PREVENTING CHRONIC DISEASE
PUBLIC HEALTH RESEARCH, PRACTICE, AND POLICY




Sleep Deprivation, Sleep Disorders, and Chronic Disease




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GUEST EDITORIAL

Sleep Deprivation, Sleep Disorders, and Chronic Disease

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PEER REVIEWED

This editorial aims to highlight the complex interplay among sleep, mental health, and chronic disease, emphasizing the critical role that sleep plays in health outcomes and overall well-being. With the mounting evidence linking sleep to numerous health problems — from mental health disorders to chronic diseases — it is paramount that we shift our focus toward understanding sleep not as a passive state but as a vital process for brain restoration and regulation. Recognizing and addressing sleep disturbances and disorders, along with promoting comprehensive strategies for improving sleep health, is a national imperative with far-reaching economic and health implications.

The articles in this collection in *Preventing Chronic Disease* (PCD) — Sleep Deprivation, Sleep Disorders, and Chronic Disease — provide valuable insights into the bidirectional relationships between sleep, mental health, and chronic disease throughout the lifespan. Furthermore, the articles shed light on key themes — starting from childhood to young adulthood — while considering the role of parents and sociodemographic factors, the effect of sleep health on various racial and ethnic groups, and the geographic variation in the prevalence of short sleep duration.

The relationships among sleep, mental health, and chronic disease have garnered considerable attention in recent years (1). Studies consistently highlight the association between 1) dimensions of sleep and sleep disorders and 2) mental, behavioral, and developmental disorders. Stemming from this research, public health awareness of the importance of sleep has increased, as highlighted in *Healthy People 2030* goals (2). In June 2022, the American Heart Association added sleep duration as a vital component of its Life's Essential 8 (an update from Life's Simple 7) as a metric for cardiovascular health (3). In addition, the American Academy of Sleep Medicine (AASM) and the Sleep Research Society jointly released a consensus statement in 2015 recommending the amount of sleep for healthy adults (4). This statement was followed by the AASM's consensus statement in 2016, which provides sleep duration recommendations for pediatric populations (5). Similarly, an expert panel convened by the National Sleep Foundation made evidence-based recommendations on sleep duration for various age groups, from 14 to 17 hours for newborns to 7 to 8 hours for older adults (6). The American Academy of Pediatrics supports the delay of school start times for adolescents to ensure they receive adequate sleep (7). The Canadian 24-Hour Movement Guidelines for Children and Youth acknowledged the importance of healthy sleep, integrating sleep recommendations along with guidelines for physical activity and sedentary behavior (8). These developments highlight the growing recognition of sleep's crucial role in overall health and well-being.

Despite this focus on healthy sleep, a substantial proportion of adults in the US fails to meet the recommended hours of sleep; thus, improving sleep is a national imperative with substantial economic and health implications (9). Growing research indicates that racial and ethnic minority groups are disproportionately affected by sleep and circadian disparities, which exacerbate chronic disease disparities (10,11). Today's 24-hour lifestyle, coupled with the pervasive use of electronics and social media, has normalized inadequate sleep among many children and adolescents, with uncertain effects on brain development, mental health, and vascular health (12). Additionally, emerging evidence links sleep deprivation to adverse cardiometabolic health and cognitive health and an increased risk of dementia among older adults — making it an important acquired risk factor in the 21st century (13). Thus, sleep may be key to reducing the burden of chronic diseases.

Sleep is far from a passive state; it is a vital process for brain restoration and regulation. Inadequate sleep disrupts critical neural processes and impairs cognitive functioning (14,15). Altering these processes provides a mechanistic link through which insufficient sleep contributes to the onset or worsening of mental health, brain disorders, and chronic diseases. Only by bridging the gap between sleep and these important health outcomes can we devel-

op integrated, comprehensive strategies to address the problems related to insufficient sleep. In addition, a growing body of research suggests that insufficient sleep plays a substantial role in the development and worsening of many chronic diseases (3,12,13).

Several studies in this PCD collection demonstrate that insufficient sleep is prevalent among children and adolescents and is associated with mental, behavioral, and developmental disorders. Claussen et al (16) reported that short sleep duration, defined as less than the recommended amount of sleep for one's age, was more prevalent among children with these disorders, children from racial and ethnic minority groups, and children from households with low socioeconomic status. Prevalence of short sleep duration was associated with inconsistent bedtimes, poor parental mental and physical health, and adverse childhood experiences. Addressing these factors may improve children's sleep and promote healthy development, particularly among children with low socioeconomic status or from racial and ethnic minority groups (16).

Bird et al (17) demonstrate that parents and caregivers play a crucial role in promoting healthy sleep behaviors in children. We need collaborative efforts between schools and parents to improve child sleep health. Evidence supports engaging parents in the school community and addressing their concerns about sleep promotion initiatives to foster a supportive environment (17).

Insufficient sleep among adolescents is associated with poor mental health, including depressive symptoms and suicidal thoughts. The study in this collection by Gunderson et al (18) analyzed data from the 2021 Florida Youth Risk Behavior Survey and showed that high school students reporting insufficient sleep (<8 hours of sleep on an average school night) were more likely to experience feelings of sadness or hopelessness, consider suicide, and make suicide plans compared with those with sufficient sleep (after adjustment for sex, race and ethnicity, and grade level) (18). These results underscore the importance of addressing sleep as a modifiable risk factor in adolescent mental health and incorporating it into suicide prevention efforts (18).

The COVID-19 pandemic has brought attention to the effect of sleep on mental health. Sliwa et al (19) used data from the Adolescent Behaviors and Experiences Survey, a one-time national survey of high school students during the pandemic, and found that a significant proportion experienced short sleep duration, which was associated with both poor mental health and increased difficulty in doing schoolwork during the pandemic compared with before the pandemic (19). Students who reported less than 7 hours of sleep or poor mental health had a higher prevalence of increased trouble with schoolwork. If we create a comprehensive strategy that incorporates sleep duration, we can better support student mental health and academic achievement.

Researchers also observed an association between sleep and mental health among older students. In a survey of college students by Mbous et al (20), one-quarter of the study population experienced insomnia, which was significantly associated with mental health conditions, specifically attention deficit hyperactivity disorder (ADHD) and depression (20). The odds of insomnia were higher among students who had depression, had symptoms of ADHD, and were employed. Tailored sleep education interventions, focusing on employed students and people with mental illnesses, can help target insomnia symptoms and severity among college students.

Sleep health is a multifaceted concept of sleep–wakefulness patterns tailored to personal, societal, and environmental needs, and it promotes overall well-being. Sleep health is not solely about getting the right amount of sleep but also encompasses the timing, regularity, satisfaction, and efficiency of sleep (21). Sleep is influenced by a mix of biological and environmental factors, often in line with major life events, health issues, lifestyle choices, and sociodemographic factors (21).

Although these various dimensions of sleep are associated with many poor health outcomes, how they are connected is not always clear. Inadequate or disturbed sleep may sometimes contribute to other health conditions and vice versa. Morey et al (22) explored how sleep disturbance could play a mediating role between stress and self-rated health among Chinese and Korean immigrants. Their mediation analyses concluded that 15% to 22% of the associations between stress (perceived stress and acculturative stress, respectively) and self-rated health was attributable to sleep disturbance — suggesting sleep is a key factor in the stress–health relationship (22).

