid further conflicts, panel members were not permitted to participate in similar consensus activities by other organizations.

2.2 Modified RAND Appropriateness Method

The RAND Appropriateness Method uses a detailed search of the relevant scientific literature, followed by two rounds of anonymous voting, to determine consensus on the appropriateness of a recommendation. The first round of voting is completed without panel interaction to prevent panel members from influencing each other's votes. The second round of voting occurs after a panel discussion of the available evidence and round 1 voting results.

In a modification to RAM, the Consensus Conference included a third round of voting, which considered all available evidence and the previous voting results, to establish a single recommendation for the amount of sleep needed to promote optimal health in adults. The third round also involved a discussion of the merits of recommending an optimal sleep duration *range* versus a simple *threshold* value. The final Consensus Recommendation Statement[55] resulted from the third round of voting.

The charge to the Consensus Conference panel was to determine a sleep duration recommendation for adults. Panel members voted on the appropriateness of one-hour increments ranging from 5 to 10 hours of sleep, and of < 5 and ≥ 10 hours of sleep. One hour increments were selected because these were the most commonly-reported units in epidemiologic and experimental studies. Substantial heterogeneity was present in sleep duration assessment instruments. For the sake of parsimony, the consensus recommendation focused on "nightly" sleep without specification of napping, as this conformed with the majority of assessments used in epidemiologic studies. The final recommendation was based on the one-hour values that were determined by the panel to be "appropriate" to promote optimal health in adults.

2.3 Detailed Literature Search and Review

The AASM and SRS charged the panel with developing a recommendation for sleep duration in adults. This charge coincides with the goals of the National Healthy Sleep Awareness Project (NHSAP) and with a Sleep Health Objective of Healthy

Table 1—Data extracted from Oxford Grade I, II, and III studies for evidence tables.

1. Study design
2. Number of study participants
3. Percent of female study participants
4. Method by which sleep duration was obtained
5. Age-range of "adult" participants
6. Major outcomes and conclusions
7. Gender differences

People 2020 to "increase the proportion of adults who get sufficient sleep."[53]

After a preliminary review of the literature, the scope of the recommendation was limited to adults aged 18 to 60 years. The age cutoffs were based on a meta-analysis of sleep obtained by healthy individuals across the lifespan that showed children and adolescents have longer sleep times than adults, and older adults show no substantial age related declines in sleep duration after the age of 60.[58] Epidemiological studies of a very large representative sample of Americans also supported the conclusion that adults aged 18 to 60 years had shorter sleep durations than those younger and older.[50,59] Older adults are also more likely to suffer from medical disorders that could confound associations between sleep duration and health outcomes. Initially, the panel planned to evaluate the literature separately for those aged 18–45 and 46–60, but the substantial overlap of age ranges among published studies precluded such analyses.

The panel also initially planned to evaluate sleep duration separately for men and women. As detailed below, gender-specific voting was conducted during round 1 voting in all categories for which gender-specific evidence was available. After round 1 voting, however, the gender-specific votes were collapsed after voting results demonstrated the evidence did not meaningfully suggest different sleep duration recommendations between genders.

A preliminary search of the literature and specific National Library of Medicine Medical Subject Headings (MeSH) terms identified several health outcomes that were most commonly examined in relation to sleep duration. Based on this evidence, the panel decided to focus on the relationships between sleep duration and nine health categories: (1) general health; (2) cardiovascular health; (3) metabolic health; (4) mental health; (5) immunologic health; (6) human performance; (7) cancer; (8) pain; and (9) mortality.

After establishing the health categories, a detailed literature search was performed in PubMed on October 28, 2014. The search terms used for the literature search are detailed in **Appendix A**. The search was restricted to studies in human adults, published in English, with no publication date limit. Case reports, editorials, commentaries, letters, and news articles were excluded from the search results. The initial search produced 5,314 publications. The search results were reviewed based on title and excluded a priori for the following reasons: focusing on sleep quality or fatigue instead of sleep duration; assessing sleep duration in specific illnesses or sleep disorders;

Table 2—Nine health categories and subcategories with indication if gender-specific recommendations were considered in round 1 voting.

Category	Sex-Specific
General Health	Yes
Cardiovascular Health a. Cardiovascular Disease b. Hypertension	Yes
Metabolic Health a. Diabetes b. Obesity	Yes
Mental Health a. Mood b. Psychiatric Health	No
Immunologic Health a. Immune Function b. Inflammation	 No Yes
Human Performance a. Cognitive Performance b. Driving Performance c. Job Performance	No
Cancer a. Female Cancers (Breast, Ovarian) b. General Cancers c. Colorectal Cancer	 No Yes Yes
Pain	No
Mortality	Yes

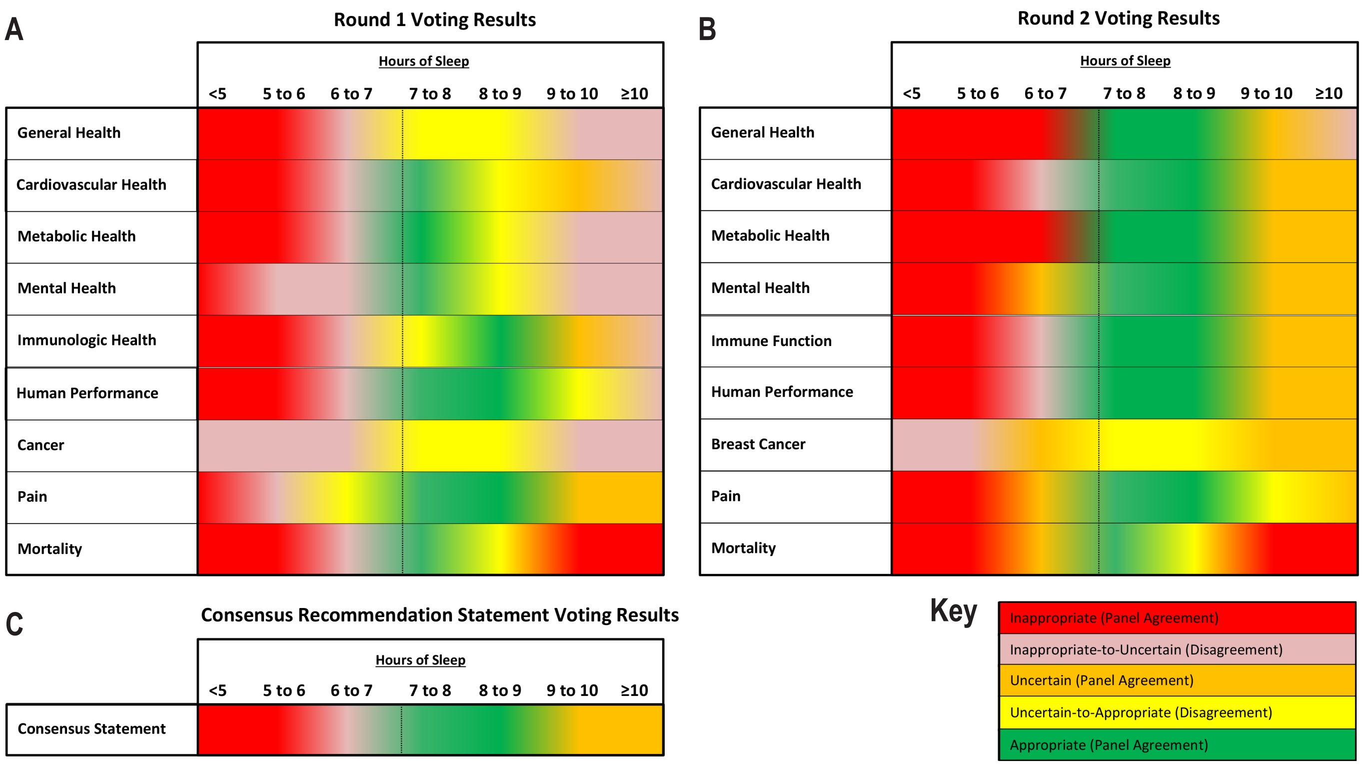
experimentation involving total sleep deprivation; inclusion of subjects sleeping outside normal day/night sleep schedules; assessing sleep deprivation as a treatment (e.g., depression); focusing on medication effects on sleep duration; and inclusion of participants outside the age range of 18 to 60 years. Application of these restrictions resulted in 1,266 publications.

The panel reviewed the abstracts of these remaining publications using the same criteria described above. Pearling was used to capture important publications that were not identified by the search. Accepted publications were graded for quality using Oxford criteria.[60] Each panel member assigned to a particular heath category was asked to identify the five most informative studies based on study design and evidence quality. All accepted publications with an Oxford grade of I, II, or III were reviewed in detail and the data listed in **Table 1** were extracted. Based on the data extraction, accepted studies were subdivided into the categories and subcategories listed in **Table 2**. The extraction sheet and full text of all accepted publications were made available to the panel members for review. A second PubMed literature search was performed immediately prior to the conference (on January 22, 2015) to collect any additional relevant studies. The final list included 311 publications for consideration by the panel (**Appendix B**).

2.4 Round 1 Voting

Prior to the conference, panel members reviewed the accepted publications and extraction sheets. Based on their

Figure 1—Voting results.



Panel members used the following sentence to generate their individual vote for Rounds 1 and 2 on each subcategory (when necessary), category and each hour range of sleep: "Based on the available evidence, [X] hours of sleep is associated with optimal health within the [X] subcategory in the [X] category." Choice options ranged from 1–9 with 1 = "Strongly Disagree," 5 = "Neither Agree nor Disagree," and 9 = "Strongly Agree." Round 1 voting **(A)** occurred without influence from other Panel members, Round 2 voting **(B)** occurred at the face-to-face meeting in Chicago after category content expert presentations and group discussion, final consensus statement voting **(C)** occurred after group discussion and review of the Round 2 voting results. Consensus statement voting involved panel members using the following modified sentence to generate their vote: "Based on the available evidence, [X] hours of sleep is associated with optimal adult health." In regards to color coding of the figure, if there was consensus among the panel that < 5 hours of sleep was not associated with, for example, cardiovascular health, the relevant area in Figure 1 would be colored red (e.g., the panel reached consensus that it feels the following statement is inappropriate: "Based on the available evidence, < 5 hours of sleep is associated with optimal health within the hypertension subcategory within the cardiovascular health category"). For expository purposes, subcategories were collapsed to provide overall category specific results. A vertical line was placed on the figures to denote the 7 hour mark.

review of this material and their clinical and research expertise, members voted to indicate their agreement with the following statement: "Based on the available evidence, [X] hours of sleep is associated with optimal health within the [X] subcategory in the [X] category." "Hours of Sleep" was categorized as < 5 hours, 5 to 6 hours, 6 to 7 hours, 7 to 8 hours, 8 to 9 hours, 9 to 10 hours, and ≥ 10 hours. The panel members voted using a 9-point Likert scale where 1 meant "strongly disagree", 9 meant "strongly agree", and 5 meant "neither agree nor disagree". Panel median values were placed into three broader categories with the following interpretations; 1–3 indicated disagreement with the statement, 4–6 indicated uncertainty, 7–9 indicated agreement with the statement.

Panel members were instructed not to discuss the evidence or their votes with each other to ensure independence. Panel members' votes were collected and compiled to determine the median and distribution of votes. Individual results tables were created and distributed to members at the consensus conference, displaying the distribution of votes (anonymized), the member's vote, and the median vote. When relevant, subcategory results were collapsed to reveal overall category specific results (**Figure 1A**).

2.5 Conference Proceedings and Round 2 Voting

Prior to the conference, one panel member was selected to act as a category expert for each category. At the conference, members reviewed the results of Round 1 voting for a category and the category expert presented a review of the best available evidence for that category. Panel members then discussed the results of Round 1 voting, the accepted publications for the category, and any other relevant evidence. After discussions, panel members completed Round 2 voting for the category and subcategories (when relevant) following the same procedures from Round 1 voting. The conference proceeded in this manner for all categories.

Based on the results of Round 1 voting and the conference discussions, and with the agreement of all panel members, some subcategories were collapsed or dropped for Round 2 voting. This decision was based on the availability and strength of evidence. This resulted in the following categories/subcategories for Round 2 voting: (1) general health, (2) cardiovascular health (subdivided into hypertension and cardiovascular disease), (3) metabolic health (subdivided into diabetes and obesity), (4) mental health (subdivided into mood and psychiatric health), (5) immunologic health, (6) human performance (subdivided into cognitive performance and driving performance), (7) breast cancer, (8) pain, and (9) mortality. As with Round 1, Round 2 voting results for subcategories were collapsed to reveal overall category specific results (**Figure 1B**).

2.6 Round 3 Voting and Development of Recommendation Statement

Panel members reviewed and discussed Round 2 voting results for all categories and the entire body of accepted publications in preparation for voting on a single recommendation statement. After discussions were concluded, panel members completed Round 3 voting for the single recommendation statement (**Figure 1**C), following the same procedures as Round 1 and Round 2 voting but using the following statement: "Based on the available evidence, [X] hours of sleep is associated with optimal adult health." Upon completion of Round 3 voting, the panel members reviewed the voting results and crafted the language of the recommendation statement. After all panel members approved the language of the final statement it was submitted to the AASM and SRS Boards of Directors for their endorsement.

3.0 SUMMARY OF LITERATURE

The following sections succinctly summarize the key evidence considered by the panel in developing the recommendation statement while acknowledging that a complete review of the evidence is beyond the scope of this document.

3.1 General Health

The majority of studies in this category were large-scale cross-sectional studies, although there were also prospective cohort and sleep restriction studies, with sample sizes ranging from 30 (prospective cohort study) to 75,718 (cross-sectional study) individuals. Some of the studies evaluated the relationship between sleep duration and general health using health-related quality-of-life (HRQOL) measures. The associations of sleep duration with HRQOL and sleep health disparities were examined in 2,391 young adults (20–39 years) using cross-sectional data from the National Health and Nutrition Examination Survey 2005–2008 (NHANES).[61] Young adults who slept < 7 hours were more likely to report poor general health and low overall physical, and mental HRQOL than those sleeping ≥ 7 hours. Other studies focused on the risk or presence of one or more specific diseases. Many but not all of the studies indicated that < 7 hours is associated with poorer general health (typically assessed by HRQOL measures) and increased risk or presence of disease compared to 7–8 hours of sleep. There is less evidence for an association of longer sleep duration and adverse health status, with only a few studies demonstrating an association of poorer general health or increased risk/presence of disease with ≥ 9 hours of sleep.

3.2 Cardiovascular Health

The panel reviewed numerous studies addressing the association between sleep duration and broadly-defined cardiovascular disease. Many studies specifically targeted the relationship between sleep duration and hypertension. Most were cohort or cross-sectional studies of community based populations, although some utilized a case-control study design. The number of participants ranged from less than 100 in the case-control studies to over 200,000 in some of the cohort studies. For studies focused on overall cardiovascular disease, the most common outcomes were coronary heart disease, stroke or a combination of both, adjudicated through medical records or central registries. Hypertension was variously defined by self-report, blood pressure measurements and/or use of anti-hypertensive medications. Sleep duration in virtually every study was ascertained by self-report and presented in several different formats, making comparisons across studies challenging.

Most studies demonstrated a positive association between sleep durations of less than 6 hours and overall cardiovascular disease in comparison to sleep durations between 7 and 8 hours. The relationship was stronger for cross-sectional than prospective studies. In contrast, only a few studies demonstrated an association with cardiovascular disease for sleep durations between 6 and 7 hours. For sleep durations greater than 8 hours, the data were more heterogeneous. However, the majority of both cross-sectional and prospective studies found a positive association between sleep duration greater than 9 hours and cardiovascular disease, in comparison to sleep durations of 7–8 hours.

Fewer prospective studies were available for hypertension, but similar to overall cardiovascular disease, short sleep durations, especially less than 6 hours were associated with hypertension in comparison to 7–8 hours of sleep. For sleep durations greater than 8 hours, the evidence was less compelling with only a few studies demonstrating a relationship with hypertension.

Several meta-analyses that included most of the large cohort studies support these general conclusions. Both "short (≤ 5–6 hours)" and "long (> 8–9 hours)" sleep duration were associated with incident cardiovascular disease in one of these.[62] In contrast, another meta-analysis found an association between both short and long sleep and hypertension in cross-sectional studies, but only for short sleep in longitudinal studies.[63]

In summary, elevated risk for both overall cardiovascular disease and hypertension is associated with sleep durations less than 6 hours, and possibly for sleep durations of 6–7 hours compared to sleep durations of 7–8 hours. Evidence for increased risk of cardiovascular disease and hypertension is less compelling for sleep durations greater than 8 hours.

3.3 Metabolic Health

Experimental studies and population-based observational studies provide strong evidence for a link between short sleep duration and metabolic function. Experimental sleep restriction reduces cellular and whole body insulin sensitivity, lowers glucose tolerance, and raises afternoon and evening levels of cortisol, an insulin antagonist.[64,65] If these effects are prolonged, the increased load on the pancreas can compromise β-cell function and lead to type 2 diabetes.[66] Experimental sleep restriction also promotes a positive energy balance by affecting levels of the hunger regulating hormones leptin and ghrelin;[27]

increasing hunger and appetite,[27] with particular cravings for fat and sweet and salty snacks;[27,28] increasing caloric intake;[27,67] decreasing caloric expenditure through physical activity;[68] and increasing body weight.[28,67,69] Over time these effects can lead to overweight and obesity which are risk factors for metabolic syndrome and diabetes. The primary limitations of experimental studies is that they examine a short duration of sleep restriction, have small sample sizes with limited generalizability, and restrict sleep to an extreme degree (typically 4 hours per night). The extent to which individuals adapt to the effects of short sleep duration over time is unknown. Conversely, small uncontrolled studies have reported beneficial effects of sleep extension on glucose metabolism and appetite ratings in individuals who habitually curtail their sleep.[70,71]

Numerous cross-sectional and longitudinal population-based observational studies have assessed the relationships between sleep duration and diabetes, obesity, and the metabolic syndrome. Three meta-analyses of prospective studies on sleep duration and diabetes were identified. All three found a significant association between short sleep duration and the incidence of type 2 diabetes.[24,72,44] A meta-analysis of cross-sectional studies found a significant negative association between hours of sleep and body mass index; short sleep duration was significantly associated with obesity.[73] A meta-analysis of longitudinal studies showed that short sleep duration was associated with incident obesity.[74] Two meta-analyses of cross sectional studies found short sleep duration to be associated with the prevalence of the metabolic syndrome.[73,74]

Some studies have also found significant associations between long sleep duration and metabolic outcomes, but the results of meta-analyses relating long sleep duration to metabolic outcomes are mixed. Two meta-analyses showed an association between long sleep duration and incidence of diabetes,[24,44] and one meta-analysis showed no relationship.[72] In a meta-analysis of longitudinal studies, no relationship was found between long sleep duration and obesity incidence.[74] One meta-analysis of cross sectional studies found a significant relationship between long sleep duration and the prevalence of the metabolic syndrome,[75] while another meta-analysis found no relationship.[76] Given the lack of experimental evidence for detrimental effects of long sleep duration, the observed associations between long sleep duration and metabolic outcomes are often interpreted to reflect residual confounding.

