Chapter 2

Epidemiology of insufficient sleep and poor sleep quality

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SLEEP AT THE POPULATION LEVEL

Sleep is a universal human phenomenon and impacts every person, every day (whether or not they actually get to sleep). For this reason, population-level estimates of sleep are important. However, they may be difficult to obtain. Since an individual is unconscious while they are sleeping (and for the time surrounding sleep onset and awakening), accurate assessment of the population burden of sleep disturbance may be difficult. Methods typically exist on a continuum whereby increased generalizability is compromised by reduced precision. For example, most population-level estimates are based on a retrospective self-report, which lacks precision. More precise measures, such as polysomnography and even actigraphy, have been thus far impractical for truly large and population-level assessments. Still, several tentative conclusions about the population can be drawn regarding sleep health.

DEFINING INSUFFICIENT SLEEP

There has been a general lack of consensus on the definition of what constitutes "insufficient sleep" in the general population since at least 1964 [1], when Hammond published the finding that habitual short and long sleep duration were associated with increased mortality rates. Since that time, there has been considerable debate regarding how sleep insufficiency should be defined. Laboratory studies where sleep is manipulated in an experimental protocol are preferred by some (because of their precision) and population-based studies where individuals are observed relative to habitual sleep behaviors are preferred by others (because of their generalizability).

Regarding the former, information about the physiologic and health consequences of sleep duration often come from studies that employ *total sleep deprivation* (defined as an experimental manipulation where an individual is kept awake for at least an entire sleep period) and *partial sleep deprivation* (defined as an experimental manipulation where an individual's sleep period is restricted over a period of days). This is also sometimes called *sleep restriction*. Sometimes, partial sleep deprivation can be characterized as *chronic partial sleep deprivation* (defined as partial sleep deprivation over a period of weeks). All of these experimental manipulations can be useful to discern physiologic effects of changes in sleep duration, but they are generally poor approximations of real-world sleep. As such, *total sleep deprivation, partial sleep deprivation/sleep restriction, and chronic partial sleep deprivation* sacrifice generalizability for precision [2–4].

Other studies use population-based studies of sleep. These studies can characterize *habitual sleep duration* (defined as typical perceived sleep duration experienced in real-world settings), often categorized as *short sleep duration, normal/normative sleep duration,* and *long sleep duration* based on cutoffs that often vary by study. These studies may also model *sleep loss* (reduction in sleep duration over time). They may also capture aspects of sleep continuity, including *total sleep time* (calculated sleep duration based on time in bed, subtracting sleep latency and wake time after sleep onset). These parameters may be assessed retrospectively (e.g., through surveys and questionnaires) or prospectively; prospective assessments can be subjective (e.g., sleep diary) or objective (e.g., actigraphy). These studies often sacrifice precision for generalizability [2–4].

But what is "insufficient sleep?" Often, terms such as *sleep deprivation*, *sleep loss*, *short sleep*, and others are used interchangeably. Also, "insufficient sleep" is sometimes used interchangeably with concepts such as *sleep deficiency* (insufficient sleep duration or inadequate sleep quality), *poor sleep quality*, and even *insomnia* despite these concepts being misapplied to insufficient sleep [2–4].

With this in mind, defining insufficient sleep has been problematic, since all of these concepts have appropriated the label of "insufficient sleep." For the purposes of

Sleep and Health. https://doi.org/10.1016/B978-0-12-815373-4.00002-2

this chapter, "insufficient sleep" will refer to sleep duration that is likely too brief to meet physiologic needs. Also, this chapter focuses on habitual sleep duration in the population and thus experimental terms such as *sleep deprivation* are not appropriate. Even at the population level, there is disagreement regarding how much sleep is "insufficient." Various studies use cutoffs of 4, 5, 6, or 7 h as representing insufficient sleep.

Recently, a consensus panel was convened by the American Academy of Sleep Medicine and Sleep Research Society to determine the recommended amount of sleep for a healthy adult. This panel recommended that 7 or more hours was recommended [5, 6]. In a follow-up manuscript, the panel members discussed in detail how this was reached, pointing out that the consensus was most clear that 6 h or less was likely insufficient and less clear for sleep durations between 6 and 7 h [5, 6]. This finding was echoed in similar consensus statements issues by the National Sleep Foundation [7, 8], the American Thoracic Society [9], and the American Heart Association [10]. Therefore, for the purposes of this chapter, "insufficient sleep" will generally refer to habitual sleep duration of 6 h or less.

PREVALENCE OF INSUFFICIENT SLEEP

In order to estimate the prevalence of insufficient sleep in the population, data sources that assess habitual sleep duration in large samples that are representative of the general population. Existing work in this area is limited, as most studies that investigate sleep in such samples do so without using well-validated assessments of sleep. It is important to note that most population estimates of habitual sleep duration are based on subjective, retrospective self-report, which presents biases in assessing sleep [11, 12]. These estimates may better reflect time in bed than actual physiologic sleep and should be interpreted with appropriate caution.