In 2020, one-third of US adults reported short sleep duration, with differences across sociodemographic characteristics and geographic areas. Pankowska et al (23) found that urban–rural differences exist — the prevalence of short sleep duration was lowest among adults living in urban (metropolitan) counties and was higher in micropolitan and rural counties (23). In addition, county-level data showed that counties in the Southeast and along the Appalachian Mountains had a higher prevalence of short sleep duration. These geographic patterns of short sleep duration partially reflect patterns of other chronic conditions. Overall, these findings suggest that incorporating neighborhood-level data and context is crucial for effective local interventions to help US adults get adequate sleep (23).

The articles in this PCD collection offer a wealth of practical information aimed at improving sleep health for the individual and in the community while also recognizing the multifactorial influences, bidirectional relationships, and individual variations in sleep health. By viewing the findings from diverse studies, we can foster a nuanced understanding and develop comprehensive approaches to address the intertwined aspects of sleep, mental health, and chronic diseases. Effectively addressing mental health requires a comprehensive approach, encompassing both sleep disturbances and underlying psychosocial factors. Furthermore, contextual elements such as cultural norms, work demands, and lifestyle constraints substantially affect sleep duration and quality. Future studies should consider tailored approaches and personalized interventions to address these individual variations and contextual factors, thereby optimizing sleep and mental health.

Most of the articles in this collection focus on sleep duration and sleep disturbances, highlighting the need for further research on other aspects of sleep, particularly sleep timing or schedules. Efforts are underway to expand our understanding of sleep beyond sleep duration and disturbances to gain insights into how sleep affects overall health. The National Health and Nutrition Examination Survey (NHANES) recently incorporated questions about weekday and weekend sleep schedules. This survey presents an excellent opportunity for researchers to explore the association between sleep timing and a wide range of health outcomes, which we anticipate may provide valuable insights into optimizing sleep patterns for better health outcomes. Sleep timing pertains to when one initiates sleep, typically referenced to societal norms and personal obligations. Other important metrics, such as sleep regularity, refer to the consistency of one's sleep and wake times across days, including both weekdays and weekends. The NHANES data, which also include actigraphy data, can be leveraged to examine variations in sleep onset and duration across weekdays and weekends, yielding measures of an individual's sleep regularity or rhythm.

In contrast, conditions like delayed sleep–wake phase disorder (DSWPD), which feature a shift in the timing of sleep onset and offset (mainly assessed by using data on weekend sleep), provide crucial insight into sleep timing. DSWPD is characterized by sleep and wake times that are substantially delayed relative to societal norms, leading to distress or impairment in social, occupational, or other important areas of functioning. DSWPD, often observed among adolescents and young adults, is characterized by a preference for sleep and wake times that are misaligned with societal demands. People with DSWPD often experience comorbid depression, among other conditions. Through continued research into sleep timing, we can advance our knowledge and improve sleep-related health outcomes (7,24,25). Aligning sleep schedules with societal obligations requires management strategies tailored to each person's needs and circumstances; however, policy changes such as later school start times could be an effective public health intervention (7).

It is vital to recognize sleep as a fundamental pillar of public health. By prioritizing sleep, addressing sleep disturbances and disorders, and promoting comprehensive approaches that encompass mental health and chronic disease prevention, public health initiatives can enhance the well-being of individuals and communities, as well as ameliorate health disparities among racial and ethnic minority groups. And by understanding the complex interplay between sleep, mental health, and chronic diseases, public health efforts can promote sleep health and improve overall well-being. Multisector efforts among individuals and groups are important for advancing research, implementing effective interventions, and addressing health disparities. Sleep health has multifactorial influences, bidirectional relationships with health outcomes, and individual variations, necessitating comprehensive, concrete solutions. For example, policy makers can promote healthier sleep patterns among teenagers by delaying school start times, as suggested by the American Academy of Pediatrics (7). Furthermore, the implementation of guidelines such as those provided by the National Sleep Foundation and the AASM can serve as practical recommendations for individuals of different age groups to ensure adequate sleep (3–6,8). Such actionable steps taken by policy makers, educators, and health organizations can contribute to enhancing sleep health.

Collaborative efforts among researchers, health care professionals, policy makers, educators, and individuals are essential for developing effective interventions and adopting beneficial policies. By doing so, we can anticipate a deeper understanding of the complex interplay among sleep, mental health, and cognitive functioning across the life span, contributing to improved public health outcomes.

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ORIGINAL RESEARCH

Short Sleep Duration: Children's Mental, Behavioral, and Developmental Disorders and Demographic, Neighborhood, and Family Context in a Nationally Representative Sample, 2016–2019

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Summary

What is already known on this topic?

Many children and adolescents experience insufficient sleep. Short sleep duration among children is associated with mental, behavioral, and developmental disorders, is influenced by demographic, neighborhood, and family contexts, and poses risks for long-term health and development.

What is added by this report?

We examined these factors concurrently and showed the significant and independent association of childhood disorders and demographic, neighborhood, and family factors with short sleep duration.

What are the implications for public health practice?

Short sleep duration is more prevalent among children with mental, behavioral, and developmental disorders, in racial and ethnic minority groups, and from low-socioeconomic households. We identified a range of neighborhood and family factors that can be targeted to improve children's sleep and promote healthy development.

Abstract

Introduction

Many children and adolescents experience insufficient sleep, which poses risks for their short- and long-term health and development. This study examined the concurrent associations of contextual factors, including child, demographic, neighborhood, and family factors, with short sleep duration.

Methods

We combined data on children aged 3 to 17 years from the 2016–2019 National Survey of Children's Health (N = 112,925) to examine the association of parent-reported child short sleep duration (ages 3–5 y, <10 h; 6–12 y, <9 h; 13–17 y, <8 h) with mental, behavioral, and developmental disorders (MBDDs); selected physical health conditions; and demographic, neighborhood, and family factors.

Results

Overall, 34.7% of children experienced short sleep duration. The prevalence was highest among children aged 6 to 12 years (37.5%); children from racial and ethnic minority groups, especially non-Hispanic Black children (50.0%); children from low-income households (44.9%); children with an MBDD (39.6%); children experiencing negative neighborhood factors (poor conditions and lack of safety, support, and amenities, 36.5%); and family factors such as inconsistent bedtime (57.3%), poor parental mental (47.5%) and physical health (46.0%), and adverse childhood experiences (44.1%). The associations between sleep and demographic, neighborhood, and family factors, and MBDD remained significant after controlling for all other factors.

Conclusion

This study identified several individual, family, and community factors that may contribute to children's short sleep duration and can be targeted to improve healthy development, particularly among children with an MBDD, from households with low socioeconomic status, or from racial and ethnic minority groups who are at increased risk for short sleep duration.

Introduction

Sleep is an essential function that predicts long-term health and well-being (1). Insufficient sleep has been associated with poor physical health (1–3), poor mental health, and problems with attention, behavior, learning, and memory (1,4–6). Insufficient sleep includes poor sleep quality and short sleep duration. This study focused on short sleep duration, which is common among children: during 2016–2018, 35% of US children aged 0 to 17 years had shorter sleep duration than recommended for their age (1) based on parent report (7). However, research on sleep among children is less extensive than among adults (4,8).

Child, family, and environmental factors can all influence sleep (5,9,10). Sleep is negatively influenced by internal and external signals of danger and disruption (11). Psychological stressors within the family, such as parental health and well-being (12–15), and psychological stressors in the social context, such as neighborhood disadvantage and lack of perceived safety, affect sleep (9,10,16,17). Sleep is also affected by child characteristics, such as special health care needs and mental disorders (7,18), and family factors, such as regular bedtimes (7,19,20).