3.4 Mental Health

Relationships between sleep duration and psychiatric health have been addressed in numerous publications. These studies vary widely in design, including observational, experimental, and treatment intervention studies; cross-sectional and longitudinal designs; healthy, patient, and population samples; and outcomes including symptom severity or categorical diagnoses. Many studies addressing sleep and mental health focus on insomnia rather than sleep duration per se. Given the number and diversity of published studies and the consensus process aims, strongest consideration was given to cross-sectional and longitudinal epidemiologic studies of self-reported sleep duration in relation to dimensionally or categorically-defined depression.[77–84] No published meta-analysis has specifically addressed the relationship between sleep duration and depression, anxiety or other psychiatric disorders.[77,79,80,85]

Short self-reported sleep duration is associated with increased cross-sectional and longitudinal risk for depression, whether measured as symptoms or as a diagnosis.[77,79–84,86] The threshold for short sleep varies across studies from 5–7 hours, with the majority using 6 hours. Some data also demonstrate increased risk associated with sleep duration longer than 8–9 hours.[80,82] Few studies parsed the specific risk associated with one-hour increments of sleep duration. Sleep duration is also associated with important symptoms related to depression, such as suicidal ideation and psychological distress.[77,87,88] Finally, the direction of sleep duration-mental health relationships is not entirely clear. Experimental[4,89,90] and longitudinal observational studies[88,91] suggest short sleep duration can lead to depression and other mental health symptoms. On the other hand, insomnia symptoms typically improve when depression is treated, even when the treatment does not specifically target sleep.[92] Variable effects of depression treatment have been observed on sleep duration per se.[93,94] Experimental data are not available to suggest a causal role for long sleep duration in relation to mental health.

3.5 Immunologic Health

The effects of sleep duration on immunity have been examined from the cellular to the systemic level, and have included outcomes ranging from natural killer cell function and leukocyte activity to vaccine immune response and risk of infection following pathogen exposure. Sleep duration has been measured with sleep logs and actigraphy, although the definition of short sleep varies between studies. Studies with small numbers of subjects in both cross-sectional and experimental designs consistently demonstrate an association between short sleep duration and decreased natural killer cell function and mobilization. One observational study[29] and one controlled study[30] assessed the effect of sleep duration on immune response and vaccine clinical protection status. In both studies, shorter sleep was associated with decreased vaccine immune response.

Two studies assessed infection risk in relation to sleep duration. One observational study of 153 individuals found that subjects reporting less than 7 hours of sleep were at higher risk of developing an upper respiratory infection following rhinovirus exposure.[31] A larger prospective observational study of over 56,000 people found that self-reported sleep of less than or equal to 5 hours and greater than or equal to 9 hours was associated with an increased risk of pneumonia.[95] The paucity and heterogeneity of literature regarding inflammation resulted in the panel dropping this subcategory from consideration in Round 2 voting.

3.6 Human Performance

This area focused on the relationship between sleep duration and various aspects of cognitive performance that have been scientifically validated to be sensitive to sleep loss, as well as daytime sleep propensity and drowsy driving. Job performance was originally included but not retained due to an inadequate number of studies measuring actual job performance. Several studies were identified as relevant to this area but the vast majority had multiple limitations that included lack of objective measurement of sleep duration, focus on a single sleep restriction (often < 6 hours), limited duration of exposure to the restriction (a factor considered essential to uncovering cumulative effects from sleep restriction, especially mild-to-moderate sleep restriction), and lack of comparison and control conditions. A number of randomized controlled trials (RCTs) met the criteria for Oxford Level of Evidence I or II for the effects of sleep duration dose on cognitive performance across days. Collectively these studies included more than 200 healthy women and men ages 21–62 years. Population-based studies on a total of more than 5,600 adults evaluated associations between self-reported sleep duration and daytime sleep propensity (measured by sleep latency) or self-reported drowsy driving.

Studies using cognitive performance as an outcome have focused especially on tasks that assess the stability of vigilant attention (e.g., psychomotor vigilance test), cognitive processing speed, and working memory. One study found that time in bed (TIB) of 9 hours for sleep yielded higher performance on some cognitive domains than did 7 hours TIB. Fourteen studies found that 8–8.5 hours TIB resulted in cognitive performance superior to 6 hours or less TIB. A few studies found that 7 hours TIB yielded better performance than 5 hours TIB, while others found that 6 hours TIB was superior to 4–5 hours TIB. Sleep time of 4 hours yielded better cognitive performance than 3, 2, 1 or 0 hours for sleep.

Research findings show two consistent cognitive performance dynamics relative to 8 hours TIB for sleep: (1) The shorter the sleep duration, the greater the cognitive performance deficits; and (2) the longer the exposure to sleep restriction, the greater the cognitive deficits. Thus, the less sleep obtained, and the longer this continues, the more quickly cognitive deficits become evident.[3,5] Self-reported sleepiness does not show the latter dynamic and therefore cannot be used to track increasing performance deficits. In addition, total sleep duration per 24 hours is the critical factor relative to performance, since split-sleep schedules also show the same sleep dose-response effects.[96] Finally, the adverse effects of limited sleep time are especially severe at circadian times when sleep propensity is high.[96,97]

Scientific reports on sleep duration relative to daytime sleep propensity and drowsy driving revealed similar findings. Daytime sleep propensity as measured by the Multiple Sleep Latency Test (MSLT) was one of the earliest objective physiological measures of the cumulative daytime effects of sleep restricted to 5 hours a night for 1 week.[98] A more recent study showed that adults reporting sleep durations of 6.75 to 7.5 hours, and less than 6.75 hours, had a 27% and 73% increase, respectively, in the risk of sleep onset during the MSLT, compared to adults reporting > 7.5 hours of sleep.[99] Motor vehicle crash risk also increases when self-reported sleep duration is less than 6 hours. A recent cross-sectional survey of drivers found an association between self-reported sleep duration less than 7 hours and at least one self-reported incident of falling asleep while driving during the prior year.[100]

In summary, Level I evidence demonstrates that cognitive performance involving vigilance attention, cognitive processing speed and working memory, as well as physiological sleep propensity and drowsy driving are all sensitive to sleep duration below 7 hours. These deficit vulnerabilities increase inversely with declining duration and increasing chronicity of sleep amount. There is no clear evidence that sleep duration greater than 8 hours has an impact on these domains, beyond what is found for sleep durations of 7–8 hours per night, although "extra" sleep may provide some prophylactic benefits for performance during subsequent sleep restriction.[101]

3.7 Cancer

The literature addressing sleep duration and cancer risk involved studies focused on "female" cancers (breast, ovarian), colorectal, and general cancer diagnoses. These were mostly large prospective cohort studies including 12,222–110,011 subjects, although some were smaller and utilized a case-control study design. Breast cancer, the most commonly investigated neoplasm, was examined in 10 studies, including five large prospective cohort studies involving a combined total of more than 250,000 women. Four studies showed no association between sleep duration and breast cancer, while one showed ≤ 6 hours of sleep was associated with increased risk of breast cancer compared to 7 hours of sleep.[46] Case-control studies showed no association between sleep duration and breast cancer.

Three large prospective cohort studies assessed sleep duration and general cancer mortality, with none showing an association for either short or long sleep duration. Three studies addressed sleep duration and colorectal cancer, and each reached different conclusions. A case-control study[102] found short sleep < 6 hours, but not long sleep, was associated with colorectal adenoma, while a large prospective cohort study showed both extreme short (≤ 5 h) and long (≥ 9 h) sleep durations were associated with increased risk of colorectal cancer.[45] A third study only found an association in those who were overweight or snored, which may signify the impact of sleep apnea and its attendant intermittent hypoxemia.[103] A number of large prospective cohort studies assessed sleep duration and general cancer mortality with none showing an association for either short or long sleep duration. One prospective cohort study assessed the association between sleep duration and ovarian cancer and found sleep > 7 hours was associated with reduced ovarian cancer risk.[104]

Given the strengths of the studies addressing breast cancer, and the small size and limitations of the data assessing colorectal cancer, general cancer, and ovarian cancer, the panel decided to focus on breast cancer alone for Round 2 voting.

3.8 Pain

A number of papers related to sleep duration and pain were reviewed, including cross-sectional survey and experimental studies, and studies with self-report and objectively-measured sleep time. Sleep durations below 5 hours were associated with increased pain in all of these study types.[18,19,105–110] Increased pain symptoms were associated with sleep duration of less than 6 hours in four studies (three self-report and one objective monitoring).[18,19,105,106] Sleep durations of 7–8 or 8–9 hours were consistently associated with reduced pain symptoms.[18,105–109] Results were less consistent for sleep durations of 6–7 hours and 9 or more hours, primarily due to the small number of studies examining sleep durations in these time ranges.

3.9 Mortality

This literature includes numerous studies, of which many were included in two independent meta-analyses.[38,111] Both meta-analyses found increased mortality risk associated with short sleep and long sleep durations. "Short" and "long" sleep were defined differently across studies. Nevertheless, self-reported sleep duration of 7–8 hours was generally associated with the lowest mortality risk, and both short and long sleep duration were associated with increased risk. Given the heterogeneity of short and long sleep definitions, the most reliable comparisons examined these broad categories. However, examination of one hour sleep duration categories in large prospective studies suggests that the most extreme sleep durations are associated with the greater risk, especially in the case of long sleep. This U-shaped relationship has been demonstrated repeatedly (but not universally) and has been replicated using objective sleep measurement with actigraphy. The sleep duration-mortality risk relationship appears relatively stable across demographic groups, with one exception: Increased mortality risk associated with long sleep may be partially explained by age.

The panel's recommendation statement focuses on adults up to age 60 years, but many of the deaths in the studies examining mortality likely took place after subjects were 60 years old, given the longitudinal study designs. One meta-analysis[111] did not find a significant difference in mortality risk by age. Further, the role of medical conditions that could lead to both mortality and either short or long sleep duration is unclear. Although many potential confounders can be entered into analyses of large data sets, it may be difficult to interpret mortality risk after accounting for many of the leading causes of death, a large number of which may also be related to sleep duration. For example, the only study to assess the relationship between sleep duration and mortality in healthy individuals showed no association;[40] an association was evident only in those who were in poor health at the start of the study. These findings suggest that sleep duration-mortality risk associations may be driven more by underlying diseases than by sleep per se. Finally, one of the reviewed studies[112] included a sample so disproportionately large that it may exert undue influence on the overall conclusion. However, another meta-analysis[38] found that similar overall effects remained even after excluding this study from analysis.

4.0 STRENGTHS AND WEAKNESSES OF THE LITERATURE

The panel recommendation statement[55] was based on a literature characterized by numerous strengths. Taken together, studies on sleep duration include data on millions of participants, studied across several continents, aggregated over several decades. The studies include cross-sectional and longitudinal epidemiologic designs, randomized controlled trials, meta-analyses, and a range of other designs. Studies in the human performance category may have the strongest evidence base, which included experimental laboratory studies, objective measure of sleep and outcomes, evidence of cumulative effects, and support from population-based cohort studies documenting "real life" outcomes (e.g., driving performance) associated with sleep duration. Studies in the cardiovascular, metabolic, and mental health categories also include both laboratory experiments and epidemiological cohort studies. Numerous, large cross-sectional and longitudinal population-based observational studies provide largely concordant findings linking short sleep duration to obesity, cardiovascular disease, diabetes, and depression. Meta-analyses further support the findings reported in individual studies. The immunologic health and pain categories are supported by fewer studies, but these also include both observational and laboratory designs. In particular, studies of immune function in relation to sleep duration examine possible mechanisms at the cellular level. The literature also includes a large number of studies spanning several decades in the general health, cancer, and mortality categories. Studies in the mortality category include large samples and demonstrate largely convergent results that are supported by multiple meta-analyses.

A number of important limitations in both epidemiologic and laboratory-based studies are also evident, as described in previous reviews.[113] Epidemiologic studies maximize generalizability at the expense of measurement precision, whereas experimental studies maximize measurement precision at the expense of generalizability. However, these limitations are mitigated by the general agreement in findings between laboratory-based and epidemiologic studies.

Epidemiologic studies pose several specific limitations. First, most of the studies reviewed were cross-sectional, precluding any statements regarding causation. Second, sleep duration is typically assessed for a limited time frame around the assessment, whereas most of the health conditions have been developing or present for years prior to assessment. While cross-sectional associations may be valid, "predicting" chronic health conditions from concurrent sleep duration presents a conceptual challenge. Third, many epidemiologic studies have limited ability to explore potential mediators and effect modifiers. Fourth, some studies may have insufficient adjustment for confounders. Conversely, excluding too many health conditions may make interpretation difficult (e.g. If likely causes of death are removed from the analysis, it is difficult to study mortality).

Specific methods of sleep assessment also present some limitations in epidemiologic studies. First, most of these studies rely on retrospective self-report of habitual sleep duration, which may be less accurate than averages from daily self-report (i.e., sleep diary). Self-reported sleep duration can over- or under-estimate sleep duration measured objectively with actigraphy or polysomnography. Second, studies have varied in how they assess self-reported sleep duration. For instance, different studies may ask participants to report "typical," "average," "weeknight," or "24-hour" sleep duration. Some epidemiologic studies capture napping, while others do not. Third, while the survey items addressing sleep duration may have good face validity, most have not been formally validated with psychometric analyses. Fourth, sleep duration is not consistently defined across studies. For example, short sleep may be categorized as < 5, 5, 6, or < 8 hours, and reference groups may have sleep durations of 7, 8, 7–8, 7–9, or 6–8 hours. Fifth, measures of sleep duration do not capture information about the regularity of sleep patterns, the timing of sleep, or the quality of sleep.

Each of these facets of sleep may interact with sleep duration to affect health. Finally, many epidemiologic studies rely on self-reported health outcomes, such as height and weight, diabetes, and hypertension which may provide an additional source of measurement error.

Experimental designs have important limitations as well. First, few studies examined sleep manipulations for more than 7 days. The acute effects of sleep deprivation may be poor approximations of real-world effects that typically reflect accumulated sleep debt over weeks, months, or years. Similarly, the time course of habituation in the laboratory may not reflect habituation effects outside of the laboratory, or the degree to which self-directed changes in sleep (e.g., oversleeping on weekends) affects risk profiles. Second, few studies examined sleep duration in the range of 6 to < 7 hours. This likely reflects the aims of experimental studies, which often maximize differences in outcomes by contrasting extreme sleep duration groups. The absence of experimental groups in the 6–7 hour sleep range creates uncertainty in recommendations for the large portion of the population that report sleep durations of 6–7 hours. Third, many experimental studies lack generalizability because they include small samples that do not represent the population in terms of age, sex, race/ethnicity, socioeconomic status, or health history. Fourth, while the focus on objective, physiological sleep is a strength of laboratory studies, these objective measures correlate weakly with self-reported sleep duration, which is the method most relevant to clinical, public health, and policy recommendations. Standard methods to model such discrepancies must be sought until accurate, scalable, objective measures of sleep duration are developed for utilization in large epidemiological studies.

5.0 VOTING SUMMARY

Voting results from all 3 rounds are presented in **Figure 1**. In general, there was consensus that 6 hours of sleep or less was inappropriate to support optimal health in adults. There was also consensus that 7–9 hours of sleep were appropriate to support optimal health in adults. There was consensus that the appropriateness of 9 or more hours of sleep on optimal adult health could not be ascertained with certainty. Consensus could not be reached regarding the appropriateness of sleep durations in the 6–7 hour range, but the median vote indicated this duration was in the inappropriate range.

The panel then discussed the merits of recommending a sleep duration threshold versus a sleep duration range to promote optimal health. Implicit to a range recommendation is the conclusion that sleep duration above a certain amount is detrimental to health. Although there was evidence of an association between long sleep and adverse health outcomes in some categories, Round 3 voting revealed uncertainty regarding the appropriateness of > 9 hours of sleep for adult health. Further, although some studies have suggested potential reasons why longer sleep durations may be harmful,[114] the panel was unable to come to a consensus regarding biologically plausible pathways by which long sleep could explicitly cause poor health (acknowledging that biological plausibility depends on knowledge available at the time). With these considerations in mind, the panel decided to recommend a minimum threshold value rather than a range. The threshold was set at the lowest sleep duration the panel agreed was appropriate to support optimal health in adults: 7 hours.[55]

6.0 DISCUSSION

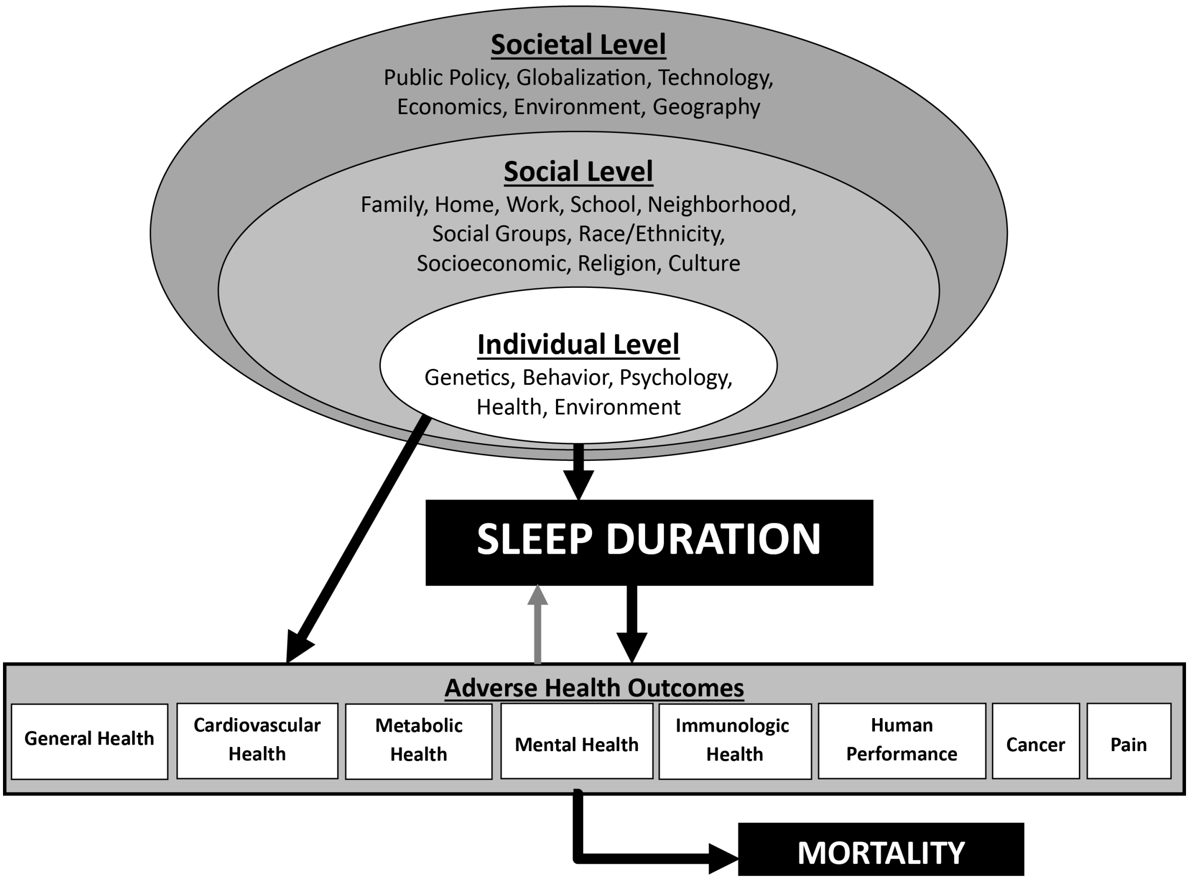
Sleep is a biological imperative. Meeting our need for sleep duration, timing, regularity, and quality requires volitional behaviors partially dictated by genetic and physiologic factors. However, a large proportion of inter-individual variability in sleep is likely explained by psychological, behavioral, social, cultural, and environmental factors (**Figure 2**). Sleep disorders, which are frequently undiagnosed and/or untreated, further contribute to this variability.