Insufficient sleep in the population

Estimates of the prevalence of insufficient sleep have used the Behavioral Risk Factor Surveillance System (BRFSS) in the United States. The BRFSS is an annual telephone survey of hundreds of thousands of US adults, conducted by the Centers for Disease Control and Prevention (CDC) (http://www.cdc.gov/brfss). It is state-based, with population-weighted samples representing each strata of age, sex, race/ethnicity, and geographic region. Sleep duration in the BRFSS is assessed with the item, "On average, how many hours of sleep do you get in a 24-h period?" Responses are coded in whole numbers. Liu and colleagues reported population-weighted prevalence estimates for sleep duration around a cutoff of 7 h (based on the consensus statement [13] from the 2014 BRFSS (N=444,306). Overall, the age-adjusted estimated prevalence of insufficient sleep (≤6 h) was reported to be 35.1% of the US population. Grandner and colleagues [14] reported prevalence estimates also using the 2014 BRFSS. Estimated prevalence by hour was calculated, such that the estimated prevalence by hour of sleep duration was 1.12% for ≤3 h, 3.19% for 4 h, 7.75% for 5 h, 23.55% for 6 h, 28.72% for 7 h, 27.64% for 8 h, 4.42% for 9 h, 2.35% for 10 h, and 1.27% for ≥11 h. See Fig. 2.1 for a graphical representation of these data.

Other prevalence estimates have also been calculated using the National Health and Nutrition Examination Survey (NHANES). The NHANES is a survey that is also conducted by the CDC that includes a nationally-representative

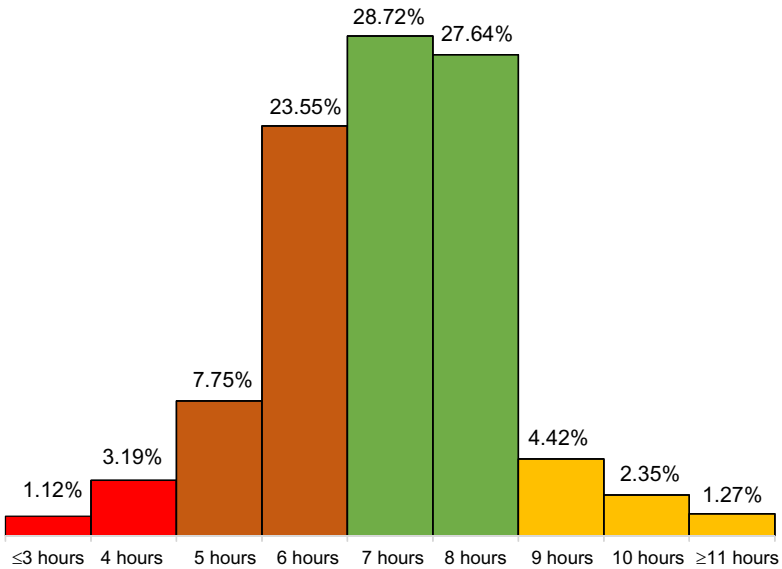

FIG. 2.1 Distribution of sleep duration in the US Population using 2014 BRFSS. *Data from Grandner MA, Seixas A, Shetty S, Shenoy S. Sleep duration and diabetes risk: population trends and potential mechanisms. Curr Diab Rep 2016;16(11):106. PubMed PMID: 27664039.*

sample (http://www.cdc.gov/nchs/nhanes). The sample size is much smaller than the BRFSS, though reliability of data may be improved since surveys were administered in person rather than over the phone. Similar to the BRFSS, NHANES assesses sleep duration by whole number hour (no partial hours). Unlike the BRFSS, though, NHANES assesses sleep duration with the item, "How much sleep do you usually get at night on weekdays or workdays?" Thus, this item may capture modal nighttime sleep, rather than 24-h sleep, which may include naps. Using the 2007–2008 wave of NHANES, Grandner and colleagues calculated prevalence estimates for sleep duration by category, with 4.96% reporting ≤4 h, 32.16% reporting 5–6 h, 55.68% reporting 7–8 h, and 7.20% reporting ≥9 h [15]. Thus, insufficient sleep (≤6 h) was reported by 37.12% of the US population. The higher estimate relative to BRFSS may be explained by the wording of the item, which does not include naps or weekends. See Fig. 2.1 for an illustration of these values.

Lower estimates of short sleep duration are reported by Basner and colleagues using data from the American Time Use Survey (ATUS) [16]. The ATUS is conducted annually by the US Bureau of Labor Statistics and assigns activity codes to each 15-min increment of the 24-h day in a representative sample of US adults (http://www.bls.gov/tus). Because ATUS does not distinguish time in bed from time asleep, values will generally overestimate sleep and understate insufficient sleep [16]. Using ATUS from 2003 to 2011 (N = 124,517), the estimated prevalence of insufficient sleep (≤6 h) was 10.6%, compared to 78.4% for 6–11 h and 11.0% for ≥11 h.

Thus, estimates for insufficient sleep (≤6 h) from relatively recent, nationally representative surveys, are 10.6% from ATUS, 35.1% from BRFSS, and 37.12% from NHANES. These may vary as a result of the survey item asked, as well as other factors including the years included and sampling methodologies. Although other studies have examined large samples using more well-validated measures, none of these studies are nationally-representative and thus cannot be used to develop population prevalence estimates.