Children experiencing poverty are at increased risk for insufficient sleep (7,21–23). Poverty is related to risks that impair sleep, such as health risks, danger and stress, crowding, lack of suitable sleep spaces, or food insecurity (9,10,15). Children from racial and ethnic minority groups experience increased risk for insufficient sleep (7,9,21,22,24), potentially through mental stress from experiencing racism and discrimination (9,23), and through structural racism and the associated higher prevalence of socioeconomic risks related to poor sleep (21,22).

Previous studies examined the association between sleep and factors such as mental health and environmental factors, and between social context and children's mental health, but not comprehensively in a single sample of young and older children. Given that demographic, social, and environmental risk factors co-occur, understanding the independent associations between different types of risks and poor sleep requires examination of these different risk factors in a comprehensive data set. Our study expands on previous research (7) that documented short sleep duration in a nationally representative sample of children and adolescents. We examined concurrent and independent associations between demographic, social, and environmental factors, mental disorders, and sleep duration in this comprehensive data set based on a nationally representative sample of children and adolescents to identify potential targets for public health intervention.

Methods

We used 4 years (2016–2019) of data from the National Survey of Children's Health, a nationally representative survey administered by the US Census Bureau and funded and directed by the Maternal and Child Health Bureau of the Health Resources and Services Administration (25). The survey uses a combination of an online and a pencil-and-paper format. Respondents are parents (including other caregivers or guardians who are familiar with the child's health and health care, hereinafter referred to as "parents") reporting on a single child aged 0 to 17 years per household.

We used guidance provided by the US Census Bureau (26) to combine data on 131,774 children aged 0 to 17 years from the 4 survey years. We used data from before the COVID-19 pandemic, because pandemic-related factors likely affected sleep duration and other indicators of interest. The overall weighted response rates were 41% (2016), 37% (2017), 43% (2018), and 42% (2019). We excluded children aged 0 to 2 years (n = 17,298) and children without valid data on sleep duration (n = 1,551). The final analytic sample size was 112,925 (Figure).

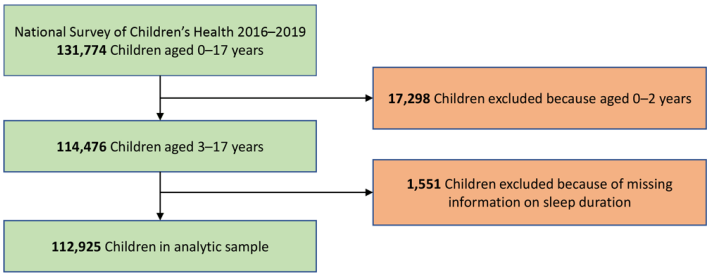

Figure. Sample size and exclusion and inclusion criteria for the analytic sample, the National Survey of Children's Health, 2016–2019.

Sleep indicator

Parents of children aged 3 to 5 years were asked, "During the past week, how many hours of sleep did this child get on an average day (count both nighttime sleep and naps)?" For ages 6 to 17 years, the question was, "During the past week, how many hours of sleep did this child get on an average weeknight?" in 2016 and 2017 and "on most weeknights?" in 2018 and 2019. On the basis of recommendations for sleep duration from the American Academy of Sleep Medicine, the survey defined short sleep duration as less than 10 hours for ages 3 to 5 years (preschool age), less than 9 hours for ages 6 to 12 years (school age), and less than 8 hours for ages 13 to 17 years (adolescents) (25).

Demographic, neighborhood, and family factors

Parents reported on demographic characteristics such as the child's sex, age, race and ethnicity, parental education (highest level of education attained by primary caregivers), and household size and family income. Data on household size and income were used by the US Census Bureau to calculate family income as a percentage of the federal poverty level. Parents also reported on neighborhood factors such as safety, support, condition, and amenities. Negative factors (unsafe neighborhood, neighborhood lacks support, neighborhood in bad condition, and neighborhood lacks amenities) were combined into a single composite variable labelled "negative neighborhood factors." Family factors included whether the child had a consistent bedtime, child's exposure to adverse childhood experiences (ACEs), and parental mental and physical health status.

Mental, behavioral, and developmental disorders

Parents were asked whether a health care provider had ever told them that their child had any of a series of disorders, including attention-deficit and hyperactivity disorder (ADHD), behavior problems, anxiety, depression, Tourette syndrome, learning disability, developmental delay, intellectual disability, speech or language disorder, and autism spectrum disorder and whether the child currently had the disorder; behavior problems, learning disability, developmental delay, intellectual disability, and speech or language disorder could also be identified by an educator. Current ADHD, behavior problems, anxiety, depression, and Tourette syndrome were grouped into the category MEB (mental, emotional, and behavioral disorders). Current learning disability, developmental delay, intellectual disability, speech or language disorder, and autism spectrum disorder were combined into the category DLLD (developmental, language, or learning disorders). MEB was combined with DLLD into the category MBDD (mental, behavioral, and developmental disorders). Parents also reported children's physical health conditions.

Analyses

We examined the relationship between short sleep duration and selected demographic characteristics (sex, age group, race and ethnicity, parental education, and family income), and presence of MBDD and physical health conditions. We also examined negative neighborhood and family factors, including inconsistent bedtime, parental mental and physical health, and number of ACEs for the child. For the publicly available data set, imputed values for missing data on family income (17.1% missing) were calculated via multiple imputation; imputed values for missing data on parental education (2.1% missing) and children's sex (0.1% missing), race (0.4% missing), and Hispanic origin (0.6% missing) were calculated via hot-deck imputation. Respondents with missing values for any other factors were excluded from item-level analyses (missingness was 3.5% or less per item). Given the minor wording change in the sleep item for children aged 6 to 17 years after 2017, we conducted sensitivity analyses to ensure that patterns of associations were similar across survey years. These analyses did not show meaningful differences across study years; therefore, we analyzed the sample as a whole.

We conducted all analyses in SAS-callable SUDAAN version 11.0.1 (RTI International) to account for the complex survey design and weighting of the data. We used individual logistic regression models with predicted marginals to calculate weighted prevalence ratios (PRs) and 95% confidence intervals (CIs) to compare the prevalence of short sleep duration among children and adolescents aged 3 to 17 years across demographic subgroups, presence or absence of neighborhood or family risk factors, and presence of any MBDD. We ran logistic regression models to produce adjusted prevalence ratios (aPRs) for the association between each MEB or presence of any DLLD or physical health condition and short sleep duration adjusted for sociodemographic, neighborhood, and family risk factors; an adjusted model of the association between any MBDD and short sleep duration also produced aPRs for all variables included in the model. To examine whether each of the demographic, family, and neighborhood characteristics were independently associated with short sleep duration when considered together, we calculated the PRs of short sleep duration for each characteristic in the adjusted model predicting short sleep duration based on MBDD status. All prevalence estimates and 95% CIs met the National Center for Health Statistics Data Presentation Standards (27).

Results

Demographic factors

Among children aged 3 to 17 years, 34.7% (95% CI, 34.1%–35.4%) were reported to experience short sleep duration. Sleep duration was associated with child's age; parents reported short sleep most frequently for children aged 6 to 12 years (37.5%; 95% CI, 36.5%–38.5%) and least for adolescents aged 13 to 17 years (30.7%; 95% CI, 29.6%–31.7%) (Table 1).