For reasons stated above, the consensus panel focused solely on the dimension of sleep duration, while recognizing the importance of other dimensions such as timing, regularity, and quality. The recommendation statement[55], which focuses on the sleep amount that promotes *optimal* adult health, does not address these other dimensions. Although our literature search excluded studies focusing primarily on one of these other dimensions, we recognize that they may have contributed important unmeasured variance to the reviewed studies. We also excluded research assessing the physiological impact of total sleep deprivation, since it can only be maintained for a few days at a time and cannot reflect habitual sleep, which was the focus of the panel.

When gauging the value and utility of the literature in addressing our question, the panel was keenly focused on the nine tenets of causality typically referred to as the Bradford Hill criteria,[115] which include: (1) strength of association, (2) consistency of findings, (3) specificity and (4) temporal sequence of association, (5) biological gradient and (6) plausibility, (7) coherence of the data, (8) experimentation results, and (9) analogous scenarios. Although empirical data were not available to address each of these criteria for each health outcome, they served as a framework for discussion, voting, and recommendations.

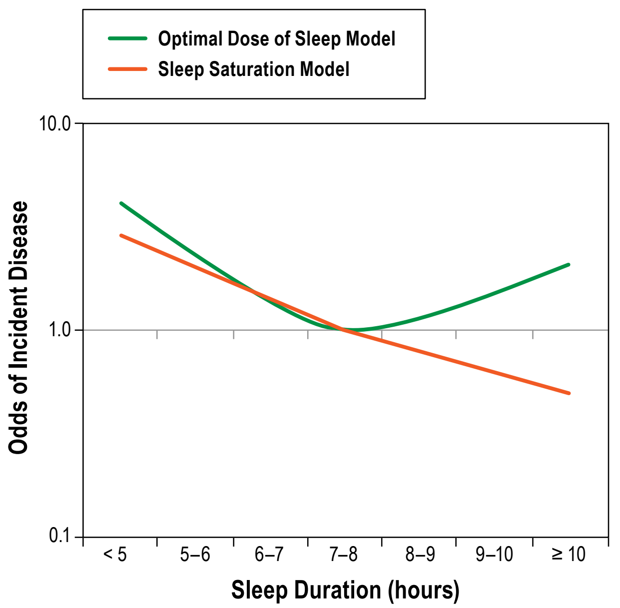
The issue of biological plausibility is particularly salient to the associations between long sleep, health, and mortality. The panel struggled to identify plausible physiologic mechanisms by which longer sleep might *cause* poor health or increase mortality. The recommendation statement indicates a threshold value for the sleep duration necessary to support optimal health in adults. This threshold implies that more sleep is likely not damaging to health. By contrast, "optimal dose" conceptualization of sleep, inherent to a range recommendation, suggests health is compromised by obtaining too little or too much sleep (**Figure 3**). Since the panel could not reach consensus that longer sleep was physiologically harmful, and since there *was* a consensus that longer sleep is beneficial for some individuals (e.g., younger adults, those recovering from sleep loss), no upper limit of sleep duration was included in the recommendation statement. As more evidence is collected regarding long sleep, this recommendation may need to be revisited. More importantly, regardless of whether a threshold or range model is endorsed, both constructs support the notion that too little sleep is unhealthy.

Figure 2—Biopsychosocial model of sleep duration drivers.



Adapted with permission from Grandner, Hale, Moore & Patel, 2010.

Figure 3—Two conceptualizations of sleep duration.



Adapted with permission from Marshall et al. Sleep Med Rev 2008;12:289–298. The green line represents an optimal dose of sleep where the odds of incident disease are lowest. The orange line represents a sleep saturation model, where longer sleep is not necessarily associated with poor health, and may be beneficial in some circumstances (e.g., recovery from sleep deprivation or illness).

Another important issue with regard to longer sleep durations is the dearth of studies assessing the physiological impact of sleep extension. Evidence in most categories regarding the association between long sleep and poor health was mixed, with the exception of mortality, where a U-shaped relationship between sleep duration and death was consistently observed (and where, indeed, relationships with long sleep may even be more robust than short sleep). Lacking convincing experimental evidence showing that sleep extension alters human physiology in unfavorable ways, and acknowledging that even the most carefully conducted epidemiological studies cannot control for all potentially relevant variables, the panel decided that the association between long sleep and increased mortality risk most likely represented the confounding effects of uncontrolled chronic illness. In other words, it seems plausible that illness associated inactivity likely increased both subjective reports of sleep duration and mortality risk. Interestingly, the only study that assessed the sleep duration/mortality question in healthy individuals failed to show an association.[40] The panel strongly encourages future experimental studies to examine the effects of sleep extension on health outcomes.

Our consensus recommendation statement presents sleep duration as static, as most epidemiological studies assessed sleep duration via a single question or measurement and experimental studies held sleep constant throughout the research protocol. However, the panel understood this is not the most ecologically valid construct for sleep duration. For instance, many individuals have a variable sleep lifestyle, curtailing sleep on weekdays and extending sleep on weekends—typically by staying up later at night and sleeping in later in the morning. This pattern can result in untoward circadian effects or "social jetlag,"[116] where the body experiences circadian disruption equivalent to taking a 2–3 hour "flight" westward on Friday night (with later circadian bedtimes and wake times than usual) only to "fly" back on Sunday night—waking earlier than desired Monday morning. Ecological validity also touches upon the limitations of highly controlled, laboratory based studies of sleep deprivation. These studies are not able to ascertain compensatory physiological effects that are likely at play over time. Thus, sleep duration in the real world is a dynamic process; understanding this process requires research that considers the many factors that influence the natural impact of sleep curtailment on human health.

The panel faced many challenges in the process of generating the consensus recommendation. Perhaps the biggest issue was the heterogeneity of sleep duration measurement.[117] Retrospective self-report, the most common method in epidemiologic studies and in clinical practice, is easy and has good face validity. However, sleep duration can vary substantially over time,[118–120] and there is little information on how individuals account for such variation in their reports. Also, self-report questions may have captured time in bed rather than time asleep. This distinction is particularly important among individuals with chronic illness who spend long periods of time in bed. It is also uncertain, in some studies, whether individuals include nap time in their reports of total sleep time. Self-reported sleep duration often differs considerably from objective measures of sleep duration, and may underestimate or overestimate sleep duration compared to these other methods.[121–123]

Polysomnography (PSG) and actigraphy were utilized as objective measures in some studies. Actigraphy has better sensitivity (detecting sleep) than specificity (detecting wake).[124] As a result it often overestimates sleep duration relative to self-reports and to a lesser extent polysomnography, particularly in poor sleepers. PSG is the only common method that directly measures brain activity. However, PSG is more intrusive than self-report or actigraphy, and may interfere with the very thing it measures, as suggested by the "first-night effect."[125] PSG is expensive and less well-suited for measuring sleep in large numbers of individuals, in participants' home environments, and over multiple nights. Moving forward, the widespread availability and acceptance of consumer sleep technologies may create opportunities for accurate, reliable, scalable objective sleep duration assessment in large epidemiological studies.[126]

7.0 FUTURE DIRECTIONS

Despite a large number of studies that have drawn connections between sleep duration and health, many critical questions remain open. The recommendations of the panel are intended to be a first step toward promoting adequate sleep duration for all adults, rather than a final destination. The panel achieved consensus based on the existing literature, but noted many knowledge gaps that need to be addressed in order to refine future recommendations. Based on this process, five specific areas for future research consideration are presented.

1. Improved sleep duration measures and study designs. Studies of sleep-health relationships should include objective measures of sleep when possible, well-validated self-report measures, and ecologically valid study designs. Epidemiological and longitudinal cohort studies would benefit from using home polysomnography, actigraphy, or other novel objective methods to measure sleep duration. The challenges of objective sleep measurement are to measure sleep without disturbing it, and to achieve this at reasonable cost. Self-report assessments should include psychometrically-validated questions and measures. When possible, measuring other dimensions of sleep health, such as timing, regularity, and quality, could lead to a more nuanced understanding of sleep-health relationships. These approaches should also be reflected in experimental studies. In addition, more laboratory studies are needed that systematically vary sleep opportunity in discrete steps between doses of 6 hours and 8 hours, using objective assessments of sleep physiology and cognitive performance. These studies should examine relevant time periods (e.g., 30 days), to develop more precise dose-response curves for sleep and recovery effects within the ranges most often reported by people in the population. Other laboratory studies could systematically mimic the more typical lifestyle of cycling through doses of shorter (restricted) and longer (recovery) sleep duration.

2. Investigate downstream mechanisms linking habitual sleep duration to health and functioning. Investigating mechanisms requires studies from epidemiologic and experimental perspectives, as well as research study designs that bridge these two approaches. For example, additional studies are needed that bring real-world short and long sleepers into the laboratory for in-depth assessment of the metabolic, cardiovascular, and neurocognitive correlates of habitual sleep duration. Intervention studies could also help to clarify whether modifying sleep improves health outcomes. Such studies could help to address whether sleep plays a causal role in health and functioning, or whether it serves as a marker of other processes.

3. Better delineate the upstream physiologic, behavioral, social, and environmental factors that may play a role in sleep duration and health outcomes. We need to better understand the genetic factors related to individual sleep need, resilience to sleep loss, and perception of sleep. In addition, the roles of race/ethnicity, socioeconomic factors, neighborhood, and other factors that may contribute to sleep and other adverse outcomes require further study. Better understanding the genetic, physiologic, and environmental factors that influence sleep duration can inform intervention strategies.

4. Develop intervention studies. Since we do not yet know whether habitual sleep duration *can* be modified in the real world, a systematic approach, moving from treatment development studies, to efficacy studies, to large-scale pragmatic trials, is warranted. Intervention studies can determine whether increasing habitual sleep duration among insufficient sleepers or extending sleep in normal sleepers results in improved outcomes, and how such changes can best be achieved. Such studies would not only assess the effects of sleep extension on human physiology, but also address the inconsistent epidemiological data showing long sleep is associated with poor

health and increased mortality. Intervention studies may also help to understand how different health and functioning outcomes are related to each other. Additional studies could examine how such behavioral changes are best achieved. In short, how can we get people who cannot find time for sleep, or do not prioritize sleep, to increase their sleep duration? How do we convince a population where undiagnosed sleep disorders are more common than diagnosed sleep disorders to get proper screening, diagnosis, and treatment?

5. Identify biomarker(s) of sleep need or sleep deprivation. Inexpensive, reliable, feasible biomarkers could advance the goals of clinical care, public health, and public policy. For instance, biomarkers would allow clinicians to provide more accurate sleep schedule recommendations to patients, and policy makers to facilitate policy decisions (e.g., transportation safety, resident duty hours). Biomarkers would also catalyze research assessing the long term consequences of sleep curtailment, or the health ramifications of "social jetlag."

8.0 CONCLUSION

The panel used a modified RAND appropriateness method to generate a consensus recommendation for the amount of sleep necessary to support optimal health in adults. Multiple rounds of evidence review, discussion, and voting were conducted to arrive at the final recommendation.[55] Additional research on the role of sleep in health will not only raise awareness of sleep's importance, but also lead to improved health and well-being for the general population and contribute to broader economic and social benefits.

NOTES

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REFERENCES

1. Rechtschaffen A, Bergmann BM. Sleep deprivation in the rat: an update of the 1989 paper. Sleep 2002;25:18–24.
2. Shaw PJ, Tononi G, Greenspan RJ, Robinson DF. Stress response genes protect against lethal effects of sleep deprivation in Drosophila. Nature 2002;417:287–91.
3. Van Dongen HP, Maislin G, Mullington JM, Dinges DF. The cumulative cost of additional wakefulness: dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. Sleep 2003;26:117–26.
4. Pilcher JJ, Huffcutt AI. Effects of sleep deprivation on performance: a meta-analysis. Sleep 1996;19:318–26.
5. Belenky G, Wesensten NJ, Thorne DR, et al. Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study. J Sleep Res 2003;12:1–12.
6. Lim J, Dinges DF. A meta-analysis of the impact of short-term sleep deprivation on cognitive variables. Psychol Bull 2010;136:375–89.
7. Maia Q, Grandner MA, Findley J, Gurubhagavatula I. Short and long sleep duration and risk of drowsy driving and the role of subjective sleep insufficiency. Accid Anal Prev 2013;59:618–22.
8. Philip P, Sagaspe P, Moore N, et al. Fatigue, sleep restriction and driving performance. Accid Anal Prev 2005;37:473–8.
9. Philibert I. Sleep loss and performance in residents and nonphysicians: a meta-analytic examination. Sleep 2005;28:1392–402.
10. Mitler MM, Carskadon MA, Czeisler CA, Dement WC, Dinges DF, Graeber RC. Catastrophes, sleep, and public policy: consensus report. Sleep 1988;11:100–9.
11. Dinges DF. An overview of sleepiness and accidents. J Sleep Res 1995;4:4–14.
12. Rogers AE, Hwang WT, Scott LD, Aiken LH, Dinges DF. The working hours of hospital staff nurses and patient safety. Health Aff 2004;23:202–12.
13. Barger LK, Cade BE, Ayas NT, et al. Extended work shifts and the risk of motor vehicle crashes among interns. N Engl J Med 2005;352:125–34.
14. Tononi G, Cirelli C. Sleep and the price of plasticity: from synaptic and cellular homeostasis to memory consolidation and integration. Neuron 2014;81:12–34.
15. Yoo SS, Hu PT, Gujar N, Jolesz FA, Walker MP. A deficit in the ability to form new human memories without sleep. Nat Neurosci 2007;10:385–92.
16. Lieberman HR, Bathalon GP, Falco CM, Kramer FM, Morgan CA, 3rd, Niro P. Severe decrements in cognition function and mood induced by sleep loss, heat, dehydration, and undernutrition during simulated combat. Biol Psychiatry 2005;57:422–9.
17. Minkel JD, Banks S, Htaik O, et al. Sleep deprivation and stressors: evidence for elevated negative affect in response to mild stressors when sleep deprived. Emotion 2012;12:1015–20.
18. Edwards RR, Almeida DM, Klick B, Haythornthwaite JA, Smith MT. Duration of sleep contributes to next-day pain report in the general population. Pain 2008;137:202–7.
19. Roehrs TA, Harris E, Randall S, Roth T. Pain sensitivity and recovery from mild chronic sleep loss. Sleep 2012;35:1667–72.
20. Mendelsohn AR, Larrick JW. Sleep facilitates clearance of metabolites from the brain: glymphatic function in aging and neurodegenerative diseases. Rejuvenation Res 2013;16:518–23.
21. Xie L, Kang H, Xu Q, et al. Sleep drives metabolite clearance from the adult brain. Science 2013;342:373–7.
22. Magee L, Hale L. Longitudinal associations between sleep duration and subsequent weight gain: a systematic review. Sleep Med Rev 2012;16:231–41.
23. Watson NF, Buchwald D, Vitiello MV, Noonan C, Goldberg J. A twin study of sleep duration and body mass index. J Clin Sleep Med 2010;6:11–7.
24. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Quantity and quality of sleep and incidence of type 2 diabetes: a systematic review and meta-analysis. Diabetes Care 2010;33:414–20.
25. Broussard JL, Ehrmann DA, Van Cauter E, Tasali E, Brady MJ. Impaired insulin signaling in human adipocytes after experimental sleep restriction: a randomized, crossover study. Ann Intern Med 2012;157:549–57.
26. Vgontzas AN, Fernandez-Mendoza J, Miksiewicz T, et al. Unveiling the longitudinal association between short sleep duration and the incidence of obesity: the Penn State Cohort. Int J Obes 2014;38:825–32.
27. Spiegel K, Tasali E, Penev P, Van Cauter E. Brief communication: sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. Ann Intern Med 2004;141:846–50.
28. Spaeth AM, Dinges DF, Goel N. Effects of experimental sleep restriction on weight gain, caloric intake, and meal timing in healthy adults. Sleep 2013;36:981–90.
29. Prather AA, Hall M, Fury JM, et al. Sleep and antibody response to hepatitis B vaccination. Sleep 2012;35:1063–9.
30. Spiegel K, Sheridan JF, Van Cauter E. Effect of sleep deprivation on response to immunization. JAMA 2002;288:1471–2.
31. Cohen S, Doyle WJ, Alper CM, Janicki-Deverts D, Turner RB. Sleep habits and susceptibility to the common cold. Arch Intern Med 2009;169:62–7.
32. Gomez-Gonzalez B, Dominguez-Salazar E, Hurtado-Alvarado G, et al. Role of sleep in the regulation of the immune system and the pituitary hormones. Ann N Y Acad Sci 2012;1261:97–106.
33. Spiegel K, Leproult R, L'Hermite-Baleriaux M, Copinschi G, Penev PD, Van Cauter E. Leptin levels are dependent on sleep duration: relationships with sympathovagal balance, carbohydrate regulation, cortisol, and thyrotropin. J Clin Endocrinol Metab 2004;89:5762–71.
34. Wang Q, Xi B, Liu M, Zhang Y, Fu M. Short sleep duration is associated with hypertension risk among adults: a systematic review and meta-analysis. Hypertens Res 2012;35:1012–8.
35. Ruiter Petrov ME, Letter AJ, Howard VJ, Kleindorfer D. Self-reported sleep duration in relation to incident stroke symptoms: nuances by body mass and race from the REGARDS study. J Stroke Cerebrovasc Dis 2014;23:e123–32.
36. Amagai Y, Ishikawa S, Gotoh T, Kayaba K, Nakamura Y, Kajii E. Sleep duration and incidence of cardiovascular events in a Japanese population: the Jichi Medical School cohort study. J Epidemiol 2010;20:106–10.