Rather than assess insufficient sleep relative to a benchmark (sleep hours), an alternative approach would be to ask individuals how often they perceive their sleep to be insufficient. The 2008 BRFSS asked, "During the past 30 days, for about how many days have you felt that you did not get enough rest or sleep?" Based on this variable, Mcknight-Eily and colleagues [17] reported prevalence estimates based on responses to this variable. They estimate that 30.7% of the population reports 0/30 days of insufficient sleep, with 1–13 days reported by 41.3% of the population, 14–29 days reported by 16.8% of the population, and 30/30 days reported by 11.1% of the population. Based on these estimates, 27.9% of the US population reports perceived sleep insufficiency at least 2 weeks out of the month. Interestingly, this estimate is similar to the ~1/3 of the population who experience insufficient sleep based on sleep duration, though the overlap between these groups is only moderate [18].

Insufficient sleep by age

Based on BRFSS data, Liu and colleagues [19] provided age-based prevalence estimates for insufficient sleep (≤6 h). They reported estimated of 32.2% for those age 18–24, 37.9% for 25–34, 38.3% for 35–44, 37.3% for 45–64, and 26.3% for those 65 or older (see Fig. 2.2). Of note, the lowest rate of insufficient sleep was seen among the oldest adults. This is consistent with other studies that showed that perceived insufficient sleep declines with age [20], as does self-reported sleep disturbance [21–23]. This is in contrast to more objective sleep disturbances, which are well-characterized to increase in older adults [24–26]. There are a number of potential reasons for this, including retirement offering greater sleep opportunity and differing expectations regarding sleep [27].

Similar prevalence estimates of sleep duration by age in NHANES were reported by Grandner and colleagues [15]. Among teenagers aged 16–17, prevalence of sleep duration was 0.63% for ≤4 h, 19.38% for 5–6 h, 62.47% for 7–8 h, and 17.52% for ≥9 h. For younger adults aged 18–30, prevalence was 4.83% for ≤4 h, 31.02% for 5–6 h, 54.44% for 7–8 h, and 9.81% for ≥9 h. For adults aged 30–50, prevalence was 5.86% for ≤4 h, 33.61% for 5–6 h, 55.49% for 7–8 h, and 5.03% for ≥9 h. For adults aged 50–65, prevalence was 4.95% for ≤4 h, 35.41% for 5–6 h, 56.04% for 7–8 h, and 3.61% for ≥9 h. For older adults 65 and older, prevalence was 4.17% for ≤4 h, 28.31% for 5–6 h, 55.58% for 7–8 h, and 11.94% for ≥9 h. Thus, prevalence of insufficient sleep (≤6 h) was reported to be 20.01% for those aged 16–17, 35.85% for those aged 18–30, 39.47% for adults 30–50, 40.36% for adults age 50–65, and 32.48% for older adults over 65. Again, prevalence of insufficient sleep is highest in working age adults.

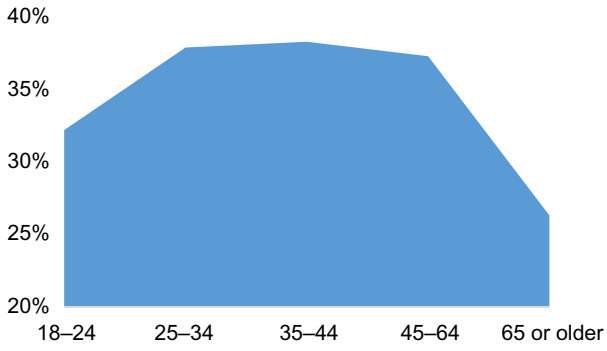

FIG. 2.2 Insufficient sleep (6 h or less) by age.

Using the ATUS data, Basner and colleagues [16] found that, compared to 15–24 year olds, increased likelihood of insufficient sleep (≤6 h) was seen in those aged 25–34 (OR = 1.38; 95% CI = 1.18;1.61), 35–44 (OR = 1.40; 95% CI = 1.22;1.62), 45–54 (OR = 1.68; 95% CI = 1.44;1.94), and 55–64 (OR = 1.41; 95% CI = 1.18;1.68), but not those 65 or older. Similarly, shortest sleep durations were seen in working age adults.

Using self-reported insufficiency from the BRFSS, Mcknight-Eily and colleagues [17] report that the prevalence of self-reported insufficient sleep at least 14 of the past 30 days was reported by 31.3% of 18–24 year olds. Estimated prevalence was 34.2% for 35–34 year olds, 32.1% for 35–44 year olds, 27.2% for 45–64 year olds, and 15.0% for those 65 or older.