We found racial and ethnic disparities in sleep duration. Compared with non-Hispanic White children, children from each of the other racial and ethnic groups had significantly higher prevalence of short sleep duration, except for the non-Hispanic Native Hawaiian and Pacific Islander group. For example, the prevalence of short sleep duration among non-Hispanic White children was 29.0%, 38.6% among Hispanic children, and 50.0% among non-Hispanic Black children.

Short sleep duration was associated with lower parental education level; children of parents with less than a high school education had the highest prevalence of short sleep duration (45.6%), and children of parents with college degrees or higher had the lowest (27.4%). Similar patterns emerged for family income. The highest percentage of short sleep duration (44.9%) was among children in families with the lowest income level (<100% of the federal poverty level). Estimates of short sleep duration decreased as income levels increased and differed among all 4 levels. Sex was not associated with short sleep duration even when stratified by age.

Neighborhood factors

All 4 negative neighborhood factors (unsafe neighborhood, neighborhood lacks support, neighborhood in bad condition, and neighborhood lacks amenities) were significantly associated with a higher prevalence of short sleep duration; 36.5% of children living in neighborhoods with 1 or more negative neighborhood factors experienced short sleep duration, compared with 28.5% living in neighborhoods without negative factors.

Family factors

Short sleep duration was experienced by 57.3% of children with an inconsistent bedtime. Having a parent with fair or poor mental health or physical health and having a higher number of ACEs were also associated with significantly higher prevalence of short sleep duration.

Disorders

The overall association of any MBDD with short sleep duration was significant (any MBDD, 39.6% vs no MBDD, 33.2%). The association also held true when comparing children with no MBDDs against those with MEBs together (40.9%), or against those with ADHD (40.3%), behavior problems (44.6%), anxiety (40.9%), and depression (48.0%) separately (Table 2). The association with Tourette syndrome was not significant. Having any DLLD was also associated with short sleep duration (38.6%) as was any physical health condition (36.1% vs 34.0% with no physical health condition).

After adjustment for demographic, family, and neighborhood characteristics, having an MBDD remained significantly associated with short sleep duration. This pattern was similar for MEB as a group and for ADHD, behavior problems, anxiety, and depression separately. The association with Tourette syndrome was significant in the adjusted model. The association of a DLLD diagnosis and having any physical health condition was no longer significant in the adjusted models (Table 2).

The magnitude of the association between short sleep duration and age was larger in the adjusted models than in the bivariate models, especially among children aged 6 to 12 years (Table 3). For race and ethnicity, only Hispanic (aPR = 1.12), non-Hispanic Black (aPR = 1.44), and non-Hispanic Asian (aPR = 1.15) children still had a significantly higher prevalence of short sleep duration than non-Hispanic White children after adjustment. Parental education, family income level, neighborhood factors, parent mental and physical health, and child's ACEs remained significantly associated with short sleep duration, but the magnitude of the association was smaller than in bivariate models. The aPR for inconsistent bedtime remained the highest among the factors in the adjusted models, only slightly reduced from 1.82 to 1.70.

Discussion

Our data show that parent-reported short sleep duration is common for children of all ages. Similar to data in previous reports (7), more than 1 in 3 children did not meet sleep recommendations during 2016–2019. The highest proportion of parent-reported short sleep duration was among children aged 6 to 12 years, with almost 2 in 5 children not meeting recommendations. Among adolescents, almost 1 in 3 had parent-reported short sleep duration.

In previous studies, a majority of adolescents self-reported shorter sleep duration than recommended for their age (28,29). Because parents may overestimate sleep, particularly among older children and adolescents, our data, based on parent report, may have conservatively estimated short sleep duration (5).

Having an inconsistent bedtime has been documented as affecting sleep duration (7,20), and was particularly notable among factors measured in our study. Our data showed that children with inconsistent bedtimes had about a 70% higher prevalence of insufficient sleep, even after controlling for child, family, and neighborhood factors.

As expected, sleep disparities were associated with social determinants of health (5,14,21,23,24). Short sleep duration was more prevalent among children in most racial and ethnic minority groups than among non-Hispanic White children (23,29). Non-Hispanic Black children had the highest prevalence and were approximately 50% more likely than non-Hispanic White children to have short sleep duration. We also found significant levels of short sleep duration among groups such as non-Hispanic Asian and American Indian or Alaskan Native children, or those with multiple races, whose sleep duration has previously not been well documented. Although associations decreased after adjusting for other demographic, family, and neighborhood factors and MBDD, children from several racial and ethnic minority groups still had significantly higher prevalence of short sleep duration, particu-

larly non-Hispanic Black children. Given that racial and ethnic minority populations are affected by additional risks for health disparities that were not addressed in the available survey data, a more comprehensive examination of systemic racism and social determinants of health may be needed to understand what contributes to these sleep disparities (9,23,30). In our study, the child's sex was not associated with short sleep duration, unlike in another study, which found shorter sleep among female adolescents (24).

As previously documented (9,14,22,24), children from households with lower socioeconomic status, as indicated by parental education and poverty levels, had higher percentages of short sleep duration. Neighborhood factors such as poor condition, and lack of amenities, safety, and support also were associated with short sleep duration, similar to previous studies (10,22,30). Short sleep duration among children was also associated with having parents with poor mental and physical health and with experiencing adversity in childhood (10,14,18,22,31).

Children with MBDD overall and MEB, including ADHD, behavior problems, anxiety, and depression specifically, had a significantly higher prevalence of short sleep duration than children without these disorders. The association with having an MBDD overall, and with each MEB disorder, was significant after controlling for demographic, neighborhood, and family factors. Having a developmental, language, or learning disorder or a physical health condition was also associated with short sleep duration; however, the associations were no longer significant after controlling for demographic, neighborhood, and family factors. Thus, this study provides further evidence that insufficient sleep is a concern among children with mental, emotional, and behavioral disorders (6,18). Associations between sleep and mental health can be bidirectional; mental health symptoms such as those experienced with ADHD, anxiety, or behavior problems can contribute to sleep problems and can also be exacerbated by insufficient sleep (1,4,6).

Given the increased probability of demographic, neighborhood, and family risk factors occurring together and being associated with children's mental health (10,11,16), we were able to examine whether these factors contributed independently. Our data showed that MBDD was associated with short sleep duration even after adjusting for the influence of other contextual factors. We also examined each child, family, and neighborhood factors' independent contribution to short sleep duration (controlling for MBDD diagnosis and all demographic, neighborhood, and family covariates) and found that, other than the child's sex, each contributed to the probability that a child would experience short sleep duration.

Evidence that children's MBDD and many of these demographic, family, and neighborhood variables are associated independently with short sleep duration points to potentially selecting these factors for prevention of insufficient sleep, particularly among communities affected by health disparities (16). Prior work suggests that sleep problems may also be a potential mechanism through which socioeconomic risk is translated into mental health problems (14,23). Further studies can explore whether comprehensive intervention approaches that improve family and community risks may improve both mental health and sleep, and thus, improve long-term healthy development.

Strengths and limitations

This study has several strengths. The large, nationally representative data set allowed for consideration of more factors and more generalizable results than clinical samples would allow. We were able to investigate differences between racial and ethnic groups such as non-Hispanic Asian, non-Hispanic American Indian and Alaskan Native, and non-Hispanic Native Hawaiian and Pacific Islander, whose sleep duration and associated risks are often not evaluated separately in studies because of small cell sizes. The comprehensive survey allowed for examination of sleep, mental health, and child, family, and neighborhood factors together.