37. Meier-Ewert HK, Ridker PM, Rifai N, et al. Effect of sleep loss on C-reactive protein, an inflammatory marker of cardiovascular risk. J Am Coll Cardiol 2004;43:678–83.
38. Gallicchio L, Kalesan B. Sleep duration and mortality: a systematic review and meta-analysis. J Sleep Res 2009;18:148–58.
39. Yeo Y, Ma SH, Park SK, et al. A prospective cohort study on the relationship of sleep duration with all-cause and disease-specific mortality in the Korean Multi-center Cancer Cohort study. J Prev Med Public Health 2013;46:271–81.
40. Magee CA, Holliday EG, Attia J, Kritharides L, Banks E. Investigation of the relationship between sleep duration, all-cause mortality, and preexisting disease. Sleep Med 2013;14:591–6.
41. Xie D, Li W, Wang Y, et al. Sleep duration, snoring habits and risk of acute myocardial infarction in China population: results of the INTERHEART study. BMC Public Health 2014;14:531.
42. Ge B, Guo X. Short and long sleep durations are both associated with increased risk of stroke: a meta-analysis of observational studies. Int J Stroke 2015;10:177–84.
43. Sun W, Huang Y, Wang Z, et al. Sleep duration associated with body mass index among Chinese adults. Sleep Med 2015;16:612–6.
44. Shan Z, Ma H, Xie M, et al. Sleep duration and risk of type 2 diabetes: a meta-analysis of prospective studies. Diabetes Care 2015;38:529–37.
45. Jiao L, Duan Z, Sangi-Haghpeykar H, Hale L, White DL, El-Serag HB. Sleep duration and incidence of colorectal cancer in postmenopausal women. Br J Cancer 2013;108:213–21.
46. Kakizaki M, Kuriyama S, Sone T, et al. Sleep duration and the risk of breast cancer: the Ohsaki Cohort Study. Br J Cancer 2008;99:1502–5.
47. Nakata A. Work hours, sleep sufficiency, and prevalence of depression among full-time employees: a community-based cross-sectional study. J Clin Psychiatry 2011;72:605–14.
48. de Castro JM. The influence of heredity on self-reported sleep patterns in free-living humans. Physiol Behav 2002;76:479–86.
49. Partinen M, Kaprio J, Koskenvuo M, Putkonen P, Langinvainio H. Genetic and environmental determination of human sleep. Sleep 1983;6:179–85.
50. Basner M, Fomberstein KM, Razavi FM, et al. American time use survey: sleep time and its relationship to waking activities. Sleep 2007;30:1085–95.
51. Ford ES, Cunningham TJ, Croft JB. Trends in self-reported sleep duration among US adults from 1985 to 2012. Sleep 2015;38:829–32.
52. Centers for Disease Control and Prevention NCfCDaPaHP, Division of Adult and Community Health. Accessed March 27, 2015. Available from: http://www.cdc.gov/features/dssleep/.
53. US Department of Health and Human Services, Sleep Health Objectives. Accessed March 27, 2015. Available from: https://www.healthypeople.gov/2020/topics-objectives/topic/sleep-health/objectives.
54. Fitch K, Bernstein S, Aguilar M, et al. The RAND/UCLA Appropriateness Method User's Manual. Santa Monica, CA: RAND, 2001.
55. Watson NF, Badr MS, Belenky G, et al. Recommended amount of sleep for a healthy adult: a joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society. Sleep 2015;38:843–4.
56. Buysse DJ. Sleep health: can we define it? Does it matter? Sleep 2014;37:9–17.
57. Czeisler C. Duration, timing and quality of sleep are each vital for health, performance and safety. Sleep Health 2015;1:5–8.
58. Ohayon MM, Carskadon MA, Guilleminault C, Vitiello MV. Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. Sleep 2004;27:1255–73.
59. Basner M, Spaeth AM, Dinges DF. Sociodemographic characteristics and waking activities and their role in the timing and duration of sleep. Sleep 2014;37:1889–906.
60. Oxford Center for Evidence Based Medicine. Accessed May 15, 2015. Available from: http://www.cebm.net/ocebm-levels-of-evidence/.
61. Chen X, Gelaye B, Williams MA. Sleep characteristics and health-related quality of life among a national sample of American young adults: assessment of possible health disparities. Qual Life Res 2014;23:613–25.
62. Cappuccio FP, Cooper D, D'Elia L, Strazzullo P, Miller MA. Sleep duration predicts cardiovascular outcomes: a systematic review and meta-analysis of prospective studies. Eur Heart J 2011;32:1484–92.
63. Guo X, Zheng L, Wang J, et al. Epidemiological evidence for the link between sleep duration and high blood pressure: a systematic review and meta-analysis. Sleep Med 2013;14:324–32.
64. Van Cauter E, Knutson KL. Sleep and the epidemic of obesity in children and adults. Eur J Endocrinol 2008;159 Suppl 1:S59–66.
65. Buxton OM, Pavlova M, Reid EW, Wang W, Simonson DC, Adler GK. Sleep restriction for 1 week reduces insulin sensitivity in healthy men. Diabetes 2010;59:2126–33.
66. Ashcroft FM, Rorsman P. Diabetes mellitus and the beta cell: the last ten years. Cell 2012;148:1160–71.
67. Bosy-Westphal A, Hinrichs S, Jauch-Chara K, et al. Influence of partial sleep deprivation on energy balance and insulin sensitivity in healthy women. Obes Facts 2008;1:266–73.
68. Schmid SM, Hallschmid M, Jauch-Chara K, et al. Short-term sleep loss decreases physical activity under free-living conditions but does not increase food intake under time-deprived laboratory conditions in healthy men. Am J Clin Nutr 2009;90:1476–82.
69. Knutson KL, Spiegel K, Penev P, Van Cauter E. The metabolic consequences of sleep deprivation. Sleep Med Rev 2007;11:163–78.
70. Leproult R, Deliens G, Gilson M, Peigneux P. Beneficial impact of sleep extension on fasting insulin sensitivity in adults with habitual sleep restriction. Sleep 2015;38:707–15.
71. Tasali E, Chapotot F, Wroblewski K, Schoeller D. The effects of extended bedtimes on sleep duration and food desire in overweight young adults: a home-based intervention. Appetite 2014;80:220–4.
72. Holliday EG, Magee CA, Kritharides L, Banks E, Attia J. Short sleep duration is associated with risk of future diabetes but not cardiovascular disease: a prospective study and meta-analysis. PloS One 2013;8:e82305.
73. Cappuccio FP, Taggart FM, Kandala NB, et al. Meta-analysis of short sleep duration and obesity in children and adults. Sleep 2008;31:619–26.
74. Wu Y, Zhai L, Zhang D. Sleep duration and obesity among adults: a meta-analysis of prospective studies. Sleep Med 2014;15:1456–62.
75. Ju SY, Choi WS. Sleep duration and metabolic syndrome in adult populations: a meta-analysis of observational studies. Nutr Diabetes 2013;3:e65.
76. Xi B, He D, Zhang M, Xue J, Zhou D. Short sleep duration predicts risk of metabolic syndrome: a systematic review and meta-analysis. Sleep Med Rev 2014;18:293–7.
77. Goodwin RD, Marusic A. Association between short sleep and suicidal ideation and suicide attempt among adults in the general population. Sleep 2008;31:1097–101.
78. Vanaelst B, Huybrechts I, Bammann K, et al. Intercorrelations between serum, salivary, and hair cortisol and child-reported estimates of stress in elementary school girls. Psychophysiology 2012;49:1072–81.
79. John U, Meyer C, Rumpf HJ, Hapke U. Relationships of psychiatric disorders with sleep duration in an adult general population sample. J Psychiatr Res 2005;39:577–83.
80. Ryu SY, Kim KS, Han MA. Factors associated with sleep duration in Korean adults: results of a 2008 community health survey in Gwangju metropolitan city, Korea. J Korean Med Sci 2011;26:1124–31.
81. Gangwisch JE, Malaspina D, Posner K, et al. Insomnia and sleep duration as mediators of the relationship between depression and hypertension incidence. Am J Hypertens 2010;23:62–9.
82. Kaneita Y, Ohida T, Uchiyama M, et al. The relationship between depression and sleep disturbances: a Japanese nationwide general population survey. J Clin Psychiatry 2006;67:196–203.
83. Fernandez-Mendoza J, Shea S, Vgontzas AN, Calhoun SL, Liao D, Bixler EO. Insomnia and incident depression: role of objective sleep duration and natural history. J Sleep Res 2015 Feb 27. [Epub ahead of print].
84. Furihata R, Uchiyama M, Suzuki M, et al. Association of short sleep duration and short time in bed with depression: a Japanese general population survey. Sleep Biol Rhythms 2015;13:136–45.
85. Luxton DD, Greenburg D, Ryan J, Niven A, Wheeler G, Mysliwiec V. Prevalence and impact of short sleep duration in redeployed OIF soldiers. Sleep 2011;34:1189–95.
86. Chang JJ, Salas J, Habicht K, Pien GW, Stamatakis KA, Brownson RC. The association of sleep duration and depressive symptoms in rural communities of Missouri, Tennessee, and Arkansas. J Rural Health 2012;28:268–76.
87. Gunnell D, Chang SS, Tsai MK, Tsao CK, Wen CP. Sleep and suicide: an analysis of a cohort of 394,000 Taiwanese adults. Soc Psychiatry Psychiatr Epidemiol 2013;48:1457–65.
88. Glozier N, Martiniuk A, Patton G, et al. Short sleep duration in prevalent and persistent psychological distress in young adults: the DRIVE study. Sleep 2010;33:1139–45.
89. Haack M, Mullington JM. Sustained sleep restriction reduces emotional and physical well-being. Pain 2005;119:56–64.

90. Babson KA, Trainor CD, Feldner MT, Blumenthal H. A test of the effects of acute sleep deprivation on general and specific self-reported anxiety and depressive symptoms: an experimental extension. J Behav Ther Exp Psychiatry 2010;41:297–303.
91. van Mill JG, Vogelzangs N, van Someren EJ, Hoogendijk WJ, Penninx BW. Sleep duration, but not insomnia, predicts the 2-year course of depressive and anxiety disorders. J Clin Psychiatry 2014;75:119–26.
92. Thase ME, Rush AJ, Manber R, et al. Differential effects of nefazodone and cognitive behavioral analysis system of psychotherapy on insomnia associated with chronic forms of major depression. J Clin Psychiatry 2002;63:493–500.
93. Buysse DJ, Kupfer DJ, Frank E, Monk TH, Ritenour A. Electroencephalographic sleep studies in depressed outpatients treated with interpersonal psychotherapy: II. Longitudinal studies at baseline and recovery. Psychiatry Res 1992;42:27–40.
94. Manber R, Rush AJ, Thase ME, et al. The effects of psychotherapy, nefazodone, and their combination on subjective assessment of disturbed sleep in chronic depression. Sleep 2003;26:130–6.
95. Patel SR, Malhotra A, Gao X, Hu FB, Neuman MI, Fawzi WW. A prospective study of sleep duration and pneumonia risk in women. Sleep 2012;35:97–101.
96. Mollicone DJ, Van Dongen HP, Rogers NL, Banks S, Dinges DF. Time of day effects on neurobehavioral performance during chronic sleep restriction. Aviat Space Environ Med 2010;81:735–44.
97. Cohen DA, Wang W, Wyatt JK, et al. Uncovering residual effects of chronic sleep loss on human performance. Sci Transl Med 2010;2:14ra3.
98. Carskadon MA, Dement WC. Cumulative effects of sleep restriction on daytime sleepiness. Psychophysiology 1981;18:107–13.
99. Punjabi NM, Bandeen-Roche K, Young T. Predictors of objective sleep tendency in the general population. Sleep 2003;26:678–83.
100. Abe T, Komada Y, Inoue Y. Short sleep duration, snoring and subjective sleep insufficiency are independent factors associated with both falling asleep and feeling sleepiness while driving. Intern Med 2012;51:3253–60.
101. Rupp TL, Wesensten NJ, Bliese PD, Balkin TJ. Banking sleep: realization of benefits during subsequent sleep restriction and recovery. Sleep 2009;32:311–21.
102. Thompson CL, Li L. Association of sleep duration and breast cancer OncotypeDX recurrence score. Breast Cancer Res Treat 2012;134:1291–5.
103. Zhang X, Giovannucci EL, Wu K, et al. Associations of self-reported sleep duration and snoring with colorectal cancer risk in men and women. Sleep 2013;36:681–8.
104. Weiderpass E, Sandin S, Inoue M, et al. Risk factors for epithelial ovarian cancer in Japan - results from the Japan Public Health Center-based Prospective Study cohort. Int J Oncol 2012;40:21–30.
105. Buxton OM, Hopcia K, Sembajwe G, et al. Relationship of sleep deficiency to perceived pain and functional limitations in hospital patient care workers. J Occup Environ Med 2012;54:851–8.
106. Hamilton NA, Catley D, Karlson C. Sleep and the affective response to stress and pain. Health Psychol 2007;26:288–95.
107. Houle TT, Butschek RA, Turner DP, Smitherman TA, Rains JC, Penzien DB. Stress and sleep duration predict headache severity in chronic headache sufferers. Pain 2012;153:2432–40.
108. Schestatsky P, Dall-Agnol L, Gheller L, et al. Pain-autonomic interaction after work-induced sleep restriction. Eur J Neurol 2013;20:638–46.
109. Smith MT, Edwards RR, McCann UD, Haythornthwaite JA. The effects of sleep deprivation on pain inhibition and spontaneous pain in women. Sleep 2007;30:494–505.
110. Tiede W, Magerl W, Baumgartner U, Durrer B, Ehlert U, Treede RD. Sleep restriction attenuates amplitudes and attentional modulation of pain-related evoked potentials, but augments pain ratings in healthy volunteers. Pain 2010;148:36–42.
111. Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. Sleep 2010;33:585–92.
112. Kripke DF, Garfinkel L, Wingard DL, Klauber MR, Marler MR. Mortality associated with sleep duration and insomnia. Arch Gen Psychiatry 2002;59:131–6.
113. Grandner MA, Patel NP, Gehrman PR, Perlis ML, Pack AI. Problems associated with short sleep: bridging the gap between laboratory and epidemiological studies. Sleep Med Rev 2010;14:239–47.
114. Grandner MA, Drummond SP. Who are the long sleepers? Towards an understanding of the mortality relationship. Sleep Med Rev 2007;11:341–60.
115. Hill SAB. The environment and disease: association of causation? Proc R Soc Med 1965;58:295–300.
116. Wittmann M, Dinich J, Merrow M, Roenneberg T. Social jetlag: misalignment of biological and social time. Chronobiol Int 2006;23:497–509.
117. Kurina LM, McClintock MK, Chen JH, Waite LJ, Thisted RA, Lauderdale DS. Sleep duration and all-cause mortality: a critical review of measurement and associations. Ann Epidemiol 2013;23:361–70.
118. Wohlgemuth WK, Edinger JD, Fins AI, Sullivan RJ, Jr. How many nights are enough? The short-term stability of sleep parameters in elderly insomniacs and normal sleepers. Psychophysiology 1999;36:233–44.
119. Buysse DJ, Cheng Y, Germain A, et al. Night-to-night sleep variability in older adults with and without chronic insomnia. Sleep Med 2010;11:56–64.
120. Israel B, Buysse DJ, Krafty RT, Begley A, Miewald J, Hall M. Short-term stability of sleep and heart rate variability in good sleepers and patients with insomnia: for some measures, one night is enough. Sleep 2012;35:1285–91.
121. Manconi M, Ferri R, Sagrada C, et al. Measuring the error in sleep estimation in normal subjects and in patients with insomnia. J Sleep Res 2010;19:478–86.
122. Zinkhan M, Berger K, Hense S, et al. Agreement of different methods for assessing sleep characteristics: a comparison of two actigraphs, wrist and hip placement, and self-report with polysomnography. Sleep Med 2014;15:1107–14.
123. Lauderdale DS, Knutson KL, Yan LL, Liu K, Rathouz PJ. Self-reported and measured sleep duration: how similar are they? Epidemiology 2008;19:838–45.
124. Sadeh A. The role and validity of actigraphy in sleep medicine: an update. Sleep Med Rev 2011;15:259–67.
125. Newell J, Mairesse O, Verbanck P, Neu D. Is a one-night stay in the lab really enough to conclude? First-night effect and night-to-night variability in polysomnographic recordings among different clinical population samples. Psychiatry Res 2012;200:795–801.
126. Ferguson T, Rowlands AV, Olds T, Maher C. The validity of consumer-level, activity monitors in healthy adults worn in free-living conditions: a cross-sectional study. Int J Behav Nutr Phys Act 2015;12:42.
127. Watson NF, Badr MS, Belenky G, et al. Joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society on the recommended amount of sleep for a healthy adult: methodology and discussion. Sleep 2015;38:1161–83.

SUBMISSION & CORRESPONDENCE INFORMATION

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APPENDIX A. LITERATURE SEARCH TERMS

Category	Search Term	
Sleep Duration	Short sleep	[All fields]
	Long sleep	[All fields]
	Sleep deprivation	[All fields]
	Insufficient sleep syndrome	[All fields]
	Excessive sleep	[All fields]
	Sleep curtailment	[All fields]
	Sleep length	[All fields]
	Sleep need	[All fields]
	Sleep duration	[All fields]
	Sleep deficiency	[All fields]
General Health	Epidemiology	[MeSH terms]
	Prevention medicine	[MeSH terms]
	Emergencies	[All fields]
	Endemic diseases	[All fields]
	Environmental medicine	[All fields]
	Environmental microbiology	[MeSH terms]
	Disease transmission, infection	[MeSH terms]
	Environmental pollution	[MeSH terms]
	Public health practice	[MeSH terms]
	Wellness	[All fields]
	Well-being	[All fields]
	Quality of life	[MeSH terms]
Cardiovascular Health	Cardiovascular diseases	[MeSH terms]
	Heart valves	[MeSH terms]
	Heart valve diseases	[MeSH terms]
Metabolic Health	Metabolism	[MeSH terms]
	Body weight	[MeSH terms]
	Metabolic disease	[MeSH terms]
	Insulin	[MeSH terms]
	Orexins	[MeSH terms]
	Ghrelin	[MeSH terms]
	Adipokines	[MeSH terms]
	Waist-hip ratio	[MeSH terms]
	Thyroid gland	[MeSH terms]
Mental Health	Mental health	[MeSH terms]
	Depression	[MeSH terms]
	Psychiatry	[MeSH terms]
	Anxiety disorders	[MeSH terms]
	Dementia	[MeSH terms]
	Mood disorders	[MeSH terms]
	Schizophrenia and disorders with psychotic features	[MeSH terms]
	Substance-related disorders	[MeSH terms]
Immunologic Health	Inflammation	[MeSH terms]
	Autoimmune disease	[MeSH terms]
	Cytokines	[MeSH terms]
	Leukocytes	[MeSH terms]
	Phagocytes	[MeSH terms]
	Immunoproteins	[MeSH terms]
	Vaccination	[MeSH terms]
Human Performance	Function	[All fields]
	Activities of daily living	[MeSH terms]
	Alertness	[All fields]
	Cognition	[MeSH terms]
	Patient safety	[All fields]
	Patient harms	[All fields]
	Accidental falls	[All fields]
	Accidents, aviation	[All fields]
	Accidents, home	[All fields]
	Accidents, occupational	[All fields]
	Accidents, traffic	[All fields]
	Fatigue	[MeSH terms]
	Vigilance	[All fields]
	Psychomotor performance	[MeSH terms]
	Reaction	[All fields]
	Learning	[MeSH terms]
	Comprehension	[MeSH terms]
	Confusion	[MeSH terms]
	Impairment	[All fields]
	Sleep satisfaction	[All fields]
	Achievement	[MeSH terms]
Cancer	Neoplasms	[MeSH terms]
Pain	Pain	[MeSH terms]
	Nociception	[MeSH terms]
	Rheumatic diseases	[MeSH terms]
Mortality	Aging	[MeSH terms]
	Death	[MeSH terms]
	Survival	[MeSH terms]
	Vital statistics	[MeSH terms]

APPENDIX B. REFERENCE LIST OF FINAL EVIDENCE

General Health

Bliwise DL, King AC, Harris RB. Habitual sleep durations and health in a 50-65 year old population. J Clin Epidemiol. 1994 Jan;47(1):35–41.