Insufficient sleep by sex

Several studies have examined sex relative to insufficient sleep. Liu and colleagues reports that based on the 2014 BRFSS data, insufficient sleep (≤6 h) is reported by 35.4% of men and 34.8% of women [19]. Using data from the 2007–2008 NHANES, Whinnery and colleagues report no sex differences in likelihood of insufficient sleep (though they report that women are 35% less likely to report long sleep duration after adjusting for covariates) [28]. Using NHIS data, Krueger and Friedman report that men are 7% less likely to report ≤5 vs 7 h of sleep [29]. Basner and colleagues report that men are more likely to report insufficient sleep (OR = 1.27; 95% CI = 1.20; 1.35) [16]. McKnight-Eily reports that self-reported insufficient sleep at least 14 out of the past 30 days was reported by 25.5% of men and 30.4% of women [17]. Taken together, sex differences in insufficient sleep are likely small and difficult to observe. This is in contrast to self-reported sleep disturbances, which are much more prevalent in women [30–32].

Insufficient sleep by race/ethnicity

Many studies have documented differences in sleep duration by race/ethnicity. In general, racial/ethnic minorities are more likely to experience insufficient sleep duration. Actigraphic studies have shown that racial/ethnic minorities demonstrate a sleep duration between 40 and 60 min less than non-Hispanic White counterparts [33–35].

More data are available from survey studies that included larger numbers of people but lack the precision of objective measurements. For example, data from the NHIS has shown that sleep duration of 6 h or less was more prevalent among Blacks/African-Americans, non-Mexican Hispanics/Latinos, and Asians/Others, compared to non-Hispanic Whites [36, 37]. Longitudinal analysis of NHIS data suggests that Black-White differences in insufficient sleep have persisted, relatively unchanged since 1977 [38, 39]. See Fig. 2.3 for an illustration of this.

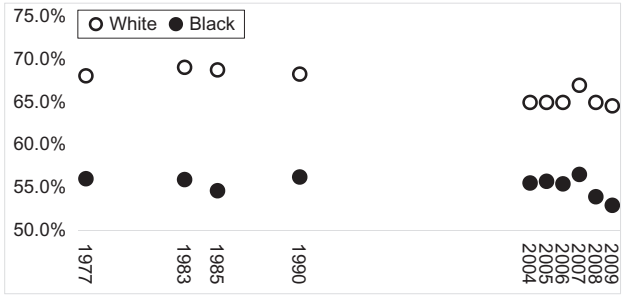

FIG. 2.3 Black-white differences in 7–8 h sleep in the US Population in NHIS. *Data from Jean-Louis G, Grandner MA, Youngstedt SD, Williams NJ, Zizi F, Sarpong DF, Ogedegbe GG. Differential increase in prevalence estimates of inadequate sleep among black and white Americans. BMC Public Health 2015;15:1185. PubMed PMID: 26611643; PMCID: PMC4661980; Jean-Louis G, Youngstedt S, Grandner M, Williams NJ, Sarpong D, Zizi F, Ogedegbe G. Unequal burden of sleep-related obesity among black and white Americans. Sleep Health. 2015;1(3):169–176. PubMed PMID: 26937487; PMCID: PMC4770938.*

Other population-level studies have found similar patterns. For example, Stamatakis showed in the Alameda County study that African-Americans were about twice as likely to report short sleep duration [40]. Using NHANES data, Whinnery and colleagues showed that Blacks/African-Americans are about 2.5 times as likely to sleep <5 h and about twice as likely to sleep 5–6 h, compared to non-Hispanic Whites. Non-Mexican Hispanics/Latinos were about 2.7 times as likely to sleep <5 h and Asians/Others were about four times as likely to sleep <5 h and about twice as likely to sleep 5–6 h. Mexican-Americans were the only minority group not more likely to report insufficient sleep [28].

Insufficient sleep by socioeconomic status

Perhaps due to environmental stressors, those of lower socioeconomic status are more likely to experience insufficient sleep. Kruger and Friedman used NHIS data to compute mean family income according to sleep duration [29]. They found that the highest mean income was reported among 7-h sleepers ($48,065), with the lowest income levels in those sleeping 5 h or less ($36,819) or 9 h or more ($34,883). Stamatakis evaluated likelihood of insufficient sleep relative to income quintile [40]. This study reported that compared to the highest income quintile, short sleep duration (6 h or less) was increasingly reported in the fourth (3% more likely), third (11% more likely), second (29% more likely), and first quintile (54% more likely). Using BRFSS data, days of perceived insufficient sleep decreased at higher levels of household income [20].

Using NHANES data, Whinnery and colleagues examined several socioeconomic indices relative to sleep duration [28]. Compared to those with family income over $75,000, increased likelihood of <5 h of sleep ($P < 0.05$) was observed for all categories, including <$20,000 (OR = 5.5), $20,000–$25,000 (OR = 2.9), $25,000–$35,000 (OR = 4.1),

$35,000–$45,000 (OR = 2.4), $45,000–$55,000 (OR = 2.8), $55,000–$65,000 (OR = 2.4), and even $65,000–$75,000 (OR = 3.8). Increased likelihood of 5–6 h sleep relative to those earning over $75,000 was only seen in the lowest income group earning <$20,000 (OR = 1.3). Education level was another socioeconomic indicator that was associated with sleep duration in this sample. Those with less than a high school education were approximately four times as likely to report <5 h of sleep, compared to college graduates. Similarly, those who completed some high school were more likely than college graduates to report <5 (OR = 5.3) and 5–6 (OR = 1.7) hours of sleep, those who completed high school were more likely than college graduates to report <5 (OR = 4.3) or 5–6 (OR = 1.6) hours, and those with some college were also more likely than college graduates to report <5 (OR = 3.6) or 5–6 (OR = 1.6) hours of sleep [28]. Another socioeconomic indicator evaluated in this study was lack of access to healthcare, which was more common among those reporting <5 h of sleep. Food insecurity—a measure of inability to financially provide healthy access to enough food—was also more common among those reporting <5 and 5–6 h of sleep [28].