This study also has several limitations. The cross-sectional analysis did not allow examination of causal pathways or bidirectional influences of sleep duration and risk factors. Parent-reported data may be affected by recall bias, social desirability, or parents' interpretation of items. The question for the sleep item had a minor wording change for children aged 6 to 17 years beginning with the 2018 survey. Although sensitivity analyses showed similar estimates and the same patterns of effects before and after the question was changed, this change should be considered when interpreting the results. The sleep indicator in this study measured a single aspect of healthy sleep, duration, and did not assess quality of sleep, presence of sleep disorders, and sleep architecture, all of which affect the restorative function of sleep (5,8). As mentioned, parents may overestimate sleep duration — possibly because parent reports often describe time in bed rather than time actually asleep — particularly for older children and adolescents, leading to lower-than-expected estimates for short sleep (32). Without objective measures, such as actigraphy or polysomnography, the association between insufficient sleep and mental health while accounting for community and family factors cannot be fully described (22).

The contextual factors included in this study do not cover the breadth of possible influences on sleep. Other related factors may affect sleep, such as the quality of the parent–child relationship or perinatal risks, among others (12,15). Moreover, school and community factors, such as later school start times and time spent in

extracurricular activities, affect sleep duration and are influenced by cultural context, which in turn can influence family factors such as enforcing consistent bedtimes (20).

The data in our study were collected before the COVID-19 pandemic, which has had positive and negative effects on factors related to adolescent sleep and mental health, such as more outdoor time and later school start times but also more stress, disruption of routines, and increased screen time (28,33). The long-term effects of the pandemic on sleep and mental health cannot yet be determined.

Implications for intervention

This study provides information to support that short sleep duration is a widespread public health concern among children of all ages. Many risk factors contribute independently to short sleep duration and present opportunities for intervention, for example, improving bedtime routines. Sleep education and behavioral health interventions may be feasible and effective (3). Parents and older children and adolescents may have misconceptions about sleep recommendations, and these misconceptions may affect sleep hygiene and sleep duration (19,24). This population may benefit from learning behaviors that promote healthy sleep, such as avoiding electronics and caffeine before bedtime (3,5). Health care providers can receive training to educate families about healthy sleep routines (1,3,5,9). Expectations about sleep and the effect of sleep interventions may be influenced by child age, family context, and cultural factors; more information could inform developmentally and culturally sensitive approaches (5,24,26,32). However, consistent bedtimes and sufficient time in bed are only 2 components of healthy sleep (8,19); health care providers can provide treatment to address other sleep problems that reduce healthy sleep, such as insomnia or obstructive sleep apnea (5,13). Addressing sleep concerns may be especially important for children with mental and developmental disorders (5,18).

Healthy sleep can also be promoted in schools and early care and education through educating children and families, and through policies and procedures that encourage sufficient sleep (3). Public health attention to the decline of sleep duration among adolescents in past decades has resulted in strategies such as later high school start times (3). Given that short sleep duration affected children of all ages and was highest in children aged 6 to 12 years, schools can also evaluate school start times for elementary and middle school and address other school policies, such as amount of homework and time required for extracurricular activities, that could affect children's ability to get sufficient sleep (20).

Our findings show risks and disparities related to child sleep on the individual, family, and community level. Attention to sleep as a risk for negative outcomes may be particularly important among children with MBDD. Conversely, addressing children's mental health concerns and improving factors that may influence mental health may result in better sleep. For example, in families where stress may interfere with sleep, parents, particularly those with poor mental or physical health, may benefit from receiving additional support for themselves and to strengthen the parent–child relationship, which may act as a buffer against poor mental health in racial and ethnic minority groups (12). Parents of children with sleep concerns, particularly if co-occurring with other disorders, may also need support to achieve sufficient sleep themselves (18).

Sleep interventions can be tailored to people who are most affected and address risks and disparities on each level — from individual to systemic (9,10). The historical decline in sleep duration disproportionately affects communities that experience other health disparities such as racial and ethnic minority groups, students living in urban areas, and those of low socioeconomic status (24), thus contributing to cumulative risk. Intervention approaches may focus on communities at risk by introducing sleep hygiene education in affordable housing communities, offering sleep education, and improving sleep hygiene by supplying beds for children and adolescents (9).

On a community level, interventions can also address improving the neighborhood context (17). Increasing safe access to green space and recreational areas such as parks and community gardens may directly and indirectly improve sleep by encouraging physical activity; reducing lights, noise, and temperature; and decreasing stress by facilitating social cohesion (9,30). Implementing public health policies to reduce crime and increase community safety can address structural inequalities and potentially ameliorate sleep disparities (9,30). Combining public health interventions that focus on improving sleep among children by addressing risks at the child, family, and community level may lead to improved long-term health, development, and well-being (2).

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Tables

Table 1. Weighted Prevalence of Short Sleep Duration Among Children Aged 3–17 Years, by Demographic, Neighborhood, and Family Characteristics, National Survey of Children's Health, United States, 2016–2019

Characteristic	No. of children	Short sleep duration,[a] weighted % (95% CI)	Prevalence ratio (95% CI)
Individual demographic factors			
Sex[b]			
Male	58,341	35.1 (34.1–36.0)	1.02 (0.98–1.06)
Female	54,584	34.4 (33.4–35.3)	1 [Reference]
Age, y			
3–5	19,966	35.0 (33.5–36.6)	1.14 (1.08–1.21)
6–12	46,897	37.5 (36.5–38.5)	1.22 (1.17–1.28)
13–17	46,062	30.7 (29.6–31.7)	1 [Reference]
Race and ethnicity[b]			
Hispanic	12,885	38.6 (36.7–40.5)	1.33 (1.26–1.40)
Non-Hispanic American Indian/Alaska Native	665	37.5 (31.2–44.2)	1.29 (1.09–1.53)
Non-Hispanic Asian	5,767	32.7 (30.2–35.1)	1.12 (1.04–1.21)
Non-Hispanic Black	7,048	50.0 (47.9–52.0)	1.72 (1.64–1.80)
Non-Hispanic Native Hawaiian/Pacific Islander	277	36.3 (25.5–48.2)	1.25 (0.93–1.69)
Non-Hispanic White	78,733	29.0 (28.4–29.6)	1 [Reference]
Non-Hispanic other (2016–2018 only)	647	36.1 (29.3–43.3)	1.24 (1.03–1.50)
Non-Hispanic ≥2 races	6,903	33.5 (31.2–35.8)	1.15 (1.07–1.24)
Parental education[b]			
Less than high school	2,680	45.6 (42.1–49.1)	1.66 (1.53–1.80)
High school	14,570	42.5 (40.8–44.3)	1.55 (1.48–1.63)

Abbreviations: ACEs, adverse childhood experiences; FPL, federal poverty level.

[a] For children aged 3–5 years: "During the past week, how many hours of sleep did this child get during an average day (count both nighttime sleep and naps)?" For children aged 6–17 years for 2018–2019: "During the past week, how many hours of sleep did this child get on most weeknights." The question in 2016–2017 asked about "an average weeknight." Short sleep duration was defined as <10 h for children aged 3–5 years, <9 h for children aged 6–12 years, and <8 h for children aged 13–17 years.

[b] If missing, this variable was imputed by using hot-deck imputation methods.

[c] If missing, family income was imputed by using sequential regression as an input to FPL; FPL was multiply imputed and contained 6 implicates.