Centers for Disease Control and Prevention (CDC). Effect of short sleep duration on daily activities--United States, 2005-2008. MMWR Morb Mortal Wkly Rep. 2011 Mar 4;60(8):239–42.

Chen X, Gelaye B, Williams MA. Sleep characteristics and health-related quality of life among a national sample of American young adults: assessment of possible health disparities. Qual Life Res. 2014 Mar;23(2):613–25.

Chiu HF, Xiang YT, Dai J, Chan SS, Yu X, Ungvari GS, Caine ED. Sleep duration and quality of life in young rural Chinese residents. Behav Sleep Med. 2013;11(5):360–8.

Furihata R, Uchiyama M, Takahashi S, Suzuki M, Konno C, Osaki K, Konno M, Kaneita Y, Ohida T, Akahoshi T, Hashimoto S, Akashiba T. The association between sleep problems and perceived health status: a Japanese nationwide general population survey. Sleep Med. 2012 Aug;13(7):831–7.

Gregory JM. Sleep: a good investment in health and safety. J Agromedicine. 2008;13(2):119–31.

Groeger JA, Zijlstra FR, Dijk DJ. Sleep quantity, sleep difficulties and their perceived consequences in a representative sample of some 2000 British adults. J Sleep Res. 2004 Dec;13(4):359–71.

Jean-Louis G, Kripke DF, Ancoli-Israel S. Sleep and quality of well-being. Sleep. 2000 Dec 15;23(8):1115–21.

Lekander M, Andreasson AN, Kecklund G, Ekman R, Ingre M, Akerstedt T, Axelsson J. Subjective health perception in healthy young men changes in response to experimentally restricted sleep and subsequent recovery sleep. Brain Behav Immun. 2013 Nov;34:43–6.

Lima MG, Barros MB, Alves MC. Sleep duration and health status self-assessment (SF-36) in the elderly: a population-based study (ISA-Camp 2008). Cad Saude Publica. 2012 Sep;28(9):1674–84.

Liu Y, Wheaton AG, Chapman DP, Croft JB. Sleep duration and chronic diseases among U.S. adults age 45 years and older: evidence from the 2010 Behavioral Risk Factor Surveillance System. Sleep. 2013 Oct 1;36(10):1421–7.

Lo CM, Lee PH. Prevalence and impacts of poor sleep on quality of life and associated factors of good sleepers in a sample of older Chinese adults. Health Qual Life Outcomes. 2012 Jun 18;10:72.

Lombardi DA, Folkard S, Willetts JL, Smith GS. Daily sleep, weekly working hours, and risk of work-related injury: US National Health Interview Survey (2004-2008). Chronobiol Int. 2010 Jul;27(5):1013–30.

Magee CA, Caputi P, Iverson DC. Relationships between self-rated health, quality of life and sleep duration in middle aged and elderly Australians. Sleep Med. 2011 Apr;12(4):346–50.

Patel SR, Malhotra A, Gao X, Hu FB, Neuman MI, Fawzi WW. A prospective study of sleep duration and pneumonia risk in women. Sleep. 2012 Jan 1;35(1):97–101.

Pilcher JJ, Ginter DR, Sadowsky B. Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. J Psychosom Res. 1997 Jun;42(6):583–96.

Rittman M, Hinojosa MS, Findley K. Subjective sleep, burden, depression, and general health among caregivers of veterans poststroke. J Neurosci Nurs. 2009 Feb;41(1):39–52.

Torre-Bouscoulet L, Garcia Sancho C, Vázquez García JC, Salazar-Peña CM, Lopez Varela MV, de Oca MM, Muiño A, Tálamo C, Valdivia G, Menezes AM, Perez-Padilla R. Perceptions of short and long sleep duration and comorbid conditions: the PLATINO study. Sleep Med. 2013 Sep;14(9):850–7.

Cardiovascular Health

Abe T, Aoki T, Yata S, Okada M. Sleep duration is significantly associated with carotid artery atherosclerosis incidence in a Japanese population. Atherosclerosis. 2011 Aug;217(2):509–13.

Altman NG, Izci-Balserak B, Schopfer E, Jackson N, Rattanaumpawan P, Gehrman PR, Patel NP, Grandner MA. Sleep duration versus sleep insufficiency as predictors of cardiometabolic health outcomes. Sleep Med. 2012 Dec;13(10):1261–70.

Amagai Y, Ishikawa S, Gotoh T, Kayaba K, Nakamura Y, Kajii E. Sleep duration and incidence of cardiovascular events in a Japanese population: the Jichi Medical School cohort study. J Epidemiol. 2010;20(2):106–10.

Ayas NT, White DP, Manson JE, Stampfer MJ, Speizer FE, Malhotra A, Hu FB. A prospective study of sleep duration and coronary heart disease in women. Arch Intern Med. 2003 Jan 27;163(2):205–9.

Bansil P, Kuklina EV, Merritt RK, Yoon PW. Associations between sleep disorders, sleep duration, quality of sleep, and hypertension: results from the National Health and Nutrition Examination Survey, 2005 to 2008. J Clin Hypertens (Greenwich). 2011 Oct;13(10):739–43.

Buman MP, Winkler EA, Kurka JM, Hekler EB, Baldwin CM, Owen N, Ainsworth BE, Healy GN, Gardiner PA. Reallocating time to sleep, sedentary behaviors, or active behaviors: associations with cardiovascular disease risk biomarkers, NHANES 2005–2006. Am J Epidemiol. 2014 Feb 1;179(3):323–34.

Buxton OM, Marcelli E. Short and long sleep are positively associated with obesity, diabetes, hypertension, and cardiovascular disease among adults in the United States. Soc Sci Med. 2010 Sep;71(5):1027–36.

Cappuccio FP, Stranges S, Kandala NB, Miller MA, Taggart FM, Kumari M, Ferrie JE, Shipley MJ, Brunner EJ, Marmot MG. Gender-specific associations of short sleep duration with prevalent and incident hypertension: the Whitehall II Study. Hypertension. 2007 Oct;50(4):693–700.

Chandola T, Ferrie JE, Perski A, Akbaraly T, Marmot MG. The effect of short sleep duration on coronary heart disease risk is greatest among those with sleep disturbance: a prospective study from the Whitehall II cohort. Sleep. 2010 Jun;33(6):739–44.

Chen JC, Brunner RL, Ren H, Wassertheil-Smoller S, Larson JC, Levine DW, Allison M, Naughton MJ, Stefanick ML. Sleep duration and risk of ischemic stroke in postmenopausal women. Stroke. 2008 Dec;39(12):3185–92.

Cheng Y, Du CL, Hwang JJ, Chen IS, Chen MF, Su TC. Working hours, sleep duration and the risk of acute coronary heart disease: a case-control study of middle-aged men in Taiwan. Int J Cardiol. 2014 Feb 15;171(3):419–22.

Chien KL, Chen PC, Hsu HC, Su TC, Sung FC, Chen MF, Lee YT. Habitual sleep duration and insomnia and the risk of cardiovascular events and all-cause death: report from a community-based cohort. Sleep. 2010 Feb;33(2):177–84.

Dean E, Bloom A, Cirillo M, Hong Q, Jawl B, Jukes J, Nijjar M, Sadovich S, Bruno SS. Association between habitual sleep duration and blood pressure and clinical implications: a systematic review. Blood Press. 2012 Feb;21(1):45–57.

Fang J, Wheaton AG, Keenan NL, Greenlund KJ, Perry GS, Croft JB. Association of sleep duration and hypertension among US adults varies by age and sex. Am J Hypertens. 2012 Mar;25(3):335–41.

Faraut B, Boudjeltia KZ, Vanhamme L, Kerkhofs M. Immune, inflammatory and cardiovascular consequences of sleep restriction and recovery. Sleep Med Rev. 2012 Apr;16(2):137–49.

Faraut B, Touchette E, Gamble H, Royant-Parola S, Safar ME, Varsat B, Léger D. Short sleep duration and increased risk of hypertension: a primary care medicine investigation. J Hypertens. 2012 Jul;30(7):1354–63.

Gangwisch JE, Feskanich D, Malaspina D, Shen S, Forman JP. Sleep duration and risk for hypertension in women: results from the nurses' health study. Am J Hypertens. 2013 Jul;26(7):903–11.

Gangwisch JE, Heymsfield SB, Boden-Albala B, Buijs RM, Kreier F, Pickering TG, Rundle AG, Zammit GK, Malaspina D. Short sleep duration as a risk factor for hypertension: analyses of the first National Health and Nutrition Examination Survey. Hypertension. 2006 May;47(5):833–9.

Gottlieb DJ, Redline S, Nieto FJ, Baldwin CM, Newman AB, Resnick HE, Punjabi NM. Association of usual sleep duration with hypertension: the Sleep Heart Health Study. Sleep. 2006 Aug;29(8):1009–14.

Grandner MA, Chakravorty S, Perlis ML, Oliver L, Gurubhagavatula I. Habitual sleep duration associated with self-reported and objectively determined cardiometabolic risk factors. Sleep Med. 2014 Jan;15(1):42–50.

Hamazaki Y, Morikawa Y, Nakamura K, Sakurai M, Miura K, Ishizaki M, Kido T, Naruse Y, Suwazono Y, Nakagawa H. The effects of sleep duration on the incidence of cardiovascular events among middle-aged male workers in Japan. Scand J Work Environ Health. 2011 Sep;37(5):411–7.

Hoevenaar-Blom MP, Spijkerman AM, Kromhout D, van den Berg JF, Verschuren WM. Sleep duration and sleep quality in relation to 12-year cardiovascular disease incidence: the MORGEN study. Sleep. 2011 Nov 1;34(11):1487–92.

Kerkhofs M, Boudjeltia KZ, Stenuit P, Brohée D, Cauchie P, Vanhaeverbeek M. Sleep restriction increases blood neutrophils, total cholesterol and low density lipoprotein cholesterol in postmenopausal women: A preliminary study. Maturitas. 2007 Feb 20;56(2):212–5.

Kim J, Jo I. Age-dependent association between sleep duration and hypertension in the adult Korean population. Am J Hypertens. 2010 Dec;23(12):1286–91.

Kim Y, Wilkens LR, Schembre SM, Henderson BE, Kolonel LN, Goodman MT. Insufficient and excessive amounts of sleep increase the risk of premature death from cardiovascular and other diseases: the Multiethnic Cohort Study. Prev Med. 2013 Oct;57(4):377–85.

King CR, Knutson KL, Rathouz PJ, Sidney S, Liu K, Lauderdale DS. Short sleep duration and incident coronary artery calcification. JAMA. 2008 Dec 24;300(24):2859–66.

Knutson KL, Van Cauter E, Rathouz PJ, Yan LL, Hulley SB, Liu K, Lauderdale DS. Association between sleep and blood pressure in midlife: the CARDIA sleep study. Arch Intern Med. 2009 Jun 8;169(11):1055–61.

Liu Y, Tanaka H; Fukuoka Heart Study Group. Overtime work, insufficient sleep, and risk of non-fatal acute myocardial infarction in Japanese men. Occup Environ Med. 2002 Jul;59(7):447–51.

Liu Y, Wheaton AG, Chapman DP, Croft JB. Sleep duration and chronic diseases among U.S. adults age 45 years and older: evidence from the 2010 Behavioral Risk Factor Surveillance System. Sleep. 2013 Oct 1;36(10):1421–7.

Ma CC, Burchfiel CM, Charles LE, Dorn JM, Andrew ME, Gu JK, Joseph PN, Fekedulegn D, Slaven JE, Hartley TA, Mnatsakanova A, Violanti JM. Associations of objectively measured and self-reported sleep duration with carotid artery intima media thickness among police officers. Am J Ind Med. 2013 Nov;56(11):1341–51.

Magee CA, Kritharides L, Attia J, McElduff P, Banks E. Short and long sleep duration are associated with prevalent cardiovascular disease in Australian adults. J Sleep Res. 2012 Aug;21(4):441–7.

Mallon L, Broman JE, Hetta J. Sleep complaints predict coronary artery disease mortality in males: a 12-year follow-up study of a middle-aged Swedish population. J Intern Med. 2002 Mar;251(3):207–16.

Meisinger C, Heier M, Löwel H, Schneider A, Döring A. Sleep duration and sleep complaints and risk of myocardial infarction in middle-aged men and women from the general population: the MONICA/KORA Augsburg cohort study. Sleep. 2007 Sep;30(9):1121–7.

Palagini L, Bruno RM, Gemignani A, Baglioni C, Ghiadoni L, Riemann D. Sleep loss and hypertension: a systematic review. Curr Pharm Des. 2013;19(13):2409–19.

Pan A, De Silva DA, Yuan JM, Koh WP. Sleep duration and risk of stroke mortality among Chinese adults: Singapore Chinese health study. Stroke. 2014 Jun;45(6):1620–5.

Qureshi AI, Giles WH, Croft JB, Bliwise DL. Habitual sleep patterns and risk for stroke and coronary heart disease: a 10-year follow-up from NHANES I. Neurology. 1997 Apr;48(4):904–11.

Ruiter Petrov ME, Letter AJ, Howard VJ, Kleindorfer D. Self-reported sleep duration in relation to incident stroke symptoms: nuances by body mass and race from the REGARDS study. J Stroke Cerebrovasc Dis. 2014 Feb;23(2):e123–32.

Sabanayagam C, Shankar A. Sleep duration and cardiovascular disease: results from the National Health Interview Survey. Sleep. 2010 Aug;33(8):1037–42.

Sands MR, Lauderdale DS, Liu K, Knutson KL, Matthews KA, Eaton CB, Linkletter CD, Loucks EB. Short sleep duration is associated with carotid intima-media thickness among men in the Coronary Artery Risk Development in Young Adults (CARDIA) Study. Stroke. 2012 Nov;43(11):2858–64.

Sands-Lincoln M, Loucks EB, Lu B, Carskadon MA, Sharkey K, Stefanick ML, Ockene J, Shah N, Hairston KG, Robinson JG, Limacher M, Hale L, Eaton CB. Sleep duration, insomnia, and coronary heart disease among postmenopausal women in the Women's Health Initiative. J Womens Health (Larchmt). 2013 Jun;22(6):477–86.

Satoh H, Nishihira J, Wada T, Fujii S, Tsutui H. The relation between habitual sleep duration and blood pressure values in Japanese male subjects. Environ Health Prev Med. 2013 May;18(3):215–20.

Shankar A, Koh WP, Yuan JM, Lee HP, Yu MC. Sleep duration and coronary heart disease mortality among Chinese adults in Singapore: a population-based cohort study. Am J Epidemiol. 2008 Dec 15;168(12):1367–73.

Stranges S, Dorn JM, Cappuccio FP, Donahue RP, Rafalson LB, Hovey KM, Freudenheim JL, Kandala NB, Miller MA, Trevisan M. A population-based study of reduced sleep duration and hypertension: the strongest association may be in premenopausal women. J Hypertens. 2010 May;28(5):896–902.

Tsukasaki K, Makimoto K, Kido T. The impact of sleep on ambulatory blood pressure of female caregivers providing home care in Japan: an observational study. Int J Nurs Stud. 2008 Dec;45(12):1721–30.

Verdecchia P, Angeli F, Borgioni C, Gattobigio R, Reboldi G. Ambulatory blood pressure and cardiovascular outcome in relation to perceived sleep deprivation. Hypertension. 2007 Apr;49(4):777–83.

Wang H, Zee P, Reid K, Chervin RD, Patwari PP, Wang B, Li Z, Tang G, Liu X, Yang J, Xu X, Wang X. Gender-specific association of sleep duration with blood pressure in rural Chinese adults. Sleep Med. 2011 Aug;12(7):693–9.

Wang Q, Xi B, Liu M, Zhang Y, Fu M. Short sleep duration is associated with hypertension risk among adults: a systematic review and meta-analysis. Hypertens Res. 2012 Oct;35(10):1012–8.

Weil BR, Greiner JJ, Stauffer BL, Desouza CA. Self-reported habitual short sleep duration is associated with endothelial fibrinolytic dysfunction in men: a preliminary report. Sleep. 2013 Feb 1;36(2):183–8.

Westerlund A, Bellocco R, Sundström J, Adami HO, Åkerstedt T, Trolle Lagerros Y. Sleep characteristics and cardiovascular events in a large Swedish cohort. Eur J Epidemiol. 2013 Jun;28(6):463–73.

Wolff B, Völzke H, Schwahn C, Robinson D, Kessler C, John U. Relation of self-reported sleep duration with carotid intima-media thickness in a general population sample. Atherosclerosis. 2008 Feb;196(2):727–32.

Xiao Q, Keadle SK, Hollenbeck AR, Matthews CE. Sleep Duration and Total and Cause-Specific Mortality in a Large US Cohort: Interrelationships With Physical Activity, Sedentary Behavior, and Body Mass Index. American Journal of Epidemiology. 2014 Oct 3;180(10):997–1006

Yoshioka E, Saijo Y, Kita T, Okada E, Satoh H, Kawaharada M, Kishi R. Relation between self-reported sleep duration and arterial stiffness: a cross-sectional study of middle-aged Japanese civil servants. Sleep. 2011 Dec 1;34(12):1681–6.