Insufficient sleep by geography

Insufficient sleep in the United States is differentially experienced across varying regions of the country. An analysis of self-reported perceived insufficient sleep using BRFSS data was reported [41]. Using a geospatial hotspot analysis, several key "hotspots" of insufficient sleep were identified in the United States, including parts of the southeast, parts of the Texas/Louisiana border, areas in the Midwest, and the largest hotspot in central Appalachia. "Coldspots" with abnormally low levels of insufficient sleep were seen in the northern Midwest (Wisconsin/Minnesota/Iowa), central Texas, central Virginia, and areas in along the West Coast. See Fig. 2.4 for a map of US counties relative to their proportion of insufficient sleep and Fig. 2.5 for a map of hotspots and coldspots.

Rather than examine statistical hotspots of perceived insufficient sleep, researchers at the CDC used BRFSS data to map prevalence of ≤6 h of sleep across the United States[19]. The US states with the highest prevalence were (in order) Hawaii (43.9%), Kentucky (39.7%), Maryland (38.9%), Alabama (38.8%), Georgia (38.7%) and Michigan (38.7%). The US states with the lowest prevalence were (in order) South Dakota (28.4%), Colorado (28.5%), Minnesota (29.2%), Nebraska (30.4%), and Idaho (30.6%).

KEY LIMITATIONS TO POPULATION ESTIMATES OF INSUFFICIENT SLEEP

There are several key limitations in the existing literature on insufficient sleep epidemiology. First, there is a lack of clarity of gold-standard methods for estimating population levels of sleep duration. Most of these studies used

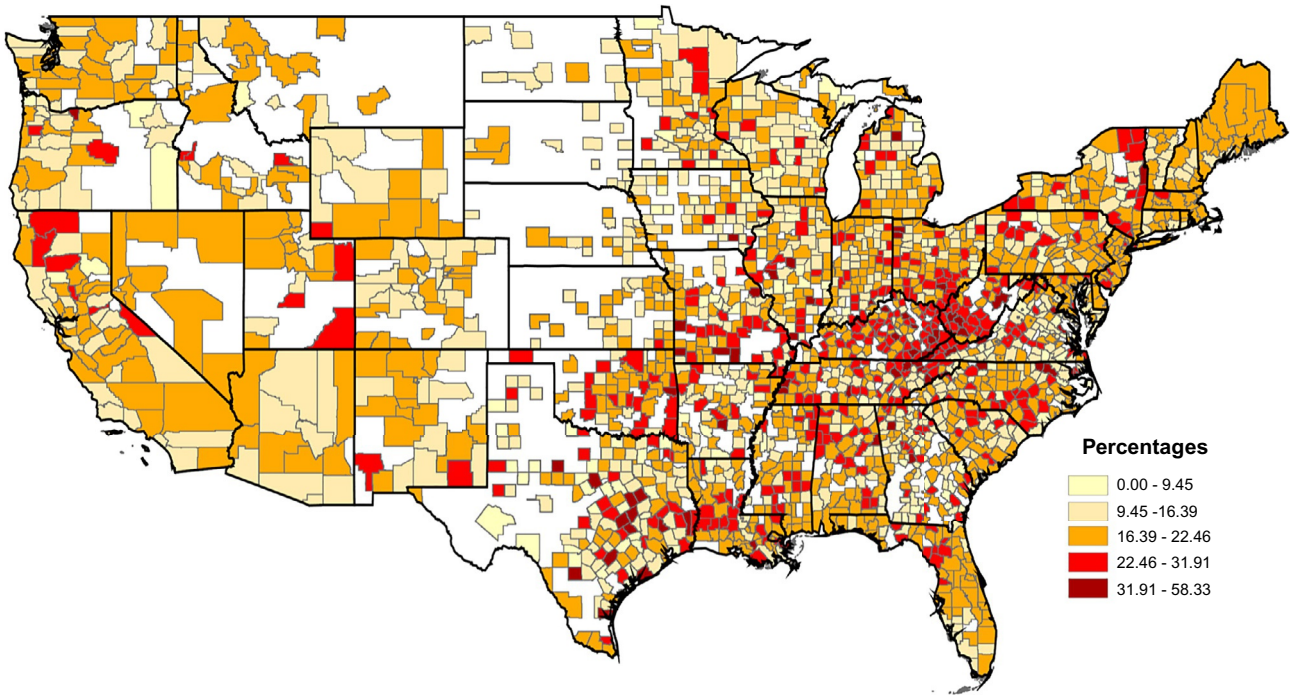

FIG. 2.4 County-level insufficient sleep in the US. *From Grandner MA, Smith TE, Jackson N, Jackson T, Burgard S, Branas C. Geographic distribution of insufficient sleep across the United States: a county-level hotspot analysis. Sleep Health 2015;1(3):158–165. PubMed PMID: 26989761; PMCID: 4790125.*