[d] Category comprised 4 subcategories: "unsafe neighborhood," "neighborhood lacks support," "neighborhood in bad condition," and "neighborhood lacks amenities." Endorsement of any of these subcategories was counted as a respondent having ≥1 negative neighborhood factor.

[e] A response of definitely disagree/somewhat disagree (vs somewhat agree/definitely agree) when asked whether the child is safe in their neighborhood.

[f] A response of definitely disagree/somewhat disagree (vs somewhat agree/definitely agree) when asked whether people in the neighborhood help each other out, watch out for each other's children, and know where to go for help in their community when they encounter difficulties.

[g] A response of yes to any of these 3 items: 1) litter or garbage on the street or sidewalk, 2) poorly kept or rundown housing, or 3) vandalism such as broken windows or graffiti in their neighborhood.

[h] A response of no to any of these 4 items: 1) sidewalks or walking paths, 2) a park or playground, 3) a recreation center, community center, or boys' and girls' club, and 4) a library or bookmobile in the neighborhood.

[i] A response of child never/rarely/sometimes (vs usually/always) goes to bed at the same time on weeknights.

[j] Parent (both parents if 2 primary caregivers) reported fair/poor (vs good/very good/ excellent) mental health.

[k] Parent (both parents if 2 primary caregivers) reported fair/poor (vs good/very good/excellent) physical health.

[l] Child's ACEs included 9 items: 1) lived in a household where it was very hard to cover the basics, like food or housing, on the family's income; 2) parent or guardian divorced; 3) parent or guardian died; 4) parent or guardian served time in jail; 5) child saw or heard parents or adults slap, hit, kick, punch one another in the home; 6) was victim of violence or witnessed violence in neighborhood; 7) lived with anyone who was mentally ill, suicidal, or severely depressed, or 8) anyone who had a problem with alcohol or drugs; and 9) treated or judged unfairly because of his or her race or ethnic group. Data on ACEs related to child maltreatment were not available because the survey was based on parent report.

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Table 1. Weighted Prevalence of Short Sleep Duration Among Children Aged 3–17 Years, by Demographic, Neighborhood, and Family Characteristics, National Survey of Children's Health, United States, 2016–2019

Characteristic	No. of children	Short sleep duration,[a] weighted % (95% CI)	Prevalence ratio (95% CI)
Some college or associate degree	26,325	38.6 (37.3–39.9)	1.41 (1.35–1.47)
College degree or higher	68,484	27.4 (26.7–28.2)	1 [Reference]
Family income, % of FPL[c]			
<100%	12,371	44.9 (43.0–46.8)	1.73 (1.63–1.82)
100% to ≤199%	18,205	39.3 (37.5–41.0)	1.51 (1.43–1.59)
200% to ≤399%	34,700	33.4 (32.2–34.7)	1.29 (1.22–1.35)
≥400%	47,649	26.0 (25.2–26.9)	1 [Reference]
Negative neighborhood factors			
Overall			
≥1 Negative neighborhood factors[d]	83,770	36.5 (35.7–37.3)	1.28 (1.22–1.34)
No negative neighborhood factors	27,901	28.5 (27.3–29.7)	1 [Reference]
Safety			
Unsafe neighborhood[e]	3,589	46.2 (42.7–49.7)	1.36 (1.26–1.47)
Safe neighborhood	107,376	34.0 (33.3–34.7)	1 [Reference]
Support			
Neighborhood lacks support[f]	23,813	40.6 (39.1–42.0)	1.25 (1.20–1.30)
Neighborhood provides support	86,446	32.4 (31.7–33.2)	1 [Reference]
Condition			
Neighborhood in bad condition[g]	23,196	40.3 (38.8–41.9)	1.24 (1.19–1.29)
Neighborhood in good condition	87,560	32.6 (31.9–33.3)	1 [Reference]

Abbreviations: ACEs, adverse childhood experiences; FPL, federal poverty level.

[a] For children aged 3–5 years: "During the past week, how many hours of sleep did this child get during an average day (count both nighttime sleep and naps)?" For children aged 6–17 years for 2018–2019: "During the past week, how many hours of sleep did this child get on most weeknights." The question in 2016–2017 asked about "an average weeknight." Short sleep duration was defined as <10 h for children aged 3–5 years, <9 h for children aged 6–12 years, and <8 h for children aged 13–17 years.

[b] If missing, this variable was imputed by using hot-deck imputation methods.

[c] If missing, family income was imputed by using sequential regression as an input to FPL; FPL was multiply imputed and contained 6 implicates.

[d] Category comprised 4 subcategories: "unsafe neighborhood," "neighborhood lacks support," "neighborhood in bad condition," and "neighborhood lacks amenities." Endorsement of any of these subcategories was counted as a respondent having ≥1 negative neighborhood factor.

[e] A response of definitely disagree/somewhat disagree (vs somewhat agree/definitely agree) when asked whether the child is safe in their neighborhood.

[f] A response of definitely disagree/somewhat disagree (vs somewhat agree/definitely agree) when asked whether people in the neighborhood help each other out, watch out for each other's children, and know where to go for help in their community when they encounter difficulties.

[g] A response of yes to any of these 3 items: 1) litter or garbage on the street or sidewalk, 2) poorly kept or rundown housing, or 3) vandalism such as broken windows or graffiti in their neighborhood.

[h] A response of no to any of these 4 items: 1) sidewalks or walking paths, 2) a park or playground, 3) a recreation center, community center, or boys' and girls' club, and 4) a library or bookmobile in the neighborhood.

[i] A response of child never/rarely/sometimes (vs usually/always) goes to bed at the same time on weeknights.

[j] Parent (both parents if 2 primary caregivers) reported fair/poor (vs good/very good/ excellent) mental health.

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[l] Child's ACEs included 9 items: 1) lived in a household where it was very hard to cover the basics, like food or housing, on the family's income; 2) parent or guardian divorced; 3) parent or guardian died; 4) parent or guardian served time in jail; 5) child saw or heard parents or adults slap, hit, kick, punch one another in the home; 6) was victim of violence or witnessed violence in neighborhood; 7) lived with anyone who was mentally ill, suicidal, or severely depressed, or 8) anyone who had a problem with alcohol or drugs; and 9) treated or judged unfairly because of his or her race or ethnic group. Data on ACEs related to child maltreatment were not available because the survey was based on parent report.

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Table 1. Weighted Prevalence of Short Sleep Duration Among Children Aged 3–17 Years, by Demographic, Neighborhood, and Family Characteristics, National Survey of Children's Health, United States, 2016–2019

Characteristic	No. of children	Short sleep duration,[a] weighted % (95% CI)	Prevalence ratio (95% CI)
Amenities			
Neighborhood lacks amenities[h]	70,140	35.8 (35.0–36.7)	1.10 (1.06–1.15)
Neighborhood has amenities	40,522	32.6 (31.5–33.7)	1 [Reference]
Family factors			
Consistency of bedtime			
Inconsistent[i]	12,448	57.3 (55.4–59.2)	1.82 (1.75–1.90)
Consistent	100,103	31.4 (30.7–32.1)	1 [Reference]
Mental health of parent			
≥1 Parent with fair/poor mental health	7,988	47.5 (45.0–50.1)	1.43 (1.35–1.51)
No parent with fair/poor mental health[j]	101,120	33.3 (32.6–34.0)	1 [Reference]
Physical health of parent			
≥1 Parent with fair/poor physical health	10,269	46.0 (43.7–48.3)	1.40 (1.32–1.47)
No parent with fair/poor physical health[k]	98,946	33.0 (32.3–33.7)	1 [Reference]
No. of ACEs[l]			
0	64,843	28.9 (28.1–29.8)	1 [Reference]
1	24,776	39.2 (37.7–40.6)	1.35 (1.29–1.42)
2	10,517	42.1 (40.0–44.2)	1.45 (1.37–1.54)
3	5,305	44.4 (41.3–47.4)	1.53 (1.42–1.65)
≥4	6,364	47.2 (44.4–49.9)	1.63 (1.53–1.74)

Abbreviations: ACEs, adverse childhood experiences; FPL, federal poverty level.