Zou D, Eder DN, Eskandari D, Grote L, Boström KB, Lindblad U, Hedner J. Association between short total sleep time and hypertension: the Skara Sleep Cohort. J Hypertens. 2013 Feb;31(2):345–51.

Metabolic Health

Appelhans BM, Janssen I, Cursio JF, Matthews KA, Hall M, Gold EB, Burns JW, Kravitz HM. Sleep duration and weight change in midlife women: the SWAN sleep study. Obesity (Silver Spring). 2013 Jan;21(1):77–84.

Ayas NT, White DP, Al-Delaimy WK, Manson JE, Stampfer MJ, Speizer FE, Patel S, Hu FB. A prospective study of self-reported sleep duration and incident diabetes in women. Diabetes Care. 2003 Feb;26(2):380–4.

Beccuti G, Pannain S. Sleep and obesity. Curr Opin Clin Nutr Metab Care. 2011 Jul;14(4):402–12.

Beihl DA, Liese AD, Haffner SM. Sleep duration as a risk factor for incident type 2 diabetes in a multiethnic cohort. Ann Epidemiol. 2009 May;19(5):351–7.

Björkelund C, Bondyr-Carlsson D, Lapidus L, Lissner L, Månsson J, Skoog I, Bengtsson C. Sleep disturbances in midlife unrelated to 32-year diabetes incidence: the prospective population study of women in Gothenburg. Diabetes Care. 2005 Nov;28(11):2739–44.

Bjorvatn B, Sagen IM, Øyane N, Waage S, Fetveit A, Pallesen S, Ursin R. The association between sleep duration, body mass index and metabolic measures in the Hordaland Health Study. J Sleep Res. 2007 Mar;16(1):66–76.

Bosy-Westphal A, Hinrichs S, Jauch-Chara K, Hitze B, Later W, Wilms B, Settler U, Peters A, Kiosz D, Muller MJ. Influence of partial sleep deprivation on energy balance and insulin sensitivity in healthy women. Obes Facts. 2008;1(5):266–73.

Boyko EJ, Seelig AD, Jacobson IG, Hooper TI, Smith B, Smith TC, Crum-Cianflone NF; Millennium Cohort Study Team. Sleep characteristics, mental health, and diabetes risk: a prospective study of U.S. military service members in the Millennium Cohort Study. Diabetes Care. 2013 Oct;36(10):3154–61.

Brondel L, Romer MA, Nougues PM, Touyarou P, Davenne D. Acute partial sleep deprivation increases food intake in healthy men. Am J Clin Nutr. 2010 Jun;91(6):1550–9.

Broussard JL, Chapotot F, Abraham V, Day A, Delebecque F, Whitmore HR, Tasali E. Sleep restriction increases free fatty acids in healthy men. Diabetologia. 2015 Feb 22.

Broussard JL, Ehrmann DA, Van Cauter E, Tasali E, Brady MJ. Impaired insulin signaling in human adipocytes after experimental sleep restriction: a randomized, crossover study. Ann Intern Med. 2012 Oct 16;157(8):549–57.

Buscemi D, Kumar A, Nugent R, Nugent K. Short sleep times predict obesity in internal medicine clinic patients. J Clin Sleep Med. 2007 Dec 15;3(7):681–8.

Buxton OM, Marcelli E. Short and long sleep are positively associated with obesity, diabetes, hypertension, and cardiovascular disease among adults in the United States. Soc Sci Med. 2010 Sep;71(5):1027–36.

Buxton OM, Pavlova M, Reid EW, Wang W, Simonson DC, Adler GK. Sleep restriction for 1 week reduces insulin sensitivity in healthy men. Diabetes. 2010 Sep;59(9):2126–33.

Byberg S, Hansen AL, Christensen DL, Vistisen D, Aadahl M, Linneberg A, Witte DR. Sleep duration and sleep quality are associated differently with alterations of glucose homeostasis. Diabet Med. 2012 Sep;29(9):e354–60.

Calvin AD, Carter RE, Adachi T, Macedo PG, Albuquerque FN, van der Walt C, Bukartyk J, Davison DE, Levine JA, Somers VK. Effects of experimental sleep restriction on caloric intake and activity energy expenditure. Chest. 2013 Jul;144(1):79–86.

Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Quantity and quality of sleep and incidence of type 2 diabetes: a systematic review and meta-analysis. Diabetes Care. 2010 Feb;33(2):414–20.

Cappuccio FP, Taggart FM, Kandala NB, Currie A, Peile E, Stranges S, Miller MA. Meta-analysis of short sleep duration and obesity in children and adults. Sleep. 2008 May;31(5):619–26.

Chao CY, Wu JS, Yang YC, Shih CC, Wang RH, Lu FH, Chang CJ. Sleep duration is a potential risk factor for newly diagnosed type 2 diabetes mellitus. Metabolism. 2011 Jun;60(6):799–804.

Chaput JP, Després JP, Bouchard C, Tremblay A. Association of sleep duration with type 2 diabetes and impaired glucose tolerance. Diabetologia. 2007 Nov;50(11):2298–304.

Chaput JP, Després JP, Bouchard C, Tremblay A. Longer sleep duration associates with lower adiposity gain in adult short sleepers. Int J Obes (Lond). 2012 May;36(5):752–6.

Chaput JP, Després JP, Bouchard C, Tremblay A. Short sleep duration is associated with reduced leptin levels and increased adiposity: Results from the Quebec family study. Obesity (Silver Spring). 2007 Jan;15(1):253–61.

Chaput JP, Després JP, Bouchard C, Tremblay A. The association between sleep duration and weight gain in adults: a 6-year prospective study from the Quebec Family Study. Sleep. 2008 Apr;31(4):517–23.

Chaput JP, Tremblay A. Sleeping habits predict the magnitude of fat loss in adults exposed to moderate caloric restriction. Obes Facts. 2012;5(4):561–6.

Cournot M, Ruidavets JB, Marquié JC, Esquirol Y, Baracat B, Ferrières J. Environmental factors associated with body mass index in a population of Southern France. Eur J Cardiovasc Prev Rehabil. 2004 Aug;11(4):291–7.

Di Milia L, Vandelanotte C, Duncan MJ. The association between short sleep and obesity after controlling for demographic, lifestyle, work and health related factors. Sleep Med. 2013 Apr;14(4):319–23.

Engeda J, Mezuk B, Ratliff S, Ning Y. Association between duration and quality of sleep and the risk of pre-diabetes: evidence from NHANES. Diabet Med. 2013 Jun;30(6):676–80.

Ford ES, Li C, Wheaton AG, Chapman DP, Perry GS, Croft JB. Sleep duration and body mass index and waist circumference among U.S. adults. Obesity (Silver Spring). 2014 Feb;22(2):598–607.

Gangwisch JE, Heymsfield SB, Boden-Albala B, Buijs RM, Kreier F, Pickering TG, Rundle AG, Zammit GK, Malaspina D. Sleep duration as a risk factor for diabetes incidence in a large U.S. sample. Sleep. 2007 Dec;30(12):1667–73.

Gangwisch JE, Malaspina D, Boden-Albala B, Heymsfield SB. Inadequate sleep as a risk factor for obesity: analyses of the NHANES I. Sleep. 2005 Oct;28(10):1289–96.

Gangwisch JE. Epidemiological evidence for the links between sleep, circadian rhythms and metabolism. Obes Rev. 2009 Nov;10 Suppl 2:37–45.

Gottlieb DJ, Punjabi NM, Newman AB, Resnick HE, Redline S, Baldwin CM, Nieto FJ. Association of sleep time with diabetes mellitus and impaired glucose tolerance. Arch Intern Med. 2005 Apr 25;165(8):863–7.

Haghighatdoost F, Karimi G, Esmaillzadeh A, Azadbakht L. Sleep deprivation is associated with lower diet quality indices and higher rate of general and central obesity among young female students in Iran. Nutrition. 2012 Nov-Dec;28(11–12):1146–50.

Hart CN, Larose JG, Fava JL, James BL, Wing RR. The association between time in bed and obesity risk in young adults. Behav Sleep Med. 2013;11(5):321–7.

Hasler G, Buysse DJ, Klaghofer R, Gamma A, Ajdacic V, Eich D, Rössler W, Angst J. The association between short sleep duration and obesity in young adults: a 13-year prospective study. Sleep. 2004 Jun 15;27(4):661–6.

Hayashino Y, Fukuhara S, Suzukamo Y, Okamura T, Tanaka T, Ueshima H; HIPOP-OHP Research group. Relation between sleep quality and quantity, quality of life, and risk of developing diabetes in healthy workers in Japan: the High-risk and Population Strategy for Occupational Health Promotion (HIPOP-OHP) Study. BMC Public Health. 2007 Jun 28;7:129.

Hayes AL, Xu F, Babineau D, Patel SR. Sleep duration and circulating adipokine levels. Sleep. 2011 Feb 1;34(2):147–52.

Holliday EG, Magee CA, Kritharides L, Banks E, Attia J. Short sleep duration is associated with risk of future diabetes but not cardiovascular disease: a prospective study and meta-analysis. PLoS One. 2013;8(11):e82305.

Hsieh SD, Muto T, Murase T, Tsuji H, Arase Y. Association of short sleep duration with obesity, diabetes, fatty liver and behavioral factors in Japanese men. Intern Med. 2011;50(21):2499–502.

Johnsen MT, Wynn R, Bratlid T. Optimal sleep duration in the subarctic with respect to obesity risk is 8-9 hours. PLoS One. 2013;8(2):e56756.

Ju SY, Choi WS. Sleep duration and metabolic syndrome in adult populations: a meta-analysis of observational studies. Nutr Diabetes. 2013 May 13;3:e65.

Kachi Y, Ohwaki K, Yano E. Association of sleep duration with untreated diabetes in Japanese men. Sleep Med. 2012 Mar;13(3):307–9.

Kadono M, Hasegawa G, Shigeta M, Nakazawa A, Ueda M, Fukui M, Yoshikawa T, Nakamura N. Joint effect of alcohol and usual sleep duration on the risk of dysglycemia. Sleep. 2007 Oct;30(10):1341–7.

Kita T, Yoshioka E, Satoh H, Saijo Y, Kawaharada M, Okada E, Kishi R. Short sleep duration and poor sleep quality increase the risk of diabetes in Japanese workers with no family history of diabetes. Diabetes Care. 2012 Feb;35(2):313–8.

Knutson KL. Does inadequate sleep play a role in vulnerability to obesity? Am J Hum Biol. 2012 May-Jun;24(3):361–71.

Kobayashi D, Takahashi O, Deshpande GA, Shimbo T, Fukui T. Association between weight gain, obesity, and sleep duration: a large-scale 3-year cohort study. Sleep Breath. 2012 Sep;16(3):829–33.

Liu R, Liu X, Arguelles LM, Patwari PP, Zee PC, Chervin RD, Ouyang F, Christoffel KK, Zhang S, Hong X, Wang G, Xu X, Wang X. A population-based twin study on sleep duration and body composition. Obesity (Silver Spring). 2012 Jan;20(1):192–9.

Liu R, Zee PC, Chervin RD, Arguelles LM, Birne J, Zhang S, Christoffel KK, Brickman WJ, Zimmerman D, Wang B, Wang G, Xu X, Wang X. Short sleep duration is associated with insulin resistance independent of adiposity in Chinese adult twins. Sleep Med. 2011 Oct;12(9):914–9.

Liu Y, Wheaton AG, Chapman DP, Croft JB. Sleep duration and chronic diseases among U.S. adults age 45 years and older: evidence from the 2010 Behavioral Risk Factor Surveillance System. Sleep. 2013 Oct 1;36(10):1421–7.

López-García E, Faubel R, León-Muñoz L, Zuluaga MC, Banegas JR, Rodríguez-Artalejo F. Sleep duration, general and abdominal obesity, and weight change among the older adult population of Spain. Am J Clin Nutr. 2008 Feb;87(2):310–6.

Lyytikäinen P, Rahkonen O, Lahelma E, Lallukka T. Association of sleep duration with weight and weight gain: a prospective follow-up study. J Sleep Res. 2011 Jun;20(2):298–302.

Magee L, Hale L. Longitudinal associations between sleep duration and subsequent weight gain: a systematic review. Sleep Med Rev. 2012 Jun;16(3):231–41.

Mallon L, Broman JE, Hetta J. High incidence of diabetes in men with sleep complaints or short sleep duration: a 12-year follow-up study of a middle-aged population. Diabetes Care. 2005 Nov;28(11):2762–7.

Markwald RR, Melanson EL, Smith MR, Higgins J, Perreault L, Eckel RH, Wright KP Jr. Impact of insufficient sleep on total daily energy expenditure, food intake, and weight gain. Proc Natl Acad Sci U S A. 2013 Apr 2;110(14):5695–700.

Marshall NS, Glozier N, Grunstein RR. Is sleep duration related to obesity? A critical review of the epidemiological evidence. Sleep Med Rev. 2008 Aug;12(4):289–98.

Meyer KA, Wall MM, Larson NI, Laska MN, Neumark-Sztainer D. Sleep duration and BMI in a sample of young adults. Obesity (Silver Spring). 2012 Jun;20(6):1279–87.

Moraes W, Poyares D, Zalcman I, de Mello MT, Bittencourt LR, Santos-Silva R, Tufik S. Association between body mass index and sleep duration assessed by objective methods in a representative sample of the adult population. Sleep Med. 2013 Apr;14(4):312–8.

Moreno CR, Louzada FM, Teixeira LR, Borges F, Lorenzi-Filho G. Short sleep is associated with obesity among truck drivers. Chronobiol Int. 2006;23(6):1295–303.

Nagai M, Tomata Y, Watanabe T, Kakizaki M, Tsuji I. Association between sleep duration, weight gain, and obesity for long period. Sleep Med. 2013 Feb;14(2):206–10.

Najafian J, Mohamadifard N, Siadat ZD, Sadri G, Rahmati MR. Association between sleep duration and diabetes mellitus: Isfahan Healthy Heart Program. Niger J Clin Pract. 2013 Jan-Mar;16(1):59–62.

Nedeltcheva AV, Kilkus JM, Imperial J, Kasza K, Schoeller DA, Penev PD. Sleep curtailment is accompanied by increased intake of calories from snacks. Am J Clin Nutr. 2009 Jan;89(1):126–33.

Nedeltcheva AV, Kilkus JM, Imperial J, Schoeller DA, Penev PD. Insufficient sleep undermines dietary efforts to reduce adiposity. Ann Intern Med. 2010 Oct 5;153(7):435–41.

Patel SR, Malhotra A, White DP, Gottlieb DJ, Hu FB. Association between reduced sleep and weight gain in women. Am J Epidemiol. 2006 Nov 15;164(10):947–54.

Rafalson L, Donahue RP, Stranges S, Lamonte MJ, Dmochowski J, Dorn J, Trevisan M. Short sleep duration is associated with the development of impaired fasting glucose: the Western New York Health Study. Ann Epidemiol. 2010 Dec;20(12):883–9.

Reynolds AC, Dorrian J, Liu PY, Van Dongen HP, Wittert GA, Harmer LJ, Banks S. Impact of five nights of sleep restriction on glucose metabolism, leptin and testosterone in young adult men. PLoS One. 2012;7(7):e41218.

Robertson MD, Russell-Jones D, Umpleby AM, Dijk DJ. Effects of three weeks of mild sleep restriction implemented in the home environment on multiple metabolic and endocrine markers in healthy young men. Metabolism. 2013 Feb;62(2):204–11.

Rontoyanni VG, Baic S, Cooper AR. Association between nocturnal sleep duration, body fatness, and dietary intake in Greek women. Nutrition. 2007 Nov-Dec;23(11–12):773–7.

Sayón-Orea C, Bes-Rastrollo M, Carlos S, Beunza JJ, Basterra-Gortari FJ, Martínez-González MA. Association between sleeping hours and siesta and the risk of obesity: the SUN Mediterranean Cohort. Obes Facts. 2013;6(4):337–47.

Schmid SM, Hallschmid M, Jauch-Chara K, Wilms B, Benedict C, Lehnert H, Born J, Schultes B. Short-term sleep loss decreases physical activity under free-living conditions but does not increase food intake under time-deprived laboratory conditions in healthy men. Am J Clin Nutr. 2009 Dec;90(6):1476–82.

Shechter A, Rising R, Albu JB, St-Onge MP. Experimental sleep curtailment causes wake-dependent increases in 24-h energy expenditure as measured by whole-room indirect calorimetry. Am J Clin Nutr. 2013 Dec;98(6):1433–9.

Singh M, Drake CL, Roehrs T, Hudgel DW, Roth T. The association between obesity and short sleep duration: a population-based study. J Clin Sleep Med. 2005 Oct 15;1(4):357–63.

Spaeth AM, Dinges DF, Goel N. Effects of Experimental Sleep Restriction on Weight Gain, Caloric Intake, and Meal Timing in Healthy Adults. Sleep. 2013 Jul 1;36(7):981–990.

Spiegel K, Knutson K, Leproult R, Tasali E, Van Cauter E. Sleep loss: a novel risk factor for insulin resistance and Type 2 diabetes. J Appl Physiol (1985). 2005 Nov;99(5):2008–19.

Spiegel K, Leproult R, Van Cauter E. Impact of sleep debt on metabolic and endocrine function. Lancet. 1999 Oct 23;354(9188):1435–9.

Spiegel K, Tasali E, Penev P, Van Cauter E. Brief communication: Sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. Ann Intern Med. 2004 Dec 7;141(11):846–50.

Stamatakis KA, Brownson RC. Sleep duration and obesity-related risk factors in the rural Midwest. Prev Med. 2008 May;46(5):439–44.

St-Onge MP, McReynolds A, Trivedi ZB, Roberts AL, Sy M, Hirsch J. Sleep restriction leads to increased activation of brain regions sensitive to food stimuli. Am J Clin Nutr. 2012 Apr;95(4):818–24.

St-Onge MP, Wolfe S, Sy M, Shechter A, Hirsch J. Sleep restriction increases the neuronal response to unhealthy food in normal-weight individuals. Int J Obes (Lond). 2014 Mar;38(3):411–6.

Stranges S, Cappuccio FP, Kandala NB, Miller MA, Taggart FM, Kumari M, Ferrie JE, Shipley MJ, Brunner EJ, Marmot MG. Cross-sectional versus prospective associations of sleep duration with changes in relative weight and body fat distribution: the Whitehall II Study. Am J Epidemiol. 2008 Feb 1;167(3):321–9.

Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. PLoS Med. 2004 Dec;1(3):e62.

Tasali E, Chapotot F, Wroblewski K, Schoeller D. The effects of extended bedtimes on sleep duration and food desire in overweight young adults: a home-based intervention. Appetite. 2014 Sep;80:220–4.

Theorell-Haglöw J, Berglund L, Janson C, Lindberg E. Sleep duration and central obesity in women - differences between short sleepers and long sleepers. Sleep Med. 2012 Sep;13(8):1079–85.