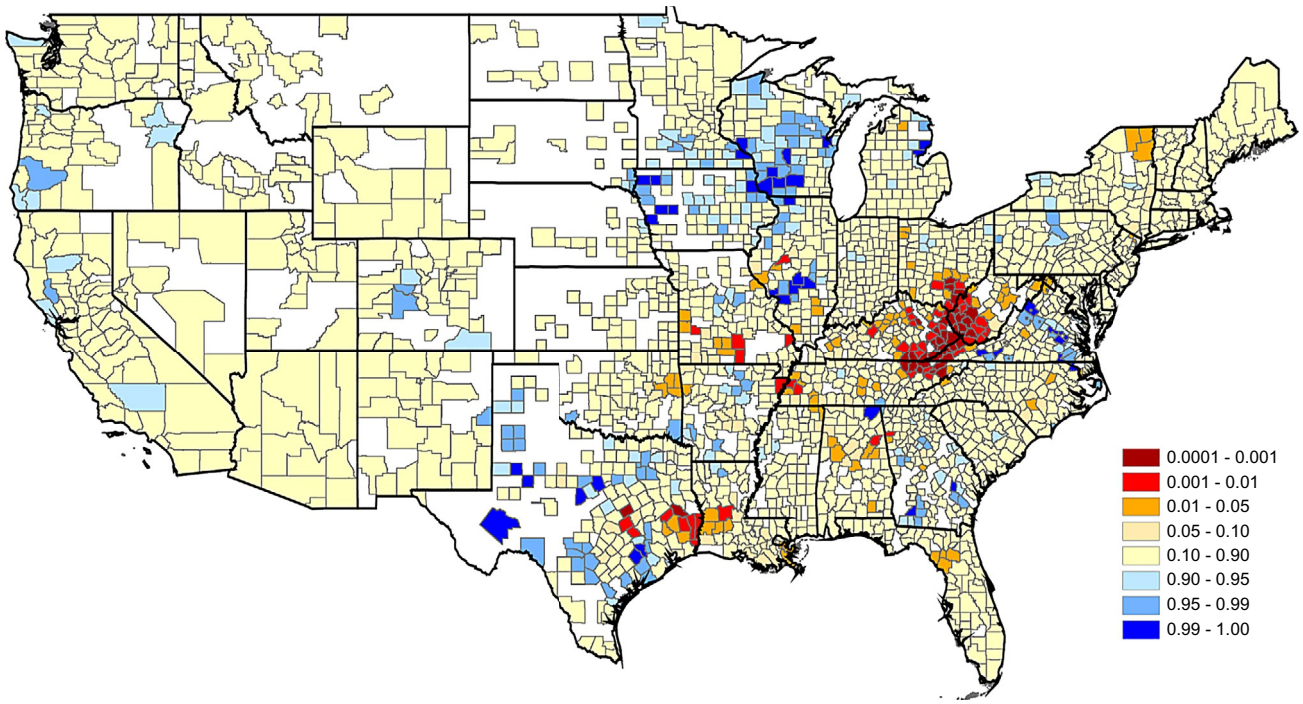

FIG. 2.5 Hotspots and coldspots of insufficient sleep in the US. *From Grandner MA, Smith TE, Jackson N, Jackson T, Burgard S, Branas C. Geographic distribution of insufficient sleep across the United States: a county-level hotspot analysis. Sleep Health 2015;1(3):158–165. PubMed PMID: 26989761; PMCID: 4790125.*

single-item self-report measures from surveys, which are fraught with psychometric problems [2, 11, 42]. Not only do self-report measures tend to over-report sleep relative to physiologic recordings and likely better approximate time in bed than physiologic sleep, they may be subject to a number of other biases, demand characteristics, and social desirability. There still exists no nationally-representative dataset that estimates sleep duration based on gold-standard approaches, especially those that record physiologic sleep.

Second, the definition of insufficient sleep varies widely across studies, and most studies do not allow enough resolution to examine different cutoffs. Given recent consensus statements [5–7, 9, 10], a cutoff of 7 h seems reasonable, but there is yet no clear consensus on the range between 6 and 7 h, where many Americans fall regarding their typical sleep habits. Also, it is not clear whether a determination of insufficient sleep should be made on the basis of physiologic sleep or perceived sleep.

Third, definitions of insufficient sleep are based on nomothetic, population-level recommendations which don't take into account individual differences in sleep need, sleep ability, and resilience to sleep loss. Also, these do not necessarily take into account sleep sufficiency relative to any particular outcome. Future work should consider these issues in order to take a more personalized/precision medicine view of sleep duration, as it relates to an individual and impacts on specific outcome measures, in a specific set of contexts.