[a] For children aged 3–5 years: "During the past week, how many hours of sleep did this child get during an average day (count both nighttime sleep and naps)?" For children aged 6–17 years for 2018–2019: "During the past week, how many hours of sleep did this child get on most weeknights." The question in 2016–2017 asked about "an average weeknight." Short sleep duration was defined as <10 h for children aged 3–5 years, <9 h for children aged 6–12 years, and <8 h for children aged 13–17 years.

[b] If missing, this variable was imputed by using hot-deck imputation methods.

[c] If missing, family income was imputed by using sequential regression as an input to FPL; FPL was multiply imputed and contained 6 implicates.

[d] Category comprised 4 subcategories: "unsafe neighborhood," "neighborhood lacks support," "neighborhood in bad condition," and "neighborhood lacks amenities." Endorsement of any of these subcategories was counted as a respondent having ≥1 negative neighborhood factor.

[e] A response of definitely disagree/somewhat disagree (vs somewhat agree/definitely agree) when asked whether the child is safe in their neighborhood.

[f] A response of definitely disagree/somewhat disagree (vs somewhat agree/definitely agree) when asked whether people in the neighborhood help each other out, watch out for each other's children, and know where to go for help in their community when they encounter difficulties.

[g] A response of yes to any of these 3 items: 1) litter or garbage on the street or sidewalk, 2) poorly kept or rundown housing, or 3) vandalism such as broken windows or graffiti in their neighborhood.

[h] A response of no to any of these 4 items: 1) sidewalks or walking paths, 2) a park or playground, 3) a recreation center, community center, or boys' and girls' club, and 4) a library or bookmobile in the neighborhood.

[i] A response of child never/rarely/sometimes (vs usually/always) goes to bed at the same time on weeknights.

[j] Parent (both parents if 2 primary caregivers) reported fair/poor (vs good/very good/ excellent) mental health.

[k] Parent (both parents if 2 primary caregivers) reported fair/poor (vs good/very good/excellent) physical health.

[l] Child's ACEs included 9 items: 1) lived in a household where it was very hard to cover the basics, like food or housing, on the family's income; 2) parent or guardian divorced; 3) parent or guardian died; 4) parent or guardian served time in jail; 5) child saw or heard parents or adults slap, hit, kick, punch one another in the home; 6) was victim of violence or witnessed violence in neighborhood; 7) lived with anyone who was mentally ill, suicidal, or severely depressed, or 8) anyone who had a problem with alcohol or drugs; and 9) treated or judged unfairly because of his or her race or ethnic group. Data on ACEs related to child maltreatment were not available because the survey was based on parent report.

Table 2. Weighted Prevalence of Short Sleep Duration Among Children Aged 3–17 Years, by Current Diagnoses, National Survey of Children's Health, United States, 2016–2019

Diagnosis	No. of children with disorder or condition[a]	Short sleep duration,[b] weighted % (95% CI)	Unadjusted PR (95% CI)	Adjusted PR[c] (95% CI)
Mental, behavioral, or developmental disorder (MBDD)[d]				
No MBDD	83,772	33.2 (32.5–34.0)	1 [Reference]	1 [Reference]
Any MBDD[e]	26,288	39.6 (38.2–40.9)	1.19 (1.14–1.24)	1.06 (1.02–1.11)
Any mental, emotional, or behavioral disorder[f]	20,974	40.9 (39.4–42.4)	1.23 (1.18–1.28)	1.11 (1.06–1.16)
ADHD	11,370	40.3 (38.4–42.2)	1.21 (1.15–1.28)	1.08 (1.02–1.15)
Behavior problems	8,220	44.6 (42.3–47.0)	1.34 (1.27–1.42)	1.10 (1.03–1.17)
Anxiety	11,053	40.9 (38.9–42.9)	1.23 (1.17–1.30)	1.14 (1.08–1.21)
Depression	4,845	48.0 (44.8–51.1)	1.44 (1.35–1.55)	1.24 (1.14–1.34)
Tourette syndrome	275	39.4 (27.1–52.9)	1.19 (0.87–1.63)	1.39 (1.13–1.71)
Any developmental, learning, or language disorders[g]	12,812	38.6 (36.7–40.6)	1.16 (1.10–1.23)	1.00 (0.94–1.06)
Physical health conditions[h]				
No physical health condition	72,361	34.0 (33.2–34.8)	1 [Reference]	1 [Reference]
Any physical health condition	36,956	36.1 (35.0–37.2)	1.06 (1.02–1.10)	1.00 (0.97–1.04)

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; PR, prevalence ratio.

[a] Categories of mental, behavioral, or developmental disorders are not mutually exclusive; children with multiple conditions are included in each applicable category.

[b] For children aged 3–5 years: "During the past week, how many hours of sleep did this child get during an average day (count both nighttime sleep and naps)?" For children aged 6–17 years for 2018–2019: "During the past week, how many hours of sleep did this child get on most weeknights." The question in 2016–2017 asked about "an average weeknight." Short sleep duration was defined as <10 h for children aged 3–5 years, <9 h for children aged 6–12 years, and <8 h for children aged 13–17 years.

[c] Adjusted PR calculated by controlling for sex, age, race and ethnicity, parental education, poverty, neighborhood factor composite (ie, ≥1 negative neighborhood factors vs no negative neighborhood factors), inconsistent bedtime, ≥1 parent with fair/poor mental health, ≥1 parent with fair/poor physical health, and ACEs.

[d] For each analysis in each group of MBDDs, children with a specific disorder were compared with children without any MBDDs. 83,772 children had no MBDDs; 2,865 children did not have information on all MBDDs and were not included in this analysis.

[e] A response of yes to current mental, behavioral, or developmental disorder (includes attention-deficit/hyperactivity disorder), behavior problems, anxiety, depression, learning disability, developmental delay, intellectual disability, speech and language disorder, autism spectrum disorder, and Tourette syndrome.

[f] A response of yes to current mental, emotional, or behavioral disorder (includes attention-deficit/hyperactivity disorder, behavior problems, anxiety, depression, Tourette syndrome).

[g] A response of yes to current developmental, language, or learning disorder (includes learning disability, developmental delay, intellectual disability, speech and language disorder, and autism spectrum disorder).

[h] A response of yes to current allergies, arthritis, asthma, blood disorder, brain injury, cerebral palsy, cystic fibrosis, diabetes, Down syndrome, epilepsy, heart condition, headaches, deafness, or blindness.