Tuomilehto H, Peltonen M, Partinen M, Seppä J, Saaristo T, Korpi-Hyövälti E, Oksa H, Puolijoki H, Saltevo J, Vanhala M, Tuomilehto J. Sleep duration is associated with an increased risk for the prevalence of type 2 diabetes in middle-aged women - The FIN-D2D survey. Sleep Med. 2008 Mar;9(3):221–7.

Van Cauter E, Knutson KL. Sleep and the epidemic of obesity in children and adults. Eur J Endocrinol. 2008 Dec;159 Suppl 1:S59–66.

van den Berg JF, Knvistingh Neven A, Tulen JH, Hofman A, Witteman JC, Miedema HM, Tiemeier H. Actigraphic sleep duration and fragmentation are related to obesity in the elderly: the Rotterdam Study. Int J Obes (Lond). 2008 Jul;32(7):1083–90.

Vgontzas AN, Fernandez-Mendoza J, Miksiewicz T, Kritikou I, Shaffer ML, Liao D, Basta M, Bixler EO. Unveiling the longitudinal association between short sleep duration and the incidence of obesity: the Penn State Cohort. Int J Obes (Lond). 2014 Jun;38(6):825–32.

Vioque J, Torres A, Quiles J. Time spent watching television, sleep duration and obesity in adults living in Valencia, Spain. Int J Obes Relat Metab Disord. 2000 Dec;24(12):1683–8.

Vorona RD, Winn MP, Babineau TW, Eng BP, Feldman HR, Ware JC. Overweight and obese patients in a primary care population report less sleep than patients with a normal body mass index. Arch Intern Med. 2005 Jan 10;165(1):25–30.

Watson NF, Buchwald D, Vitiello MV, Noonan C, Goldberg J. A twin study of sleep duration and body mass index. J Clin Sleep Med. 2010 Feb 15;6(1):11–7.

Wu Y, Zhai L, Zhang D. Sleep duration and obesity among adults: a meta-analysis of prospective studies. Sleep Med. 2014 Dec;15(12):1456–62.

Xi B, He D, Zhang M, Xue J, Zhou D. Short sleep duration predicts risk of metabolic syndrome: a systematic review and meta-analysis. Sleep Med Rev. 2014 Aug;18(4):293–7.

Xiao Q, Arem H, Moore SC, Hollenbeck AR, Matthews CE. A large prospective investigation of sleep duration, weight change, and obesity in the NIH-AARP Diet and Health Study cohort. Am J Epidemiol. 2013 Dec 1;178(11):1600–10.

Xiao Q, Keadle SK, Hollenbeck AR, Matthews CE. Sleep Duration and Total and Cause-Specific Mortality in a Large US Cohort: Interrelationships With Physical Activity, Sedentary Behavior, and Body Mass Index. American Journal of Epidemiology. 2014 Oct 3;180(10):997–1006

Yaggi HK, Araujo AB, McKinlay JB. Sleep duration as a risk factor for the development of type 2 diabetes. Diabetes Care. 2006 Mar;29(3):657–61.

Yi S, Nakagawa T, Yamamoto S, Mizoue T, Takahashi Y, Noda M, Matsushita Y. Short sleep duration in association with CT-scanned abdominal fat areas: the Hitachi Health Study. Int J Obes (Lond). 2013 Jan;37(1):129–34.

Zizi F, Pandey A, Murrray-Bachmann R, Vincent M, McFarlane S, Ogedegbe G, Jean-Louis G. Race/ethnicity, sleep duration, and diabetes mellitus: analysis of the National Health Interview Survey. Am J Med. 2012 Feb;125(2):162–7.

Mental Health

Babson KA, Trainor CD, Feldner MT, Blumenthal H. A test of the effects of acute sleep deprivation on general and specific self-reported anxiety and depressive symptoms: an experimental extension. J Behav Ther Exp Psychiatry. 2010 Sep;41(3):297–303.

Bae SM, Lee YJ, Cho IH, Kim SJ, Im JS, Cho SJ. Risk factors for suicidal ideation of the general population. J Korean Med Sci. 2013 Apr;28(4):602–7.

Benito-León J, Louis ED, Bermejo-Pareja F. Cognitive decline in short and long sleepers: a prospective population-based study (NEDICES). J Psychiatr Res. 2013 Dec;47(12):1998–2003.

Chang JJ, Salas J, Habicht K, Pien GW, Stamatakis KA, Brownson RC. The association of sleep duration and depressive symptoms in rural communities of Missouri, Tennessee, and Arkansas. J Rural Health. 2012 Summer;28(3):268–76.

Chen MC, Burley HW, Gotlib IH. Reduced sleep quality in healthy girls at risk for depression. J Sleep Res. 2012 Feb;21(1):68–72.

Clark CP, Golshan S. Polysomnography and criteria for the antidepressant response to sleep deprivation. J Affect Disord. 2007 Aug;101(1–3):195–200.

Furihata R, Uchiyama M, Takahashi S, Suzuki M, Konno C, Osaki K, Konno M, Kaneita Y, Ohida T, Akahoshi T, Hashimoto S, Akashiba T. The association between sleep problems and perceived health status: a Japanese nationwide general population survey. Sleep Med. 2012 Aug;13(7):831–7.

Glozier N, Martiniuk A, Patton G, Ivers R, Li Q, Hickie I, Senserrick T, Woodward M, Norton R, Stevenson M. Short sleep duration in prevalent and persistent psychological distress in young adults: the DRIVE study. Sleep. 2010 Sep;33(9):1139–45.

Goodwin RD, Marusic A. Association between short sleep and suicidal ideation and suicide attempt among adults in the general population. Sleep. 2008 Aug;31(8):1097–101.

Gunnell D, Chang SS, Tsai MK, Tsao CK, Wen CP. Sleep and suicide: an analysis of a cohort of 394,000 Taiwanese adults. Soc Psychiatry Psychiatr Epidemiol. 2013 Sep;48(9):1457–65.

Haack M, Mullington JM. Sustained sleep restriction reduces emotional and physical well-being. Pain. 2005 Dec 15;119(1–3):56–64.

Harvey AG. Sleep and circadian functioning: critical mechanisms in the mood disorders? Annu Rev Clin Psychol. 2011;7:297–319.

Hintsanen M, Puttonen S, Smith K, Törnroos M, Jokela M, Pulkki-Råback L, Hintsa T, Merjonen P, Dwyer T, Raitakari OT, Venn A, Keltikangas-Järvinen L. Five-factor personality traits and sleep: evidence from two population-based cohort studies. Health Psychol. 2014 Oct;33(10):1214–23.

Irwin MR, Olmstead R, Carrillo C, Sadeghi N, Fitzgerald JD, Ranganath VK, Nicassio PM. Sleep loss exacerbates fatigue, depression, and pain in rheumatoid arthritis. Sleep. 2012 Apr 1;35(4):537–43.

John U, Meyer C, Rumpf HJ, Hapke U. Relationships of psychiatric disorders with sleep duration in an adult general population sample. J Psychiatr Res. 2005 Nov;39(6):577–83.

Kravitz HM, Avery E, Sowers M, Bromberger JT, Owens JF, Matthews KA, Hall M, Zheng H, Gold EB, Buysse DJ. Relationships between menopausal and mood symptoms and EEG sleep measures in a multi-ethnic sample of middle-aged women: the SWAN sleep study. Sleep. 2011 Sep 1;34(9):1221–32.

Lemola S, Räikkönen K, Gomez V, Allemand M. Optimism and self-esteem are related to sleep. Results from a large community-based sample. Int J Behav Med. 2013 Dec;20(4):567–71.

Leonard C, Fanning N, Attwood J, Buckley M. The effect of fatigue, sleep deprivation and onerous working hours on the physical and mental wellbeing of pre-registration house officers. Ir J Med Sci. 1998 Jan-Mar;167(1):22–5.

Lieberman HR, Bathalon GP, Falco CM, Kramer FM, Morgan CA 3rd, Niro P. Severe decrements in cognition function and mood induced by sleep loss, heat, dehydration, and undernutrition during simulated combat. Biol Psychiatry. 2005 Feb 15;57(4):422–9.

Luxton DD, Greenburg D, Ryan J, Niven A, Wheeler G, Mysliwiec V. Prevalence and impact of short sleep duration in redeployed OIF soldiers. Sleep. 2011 Sep 1;34(9):1189–95.

Monk TH, Buysse DJ, Welsh DK, Kennedy KS, Rose LR. A sleep diary and questionnaire study of naturally short sleepers. J Sleep Res. 2001 Sep;10(3):173–9.

Nakata A. Work hours, sleep sufficiency, and prevalence of depression among full-time employees: a community-based cross-sectional study. J Clin Psychiatry. 2011 May;72(5):605–14.

Nishikitani M, Nakao M, Karita K, Nomura K, Yano E. Influence of overtime work, sleep duration, and perceived job characteristics on the physical and mental status of software engineers. Ind Health. 2005 Oct;43(4):623–9.

Perlman CA, Johnson SL, Mellman TA. The prospective impact of sleep duration on depression and mania. Bipolar Disord. 2006 Jun;8(3):271–4.

Pilcher JJ, Huffcutt AI. Effects of sleep deprivation on performance: a meta-analysis. Sleep. 1996 May;19(4):318–26.

Rose M, Manser T, Ware JC. Effects of call on sleep and mood in internal medicine residents. Behav Sleep Med. 2008;6(2):75–88.

Ryu SY, Kim KS, Han MA. Factors associated with sleep duration in Korean adults: results of a 2008 community health survey in Gwangju metropolitan city, Korea. J Korean Med Sci. 2011 Sep;26(9):1124–31.

Schüle C, di Michele F, Baghai T, Romeo E, Bernardi G, Zwanzger P, Padberg F, Pasini A, Rupprecht R. Influence of sleep deprivation on neuroactive steroids in major depression. Neuropsychopharmacology. 2003 Mar;28(3):577–81.

Totterdell P, Reynolds S, Parkinson B, Briner RB. Associations of sleep with everyday mood, minor symptoms and social interaction experience. Sleep. 1994 Aug;17(5):466–75.

van Mill JG, Vogelzangs N, van Someren EJ, Hoogendijk WJ, Penninx BW. Sleep duration, but not insomnia, predicts the 2-year course of depressive and anxiety disorders. J Clin Psychiatry. 2014 Feb;75(2):119–26.

Wong ML, Lau EY, Wan JH, Cheung SF, Hui CH, Mok DS. The interplay between sleep and mood in predicting academic functioning, physical health and psychological health: a longitudinal study. J Psychosom Res. 2013 Apr;74(4):271–7.

Zohar D, Tzischinsky O, Epstein R, Lavie P. The effects of sleep loss on medical residents' emotional reactions to work events: a cognitive-energy model. Sleep. 2005 Jan;28(1):47–54.

Immunologic Health

Axelsson J, Rehman JU, Akerstedt T, Ekman R, Miller GE, Höglund CO, Lekander M. Effects of sustained sleep restriction on mitogen-stimulated cytokines, chemokines and T helper 1/ T helper 2 balance in humans. PLoS One. 2013 Dec 11;8(12):e82291.

Boudjeltia KZ, Faraut B, Stenuit P, Esposito MJ, Dyzma M, Brohée D, Ducobu J, Vanhaeverbeek M, Kerkhofs M. Sleep restriction increases white blood cells, mainly neutrophil count, in young healthy men: a pilot study. Vasc Health Risk Manag. 2008;4(6):1467–70.

Chiang JK. Short duration of sleep is associated with elevated high-sensitivity C-reactive protein level in Taiwanese adults: a cross-sectional study. J Clin Sleep Med. 2014 Jul 15;10(7):743–9.

Cohen S, Doyle WJ, Alper CM, Janicki-Deverts D, Turner RB. Sleep habits and susceptibility to the common cold. Arch Intern Med. 2009 Jan 12;169(1):62–7.

Faraut B, Boudjeltia KZ, Dyzma M, Rousseau A, David E, Stenuit P, Franck T, Van Antwerpen P, Vanhaeverbeek M, Kerkhofs M. Benefits of napping and an extended duration of recovery sleep on alertness and immune cells after acute sleep restriction. Brain Behav Immun. 2011 Jan;25(1):16–24.

Faraut B, Boudjeltia KZ, Vanhamme L, Kerkhofs M. Immune, inflammatory and cardiovascular consequences of sleep restriction and recovery. Sleep Med Rev. 2012 Apr;16(2):137–49.

Ferrie JE, Kivimäki M, Akbaraly TN, Singh-Manoux A, Miller MA, Gimeno D, Kumari M, Davey Smith G, Shipley MJ. Associations between change in sleep duration and inflammation: findings on C-reactive protein and interleukin 6 in the Whitehall II Study. Am J Epidemiol. 2013 Sep 15;178(6):956–61.

Fondell E, Axelsson J, Franck K, Ploner A, Lekander M, BÃ¤lter K, Gaines H. Short natural sleep is associated with higher T cell and lower NK cell activities. Brain Behav Immun. 2011 Oct;25(7):1367–75.

Grandner MA, Buxton OM, Jackson N, Sands-Lincoln M, Pandey A, Jean-Louis G. Extreme sleep durations and increased C-reactive protein: effects of sex and ethnoracial group. Sleep. 2013 May 1;36(5):769–779E.

Haack M, Sanchez E, Mullington JM. Elevated inflammatory markers in response to prolonged sleep restriction are associated with increased pain experience in healthy volunteers. Sleep. 2007 Sep;30(9):1145–52.

Irwin M, Mascovich A, Gillin JC, Willoughby R, Pike J, Smith TL. Partial sleep deprivation reduces natural killer cell activity in humans. Psychosom Med. 1994 Nov-Dec;56(6):493–8.

Irwin M, Thompson J, Miller C, Gillin JC, Ziegler M. Effects of sleep and sleep deprivation on catecholamine and interleukin-2 levels in humans: clinical implications. J Clin Endocrinol Metab. 1999 Jun;84(6):1979–85.

Irwin MR, Carrillo C, Olmstead R. Sleep loss activates cellular markers of inflammation: sex differences. Brain Behav Immun. 2010 Jan;24(1):54–7.

Irwin MR, Wang M, Campomayor CO, Collado-Hidalgo A, Cole S. Sleep deprivation and activation of morning levels of cellular and genomic markers of inflammation. Arch Intern Med. 2006 Sep 18;166(16):1756–62.

Irwin MR, Wang M, Ribeiro D, Cho HJ, Olmstead R, Breen EC, Martinez-Maza O, Cole S. Sleep loss activates cellular inflammatory signaling. Biol Psychiatry. 2008 Sep 15;64(6):538–40.

Jackowska M, Kumari M, Steptoe A. Sleep and biomarkers in the English Longitudinal Study of Ageing: associations with C-reactive protein, fibrinogen, dehydroepiandrosterone sulfate and hemoglobin. Psychoneuroendocrinology. 2013 Sep;38(9):1484–93.

Miller MA, Kandala NB, Kivimaki M, Kumari M, Brunner EJ, Lowe GD, Marmot MG, Cappuccio FP. Gender differences in the cross-sectional relationships between sleep duration and markers of inflammation: Whitehall II study. Sleep. 2009 Jul;32(7):857–64.

Patel SR, Malhotra A, Gao X, Hu FB, Neuman MI, Fawzi WW. A prospective study of sleep duration and pneumonia risk in women. Sleep. 2012 Jan 1;35(1):97–101.

Patel SR, Zhu X, Storfer-Isser A, Mehra R, Jenny NS, Tracy R, Redline S. Sleep duration and biomarkers of inflammation. Sleep. 2009 Feb;32(2):200–4.

Pejovic S, Basta M, Vgontzas AN, Kritikou I, Shaffer ML, Tsaoussoglou M, Stiffler D, Stefanakis Z, Bixler EO, Chrousos GP. Effects of recovery sleep after one work week of mild sleep restriction on interleukin-6 and cortisol secretion and daytime sleepiness and performance. Am J Physiol Endocrinol Metab. 2013 Oct 1;305(7):E890–6.

Prather AA, Hall M, Fury JM, Ross DC, Muldoon MF, Cohen S, Marsland AL. Sleep and antibody response to hepatitis B vaccination. Sleep. 2012 Aug 1;35(8):1063–9.

Prather AA, Vogelzangs N, Penninx BW. Sleep duration, insomnia, and markers of systemic inflammation: results from the Netherlands Study of Depression and Anxiety (NESDA). J Psychiatr Res. 2015 Jan;60:95–102.

Shakhar K, Valdimarsdottir HB, Guevarra JS, Bovbjerg DH. Sleep, fatigue, and NK cell activity in healthy volunteers: significant relationships revealed by within subject analyses. Brain Behav Immun. 2007 Feb;21(2):180–4.

Spiegel K, Sheridan JF, Van Cauter E. Effect of sleep deprivation on response to immunization. JAMA. 2002 Sep 25;288(12):1471–2.

Taheri S, Austin D, Lin L, Nieto FJ, Young T, Mignot E. Correlates of serum C-reactive protein (CRP)--no association with sleep duration or sleep disordered breathing. Sleep. 2007 Aug;30(8):991–6.

Taveras EM, Rifas-Shiman SL, Rich-Edwards JW, Mantzoros CS. Maternal short sleep duration is associated with increased levels of inflammatory markers at 3 years postpartum. Metabolism. 2011 Jul;60(7):982–6.

van Leeuwen WM, Lehto M, Karisola P, Lindholm H, Luukkonen R, Sallinen M, Härmä M, Porkka-Heiskanen T, Alenius H. Sleep restriction increases the risk of developing cardiovascular diseases by augmenting proinflammatory responses through IL-17 and CRP. PLoS One. 2009;4(2):e4589.

Vgontzas AN, Zoumakis E, Bixler EO, Lin HM, Follett H, Kales A, Chrousos GP. Adverse effects of modest sleep restriction on sleepiness, performance, and inflammatory cytokines. J Clin Endocrinol Metab. 2004 May;89(5):2119–26.

Wright CE, Erblich J, Valdimarsdottir HB, Bovbjerg DH. Poor sleep the night before an experimental stressor predicts reduced NK cell mobilization and slowed recovery in healthy women. Brain Behav Immun. 2007 Mar;21(3):358–63.

Human Performance

Abe T, Komada Y, Inoue Y. Short sleep duration, snoring and subjective sleep insufficiency are independent factors associated with both falling asleep and feeling sleepiness while driving. Intern Med. 2012;51(23):3253–60.

Abe T, Komada Y, Nishida Y, Hayashida K, Inoue Y. Short sleep duration and long spells of driving are associated with the occurrence of Japanese drivers' rear-end collisions and single-car accidents. J Sleep Res. 2010 Jun;19(2):310–6.

Akerstedt T, Ingre M, Kecklund G, Anund A, Sandberg D, Wahde M, Philip P, Kronberg P. Reaction of sleepiness indicators to partial sleep deprivation, time of day and time on task in a driving simulator--the DROWSI project. J Sleep Res. 2010 Jun;19(2):298–309.