PREVALENCE OF POOR SLEEP QUALITY

Poor sleep quality, like insufficient sleep, has been variably defined. The National Sleep Foundation has recently attempted to develop a coherent conceptualization of sleep quality [43, 44]. In a consensus document, elements of sleep quality included sleep latency (amount of time to fall asleep), wake time after sleep onset (amount of time awake at night), and sleep efficiency (proportion of the time in bed spent sleeping). Thus, sleep quality was generally defined as good sleep continuity. Recognizing the limitations of this, the National Sleep Foundation has begun work on a tool to measure sleep satisfaction with is presented as another key element of overall sleep quality [45]. In addition to sleep-focused elements as indicators of sleep quality, perhaps daytime indicators can be useful as well. For example, daytime sleepiness is often an indicator of poor nighttime sleep [46, 47] and may also serve as an indicator of poor sleep quality.

Prevalence of sleep disorders

Poor sleep quality can refer to a relatively wide range of problems, including sleep disorders as well as sleep symptoms. The most common types of sleep disorders in the population are insomnia and sleep apnea. Although other chapters in this volume focus specifically on these issues at the population level, it is important to note that the

population prevalence of acute insomnia is high (about 4% per month) [48, 49] and that although most of these resolve, approximately 10% of the population likely meets criteria for an insomnia disorder [50, 51].

Regarding sleep apnea, prevalence estimates need to account for sex and body mass index. Relatively recent estimates of the prevalence of sleep apnea estimate that among men age 30–49, rates are 7.0%, 18.3%, 44.6%, and 79.5% for those with BMI of <25, 25–29.9, 30–39.9, and 40 or above, respectively. For men 50–70, the rates increase to 18.9%, 36.6%, 61.4%, and 82.8%, respectively. For women age 30–49, the rates of sleep apnea are lower, at 1.4$, 4.2%, 13.5%, and 43.0% for women with a BMI of <25, 25–29.9, 30–39.9, and 40 or higher, respectively. As with men, these numbers are higher in women age 50–70, with 9.3%, 20.2%, 41.1%, and 67.9% with sleep apnea among those with BMI of <25, 25–29.9, 30–39.9, and 40 or greater, respectively. This high prevalence of sleep apnea (Fig. 2.6) is particularly notable [52], especially since recent estimates suggest that approximately 85% of sleep apnea cases are never diagnosed, and up to half of diagnosed cases remain insufficiently treated [53].

Regarding circadian rhythm sleep disorders, the prevalence of delayed sleep phase disorder is estimated to be about 0.2% of the general population but 7–16% of adolescents [54]. Prevalence of other circadian rhythm sleep disorders is largely unknown, though the prevalence of shift work disorder is estimated to be about 5–10% of the population, based on prevalence estimates of night shift work and the prevalence of the disorder among shift workers [55].

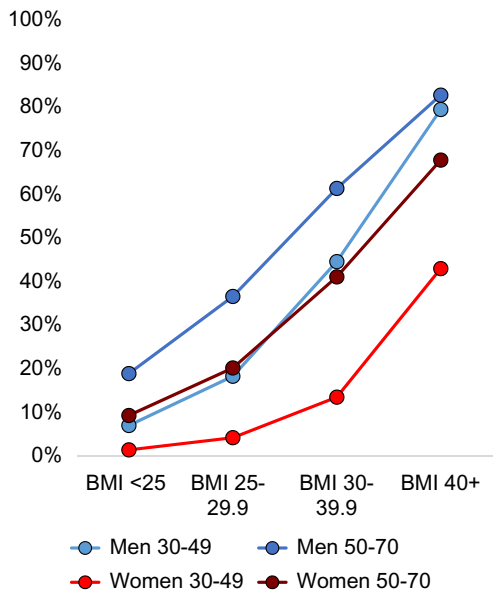

FIG. 2.6 Estimated prevalence of sleep apnea by age group, sex, and BMI. *From Peppard PE, Young T, Barnet JH, Palta M, Hagen EW, Hla KM. Increased prevalence of sleep-disordered breathing in adults. Am J Epidemiol. 2013. PubMed PMID: 23589584; PMCID: 3639722.*

Prevalence of sleep complaints

Several studies have examined prevalence of sleep complaints in the general population. For example, Grandner and colleagues [21] found that the rate of general sleep disturbance in the US population was about 16% in men and 21% in women, and general daytime fatigue was 18% in men and 26% in women. However, this depended on age. Fig. 2.7 depicts the rates of these across age groups, illustrating a general decline in reports with age. Of note, in women, increased sleep duration and tiredness are evident around the age typical of menopause and in both men and women, fatigue increases starting at age 70. When odds ratios for these outcomes were computed after adjusting for covariates that included sociodemographics, health and depression, the decrease in symptoms with age was even more pronounced. This has been replicated by several others, using other databases and addressing the issue of subjective sleep complaint in different ways [20, 22]. In general, self-reported sleep complaints generally decrease with age. This is in contrast to objective sleep disturbances, which generally increase with age [24].

This general sleep complaint may be differentially experienced across demographic groups. Grandner and colleagues [56] showed that in addition to age and sex, general sleep disturbance was reported more frequently among non-Hispanic Whites, compared to other groups. It was also more frequently reported by those with less education, less income, and lack of employment. In addition, it is reported more frequently among those in worse health overall and less healthcare access [21].