Banks S, Dinges DF. Behavioral and physiological consequences of sleep restriction. J Clin Sleep Med. 2007 Aug 15;3(5):519–28. Review.

Carter N, Ulfberg J, Nyström B, Edling C. Sleep debt, sleepiness and accidents among males in the general population and male professional drivers. Accid Anal Prev. 2003 Jul;35(4):613–7.

Centers for Disease Control and Prevention (CDC). Drowsy driving - 19 states and the District of Columbia, 2009-2010. MMWR Morb Mortal Wkly Rep. 2013 Jan 4;61(51–52):1033–7.

Elmenhorst D, Elmenhorst EM, Luks N, Maass H, Mueller EW, Vejvoda M, Wenzel J, Samel A. Performance impairment during four days partial sleep deprivation compared with the acute effects of alcohol and hypoxia. Sleep Med. 2009 Feb;10(2):189–97.

Fairclough SH, Graham R. Impairment of driving performance caused by sleep deprivation or alcohol: a comparative study. Hum Factors. 1999 Mar;41(1):118–28.

Leechawengwongs M, Leechawengwongs E, Sukying C, Udomsubpayakul U. Role of drowsy driving in traffic accidents: a questionnaire survey of Thai commercial bus/truck drivers. J Med Assoc Thai. 2006 Nov;89(11):1845–50.

Maia Q, Grandner MA, Findley J, Gurubhagavatula I. Short and long sleep duration and risk of drowsy driving and the role of subjective sleep insufficiency. Accid Anal Prev. 2013 Oct;59:618–22.

Marcus CL, Loughlin GM. Effect of sleep deprivation on driving safety in housestaff. Sleep. 1996 Dec;19(10):763–6.

Martiniuk AL, Senserrick T, Lo S, Williamson A, Du W, Grunstein RR, Woodward M, Glozier N, Stevenson M, Norton R, Ivers RQ. Sleep-deprived young drivers and the risk for crash: the DRIVE prospective cohort study. JAMA Pediatr. 2013 Jul;167(7):647–55.

Miyata S, Noda A, Ozaki N, Hara Y, Minoshima M, Iwamoto K, Takahashi M, Iidaka T, Koike Y. Insufficient sleep impairs driving performance and cognitive function. Neurosci Lett. 2010 Jan 22;469(2):229–33.

Pack AI, Maislin G, Staley B, Pack FM, Rogers WC, George CF, Dinges DF. Impaired performance in commercial drivers: role of sleep apnea and short sleep duration. Am J Respir Crit Care Med. 2006 Aug 15;174(4):446–54.

Philip P, Sagaspe P, Moore N, Taillard J, Charles A, Guilleminault C, Bioulac B. Fatigue, sleep restriction and driving performance. Accid Anal Prev. 2005 May;37(3):473–8.

Philip P, Sagaspe P, Taillard J, Valtat C, Moore N, Akerstedt T, Charles A, Bioulac B. Fatigue, sleepiness, and performance in simulated versus real driving conditions. Sleep. 2005 Dec;28(12):1511–6.

Rupp T, Arnedt JT, Acebo C, Carskadon MA. Performance on a dual driving simulation and subtraction task following sleep restriction. Percept Mot Skills. 2004 Dec;99(3 Pt 1):739–53.

Russo M, Thomas M, Thorne D, Sing H, Redmond D, Rowland L, Johnson D, Hall S, Krichmar J, Balkin T. Oculomotor impairment during chronic partial sleep deprivation. Clin Neurophysiol. 2003 Apr;114(4):723–36.

Scott LD, Hwang WT, Rogers AE, Nysse T, Dean GE, Dinges DF. The relationship between nurse work schedules, sleep duration, and drowsy driving. Sleep. 2007 Dec;30(12):1801–7.

Taylor DJ, Bramoweth AD. Patterns and consequences of inadequate sleep in college students: substance use and motor vehicle accidents. J Adolesc Health. 2010 Jun;46(6):610–2.

Cancer

Bellavia A, Âkerstedt T, Bottai M, Wolk A, Orsini N. Sleep duration and survival percentiles across categories of physical activity. Am J Epidemiol. 2014 Feb 15;179(4):484–91.

Forsythe LP, Helzlsouer KJ, MacDonald R, Gallicchio L. Daytime sleepiness and sleep duration in long-term cancer survivors and non-cancer controls: results from a registry-based survey study. Support Care Cancer. 2012 Oct;20(10):2425–32.

Girschik J, Heyworth J, Fritschi L. Self-reported sleep duration, sleep quality, and breast cancer risk in a population-based case-control study. Am J Epidemiol. 2013 Feb 15;177(4):316–27.

Ikehara S, Iso H, Date C, Kikuchi S, Watanabe Y, Wada Y, Inaba Y, Tamakoshi A; JACC Study Group. Association of sleep duration with mortality from cardiovascular disease and other causes for Japanese men and women: the JACC study. Sleep. 2009 Mar;32(3):295–301.

Jiao L, Duan Z, Sangi-Haghpeykar H, Hale L, White DL, El-Serag HB. Sleep duration and incidence of colorectal cancer in postmenopausal women. Br J Cancer. 2013 Jan 15;108(1):213–21.

Kakizaki M, Kuriyama S, Sone T, Ohmori-Matsuda K, Hozawa A, Nakaya N, Fukudo S, Tsuji I. Sleep duration and the risk of breast cancer: the Ohsaki Cohort Study. Br J Cancer. 2008 Nov 4;99(9):1502–5.

McElroy JA, Newcomb PA, Titus-Ernstoff L, Trentham-Dietz A, Hampton JM, Egan KM. Duration of sleep and breast cancer risk in a large population-based case-control study. J Sleep Res. 2006 Sep;15(3):241–9.

Pinheiro SP, Schernhammer ES, Tworoger SS, Michels KB. A prospective study on habitual duration of sleep and incidence of breast cancer in a large cohort of women. Cancer Res. 2006 May 15;66(10):5521–5.

Thompson CL, Larkin EK, Patel S, Berger NA, Redline S, Li L. Short duration of sleep increases risk of colorectal adenoma. Cancer. 2011 Feb 15;117(4):841–7.

Thompson CL, Li L. Association of sleep duration and breast cancer OncotypeDX recurrence score. Breast Cancer Res Treat. 2012 Aug;134(3):1291–5.

Verkasalo PK, Lillberg K, Stevens RG, Hublin C, Partinen M, Koskenvuo M, Kaprio J. Sleep duration and breast cancer: a prospective cohort study. Cancer Res. 2005 Oct 15;65(20):9595–600.

Vogtmann E, Levitan EB, Hale L, Shikany JM, Shah NA, Endeshaw Y, Lewis CE, Manson JE, Chlebowski RT. Association between sleep and breast cancer incidence among postmenopausal women in the Women's Health Initiative. Sleep. 2013 Oct 1;36(10):1437–44.

Weiderpass E, Sandin S, Inoue M, Shimazu T, Iwasaki M, Sasazuki S, Sawada N, Yamaji T, Tsugane S. Risk factors for epithelial ovarian cancer in Japan - results from the Japan Public Health Center-based Prospective Study cohort. Int J Oncol. 2012 Jan;40(1):21–30.

Wu AH, Stanczyk FZ, Wang R, Koh WP, Yuan JM, Yu MC. Sleep duration, spot urinary 6-sulfatoxymelatonin levels and risk of breast cancer among Chinese women in Singapore. Int J Cancer. 2013 Feb 15;132(4):891–6.

Wu AH, Wang R, Koh WP, Stanczyk FZ, Lee HP, Yu MC. Sleep duration, melatonin and breast cancer among Chinese women in Singapore. Carcinogenesis. 2008 Jun;29(6):1244–8.

Xiao Q, Keadle SK, Hollenbeck AR, Matthews CE. Sleep Duration and Total and Cause-Specific Mortality in a Large US Cohort: Interrelationships With Physical Activity, Sedentary Behavior, and Body Mass Index. American Journal of Epidemiology. 2014 Oct 3;180(10):997–1006

Yeo Y, Ma SH, Park SK, Chang SH, Shin HR, Kang D, Yoo KY. A prospective cohort study on the relationship of sleep duration with all-cause and disease-specific mortality in the Korean Multi-center Cancer Cohort study. J Prev Med Public Health. 2013 Sep;46(5):271–81.

Zhang X, Giovannucci EL, Wu K, Gao X, Hu F, Ogino S, Schernhammer ES, Fuchs CS, Redline S, Willett WC, Ma J. Associations of self-reported sleep duration and snoring with colorectal cancer risk in men and women. Sleep. 2013 May 1;36(5):681–8.

Pain

Andrews NE, Strong J, Meredith PJ, D'Arrigo RG. Association between physical activity and sleep in adults with chronic pain: a momentary, within-person perspective. Phys Ther. 2014 Apr;94(4):499–510.

Buxton OM, Hopcia K, Sembajwe G, Porter JH, Dennerlein JT, Kenwood C, Stoddard AM, Hashimoto D, Sorensen G. Relationship of sleep deficiency to perceived pain and functional limitations in hospital patient care workers. J Occup Environ Med. 2012 Jul;54(7):851–8.

Edwards RR, Almeida DM, Klick B, Haythornthwaite JA, Smith MT. Duration of sleep contributes to next-day pain report in the general population. Pain. 2008 Jul;137(1):202–7.

Haack M, Lee E, Cohen DA, Mullington JM. Activation of the prostaglandin system in response to sleep loss in healthy humans: potential mediator of increased spontaneous pain. Pain. 2009 Sep;145(1–2):136–41.

Haack M, Mullington JM. Sustained sleep restriction reduces emotional and physical well-being. Pain. 2005 Dec 15;119(1–3):56–64.

Haack M, Sanchez E, Mullington JM. Elevated inflammatory markers in response to prolonged sleep restriction are associated with increased pain experience in healthy volunteers. Sleep. 2007 Sep;30(9):1145–52.

Hamilton NA, Catley D, Karlson C. Sleep and the affective response to stress and pain. Health Psychol. 2007 May;26(3):288–95.

Houle TT, Butschek RA, Turner DP, Smitherman TA, Rains JC, Penzien DB. Stress and sleep duration predict headache severity in chronic headache sufferers. Pain. 2012 Dec;153(12):2432–40.

Roehrs TA, Harris E, Randall S, Roth T. Pain sensitivity and recovery from mild chronic sleep loss. Sleep. 2012 Dec 1;35(12):1667–72.

Schestatsky P, Dall-Agnol L, Gheller L, Stefani LC, Sanches PR, de Souza IC, Torres IL, Caumo W. Pain-autonomic interaction after work-induced sleep restriction. Eur J Neurol. 2013 Apr;20(4):638–46.

Smith MT, Edwards RR, McCann UD, Haythornthwaite JA. The effects of sleep deprivation on pain inhibition and spontaneous pain in women. Sleep. 2007 Apr;30(4):494–505.

Tiede W, Magerl W, Baumgärtner U, Durrer B, Ehlert U, Treede RD. Sleep restriction attenuates amplitudes and attentional modulation of pain-related evoked potentials, but augments pain ratings in healthy volunteers. Pain. 2010 Jan;148(1):36–42.

Mortality

Amagai Y, Ishikawa S, Gotoh T, Doi Y, Kayaba K, Nakamura Y, Kajii E. Sleep duration and mortality in Japan: the Jichi Medical School Cohort Study. J Epidemiol. 2004 Jul;14(4):124–8.

Azevedo Da Silva M, Singh-Manoux A, Shipley MJ, Vahtera J, Brunner EJ, Ferrie JE, Kivimäki M, Nabi H. Sleep duration and sleep disturbances partly explain the association between depressive symptoms and cardiovascular mortality: the Whitehall II cohort study. J Sleep Res. 2014 Feb;23(1):94–7.

Bellavia A, Âkerstedt T, Bottai M, Wolk A, Orsini N. Sleep duration and survival percentiles across categories of physical activity. Am J Epidemiol. 2014 Feb 15;179(4):484–91.

Burazeri G, Gofin J, Kark JD. Over 8 hours of sleep--marker of increased mortality in Mediterranean population: follow-up population study. Croat Med J. 2003 Apr;44(2):193–8.

Cappuccio FP, D'Elia L, Strazzullo P, Miller MA. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. Sleep. 2010 May;33(5):585–92.

Castro-Costa E, Dewey ME, Ferri CP, Uchôa E, Firmo JO, Rocha FL, Prince M, Lima-Costa MF, Stewart R. Association between sleep duration and all-cause mortality in old age: 9-year follow-up of the Bambuí Cohort Study, Brazil. J Sleep Res. 2011 Jun;20(2):303–10.

Chen HC, Su TP, Chou P. A nine-year follow-up study of sleep patterns and mortality in community-dwelling older adults in Taiwan. Sleep. 2013 Aug 1;36(8):1187–98.

Chien KL, Chen PC, Hsu HC, Su TC, Sung FC, Chen MF, Lee YT. Habitual sleep duration and insomnia and the risk of cardiovascular events and all-cause death: report from a community-based cohort. Sleep. 2010 Feb;33(2):177–84.

Cohen-Mansfield J, Perach R. Sleep duration, nap habits, and mortality in older persons. Sleep. 2012 Jul 1;35(7):1003–9.

Gallicchio L, Kalesan B. Sleep duration and mortality: a systematic review and meta-analysis. J Sleep Res. 2009 Jun;18(2):148–58.

Gangwisch JE, Heymsfield SB, Boden-Albala B, Buijs RM, Kreier F, Opler MG, Pickering TG, Rundle AG, Zammit GK, Malaspina D. Sleep duration associated with mortality in elderly, but not middle-aged, adults in a large US sample. Sleep. 2008 Aug;31(8):1087–96.

Grandner MA, Hale L, Moore M, Patel NP. Mortality associated with short sleep duration: The evidence, the possible mechanisms, and the future. Sleep Med Rev. 2010 Jun;14(3):191–203.

Hublin C, Partinen M, Koskenvuo M, Kaprio J. Sleep and mortality: a population-based 22-year follow-up study. Sleep. 2007 Oct;30(10):1245–53.

Ikehara S, Iso H, Date C, Kikuchi S, Watanabe Y, Wada Y, Inaba Y, Tamakoshi A; JACC Study Group. Association of sleep duration with mortality from cardiovascular disease and other causes for Japanese men and women: the JACC study. Sleep. 2009 Mar;32(3):295–301.

Jung KI, Song CH, Ancoli-Israel S, Barrett-Connor E. Gender differences in nighttime sleep and daytime napping as predictors of mortality in older adults: the Rancho Bernardo study. Sleep Med. 2013 Jan;14(1):12–9.

Kakizaki M, Kuriyama S, Nakaya N, Sone T, Nagai M, Sugawara Y, Hozawa A, Fukudo S, Tsuji I. Long sleep duration and cause-specific mortality according to physical function and self-rated health: the Ohsaki Cohort Study. J Sleep Res. 2013 Apr;22(2):209–16.

Kim Y, Wilkens LR, Schembre SM, Henderson BE, Kolonel LN, Goodman MT. Insufficient and excessive amounts of sleep increase the risk of premature death from cardiovascular and other diseases: the Multiethnic Cohort Study. Prev Med. 2013 Oct;57(4):377–85.

Kojima M, Wakai K, Kawamura T, Tamakoshi A, Aoki R, Lin Y, Nakayama T, Horibe H, Aoki N, Ohno Y. Sleep patterns and total mortality: a 12-year follow-up study in Japan. J Epidemiol. 2000 Mar;10(2):87–93.

Kripke DF, Garfinkel L, Wingard DL, Klauber MR, Marler MR. Mortality associated with sleep duration and insomnia. Arch Gen Psychiatry. 2002 Feb;59(2):131–6.

Kripke DF, Langer RD, Elliott JA, Klauber MR, Rex KM. Mortality related to actigraphic long and short sleep. Sleep Med. 2011 Jan;12(1):28–33.

Kronholm E, Laatikainen T, Peltonen M, Sippola R, Partonen T. Self-reported sleep duration, all-cause mortality, cardiovascular mortality and morbidity in Finland. Sleep Med. 2011 Mar;12(3):215–21.

Krueger PM, Saint Onge JM, Chang VW. Race/ethnic differences in adult mortality: the role of perceived stress and health behaviors. Soc Sci Med. 2011 Nov;73(9):1312–22.

Lan TY, Lan TH, Wen CP, Lin YH, Chuang YL. Nighttime sleep, Chinese afternoon nap, and mortality in the elderly. Sleep. 2007 Sep;30(9):1105–10.

Li Y, Sato Y, Yamaguchi N. Potential biochemical pathways for the relationship between sleep duration and mortality. Sleep Med. 2013 Jan;14(1):98–104.

Magee CA, Holliday EG, Attia J, Kritharides L, Banks E. Investigation of the relationship between sleep duration, all-cause mortality, and preexisting disease. Sleep Med. 2013 Jul;14(7):591–6.

Mesas AE, López-García E, León-Muñoz LM, Guallar-Castillón P, Rodríguez-Artalejo F. Sleep duration and mortality according to health status in older adults. J Am Geriatr Soc. 2010 Oct;58(10):1870–7.

Patel SR, Malhotra A, Gottlieb DJ, White DP, Hu FB. Correlates of long sleep duration. Sleep. 2006 Jul;29(7):881–9.

Qiu L, Sautter J, Liu Y, Gu D. Age and gender differences in linkages of sleep with subsequent mortality and health among very old Chinese. Sleep Med. 2011 Dec;12(10):1008–17.

Reinhard W, Plappert N, Zeman F, Hengstenberg C, Riegger G, Novack V, Maimon N, Pfeifer M, Arzt M. Prognostic impact of sleep duration and sleep efficiency on mortality in patients with chronic heart failure. Sleep Med. 2013 Jun;14(6):502–9.

Suzuki E, Yorifuji T, Ueshima K, Takao S, Sugiyama M, Ohta T, Ishikawa-Takata K, Doi H. Sleep duration, sleep quality and cardiovascular disease mortality among the elderly: a population-based cohort study. Prev Med. 2009 Aug-Sep;49(2–3):135–41.

Tamakoshi A, Ohno Y; JACC Study Group. Self-reported sleep duration as a predictor of all-cause mortality: results from the JACC study, Japan. Sleep. 2004 Feb 1;27(1):51–4.

Xiao Q, Keadle SK, Hollenbeck AR, Matthews CE. Sleep Duration and Total and Cause-Specific Mortality in a Large US Cohort: Interrelationships With Physical Activity, Sedentary Behavior, and Body Mass Index. American Journal of Epidemiology. 2014 Oct 3;180(10):997–1006

Yeo Y, Ma SH, Park SK, Chang SH, Shin HR, Kang D, Yoo KY. A prospective cohort study on the relationship of sleep duration with all-cause and disease-specific mortality in the Korean Multi-center Cancer Cohort study. J Prev Med Public Health. 2013 Sep;46(5):271–81.