Regarding specific sleep complaints, Grandner and colleagues [57] examined data from the NHANES. In a nationally-representative sample, the prevalence of self-reported sleep latency >30 min was 18.8%. Regarding other insomnia symptoms, the prevalence of difficulty at least once per week was 19.4% for falling asleep, 20.9% for resuming sleep during the night, and 16.5% for early morning awakenings; regarding problems at least three nights per week, these rates were reduced to 7.7%, 7.7%, and 5.8%, respectively. Regarding daytime symptoms, daytime sleepiness and non-restorative sleep at least once per week were reported by 18.8% and 28.7% of the population, respectively; when the criterion was increased to three nights per week, this was reduced to 5.8% and 10.9%, respectively. In this sample, 70.6% of adults reported snoring at least once per week and 51% reported snoring at least three nights per week.

SUMMARY AND CONCLUSIONS

Although accurately measuring sleeping individuals in large numbers is difficult, prevalence estimates for insufficient and poor quality sleep can be obtained from large-scale studies of health. Despite limitations of these estimates,

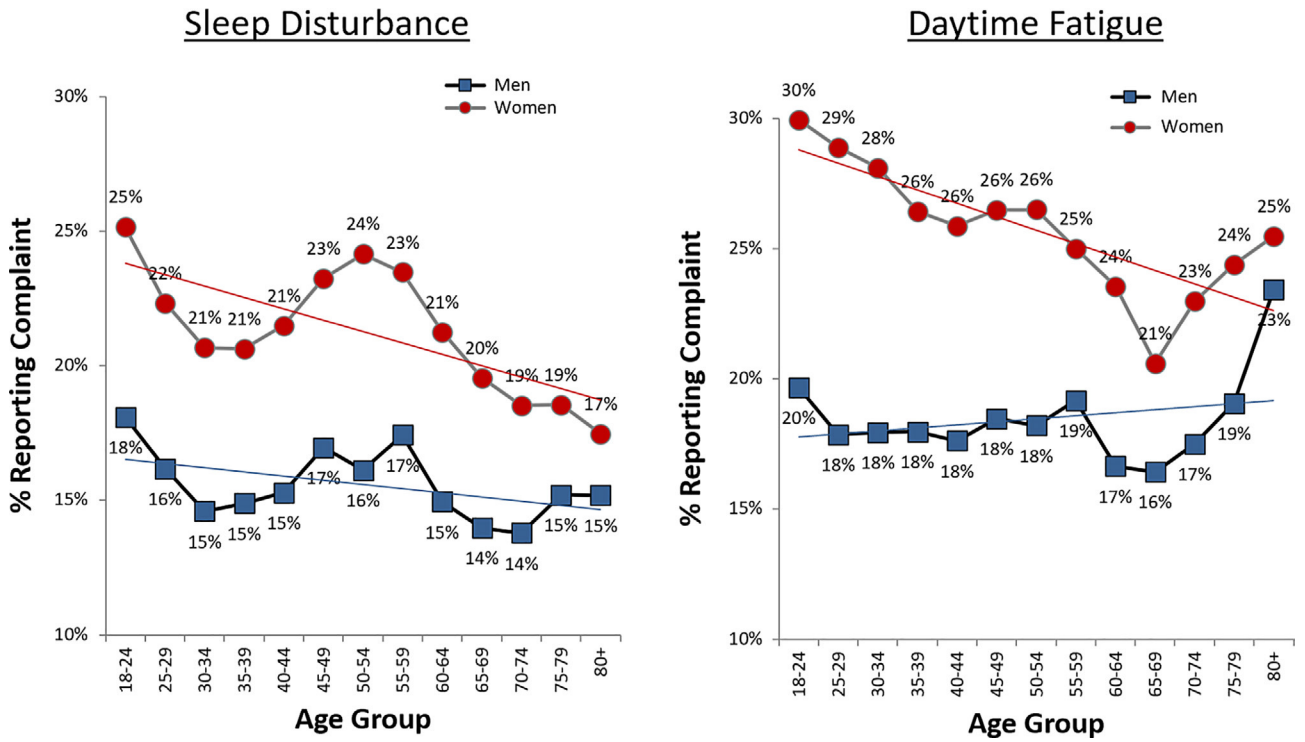

FIG. 2.7 Prevalence of sleep disturbance and daytime fatigue by age and sex. *Adapted from Grandner MA, Martin JL, Patel NP, Jackson NJ, Gehrman PR, Pien G, Perlis ML, Xie D, Sha D, Weaver T, Gooneratne NS. Age and sleep disturbances among American men and women: data from the U.S. Behavioral risk factor surveillance system. Sleep. 2012;35(3):395–406. Epub 2012/03/02. PubMed PMID: 22379246; PMCID: 3274341.*

it is clear that many adults are achieving insufficient sleep duration and/or inadequate sleep quality. This is concerning, since sleep is associated with so many important outcomes including health, daytime functioning, and mental well-being. Public health surveillance efforts should aim to improve measurement of sleep health at the population level across multiple domains. In addition, public health intervention efforts should address healthy sleep as an important population health goal.

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