Table 3. Independent Contribution of Children's Mental, Behavioral, or Developmental Disorders, Demographic, Neighborhood, and Family Factors to Short Sleep Duration, National Survey of Children's Health, United States, 2016–2019

Variable	Short sleep duration,[a] adjusted prevalence ratio (95% CI)[b]
Mental, behavioral, or developmental disorders	
None	1 [Reference]
Any[c]	1.06 (1.02–1.11)
Demographic characteristics	
Sex[d]	
Male	1.01 (0.98–1.05)
Female	1 [Reference]
Age, y	
3–5	1.29 (1.22–1.36)
6–12	1.33 (1.27–1.38)
13–17	1 [Reference]
Race and ethnicity[d]	
Hispanic	1.12 (1.06–1.19)
Non-Hispanic American Indian/Alaska Native	1.00 (0.82–1.21)
Non-Hispanic Asian	1.15 (1.06–1.24)
Non-Hispanic Black	1.44 (1.36–1.51)
Non-Hispanic Native Hawaiian/Pacific Islander	1.03 (0.76–1.39)
Non-Hispanic White	1 [Reference]
Non-Hispanic other (2016–2018 only)	1.05 (0.85–1.29)
Non-Hispanic ≥2 races	1.05 (0.98–1.12)
Parental education[d]	
Less than high school	1.34 (1.22–1.48)
High school	1.25 (1.18–1.32)

Abbreviation: ACEs, adverse childhood experiences; FPL, federal poverty level.

[a] For children aged 3–5 years: "During the past week, how many hours of sleep did this child get during an average day (count both nighttime sleep and naps)?" For children aged 6–17 years for 2018–2019: "During the past week, how many hours of sleep did this child get on most weeknights." The question in 2016–2017 asked about "an average weeknight." Short sleep duration was defined as <10 h for children aged 3–5 years, <9 h for children aged 6–12 years, and <8 h for children aged 13–17 years.

[b] Adjusted prevalence ratio calculated by controlling for all other factors in the model: sex, age, race and ethnicity, parental education, poverty, neighborhood factor composite (ie, ≥1 negative neighborhood factors vs no negative neighborhood factors), inconsistent bedtime, ≥1 parent with fair/poor mental health, ≥1 parent with fair/poor physical health, ACEs, and mental, behavioral, or developmental disorders.

[c] A response of yes to current mental, behavioral, or developmental disorder (includes attention-deficit/hyperactivity disorder), behavior problems, anxiety, depression, learning disability, developmental delay, intellectual disability, speech and language disorder, autism spectrum disorder, and Tourette syndrome.

[d] If missing, this variable was imputed by using hot-deck imputation methods.

[e] If missing, family income was imputed by using sequential regression as an input to the FPL; FPL was multiply imputed and contained 6 implicates.

[f] Category comprised 4 subcategories: "unsafe neighborhood," "neighborhood lacks support," "neighborhood in bad condition," and "neighborhood lacks amenities." Endorsement of any of these subcategories was counted as a respondent having ≥1 negative neighborhood factor.

[g] A response of child never/rarely/sometimes (vs usually/always) goes to bed same time on weeknights.

[h] Parent (both parents if 2 primary caregivers) reported fair/poor (vs good/very good/ excellent) mental health.

[i] Parent (both parents if 2 primary caregivers) reported fair/poor (vs good/very good/ excellent) physical health.

[j] Child's ACEs included 9 items: 1) lived in a household where it was very hard to cover the basics, like food or housing, on the family's income; 2) parent or guardian divorced; 3) parent or guardian died; 4) parent or guardian served time in jail; 4) child saw or heard parents or adults slap, hit, kick, punch one another in the home; 6) was victim of violence or witnessed violence in neighborhood; 7) lived with anyone who was mentally ill, suicidal, or severely depressed, or 8) anyone who had a problem with alcohol or drugs; and 9) treated or judged unfairly because of his or her race or ethnic group. Data on ACEs related to child maltreatment were not available because the survey was based on parent report.

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Table 3. Independent Contribution of Children's Mental, Behavioral, or Developmental Disorders, Demographic, Neighborhood, and Family Factors to Short Sleep Duration, National Survey of Children's Health, United States, 2016–2019

Variable	Short sleep duration,[a] adjusted prevalence ratio (95% CI)[b]
Some college or associate degree	1.18 (1.13–1.24)
College degree or higher	1 [Reference]
Family income level, % of FPL[e]	
<100%	1.12 (1.04–1.20)
100% to ≤199%	1.08 (1.01–1.15)
200% to ≤399%	1.07 (1.02–1.12)
≥400%	1 [Reference]
Negative neighborhood factors[f]	
≥1	1.10 (1.05–1.15)
None	1 [Reference]
Family factors	
Consistency of bedtime	
Inconsistent[g]	1.70 (1.63–1.78)
Consistent	1 [Reference]
Mental health of parent	
≥1 Parent with fair/poor mental health	1.09 (1.01–1.17)
No parent with fair/poor mental health[h]	1 [Reference]
Physical health of parent	
≥1 Parent with fair/poor physical health	1.09 (1.02–1.16)
No parent with fair/poor physical health[i]	1 [Reference]
No. of ACEs[J]	
0	1 [Reference]

Abbreviation: ACEs, adverse childhood experiences; FPL, federal poverty level.

[a] For children aged 3–5 years: "During the past week, how many hours of sleep did this child get during an average day (count both nighttime sleep and naps)?" For children aged 6–17 years for 2018–2019: "During the past week, how many hours of sleep did this child get on most weeknights." The question in 2016–2017 asked about "an average weeknight." Short sleep duration was defined as <10 h for children aged 3–5 years, <9 h for children aged 6–12 years, and <8 h for children aged 13–17 years.

[b] Adjusted prevalence ratio calculated by controlling for all other factors in the model: sex, age, race and ethnicity, parental education, poverty, neighborhood factor composite (ie, ≥1 negative neighborhood factors vs no negative neighborhood factors), inconsistent bedtime, ≥1 parent with fair/poor mental health, ≥1 parent with fair/poor physical health, ACEs, and mental, behavioral, or developmental disorders.

[c] A response of yes to current mental, behavioral, or developmental disorder (includes attention-deficit/hyperactivity disorder), behavior problems, anxiety, depression, learning disability, developmental delay, intellectual disability, speech and language disorder, autism spectrum disorder, and Tourette syndrome.

[d] If missing, this variable was imputed by using hot-deck imputation methods.

[e] If missing, family income was imputed by using sequential regression as an input to the FPL; FPL was multiply imputed and contained 6 implicates.

[f] Category comprised 4 subcategories: "unsafe neighborhood," "neighborhood lacks support," "neighborhood in bad condition," and "neighborhood lacks amenities." Endorsement of any of these subcategories was counted as a respondent having ≥1 negative neighborhood factor.

[g] A response of child never/rarely/sometimes (vs usually/always) goes to bed same time on weeknights.

[h] Parent (both parents if 2 primary caregivers) reported fair/poor (vs good/very good/ excellent) mental health.

[i] Parent (both parents if 2 primary caregivers) reported fair/poor (vs good/very good/ excellent) physical health.

[j] Child's ACEs included 9 items: 1) lived in a household where it was very hard to cover the basics, like food or housing, on the family's income; 2) parent or guardian divorced; 3) parent or guardian died; 4) parent or guardian served time in jail; 4) child saw or heard parents or adults slap, hit, kick, punch one another in the home; 6) was victim of violence or witnessed violence in neighborhood; 7) lived with anyone who was mentally ill, suicidal, or severely depressed, or 8) anyone who had a problem with alcohol or drugs; and 9) treated or judged unfairly because of his or her race or ethnic group. Data on ACEs related to child maltreatment were not available because the survey was based on parent report.

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Table 3. Independent Contribution of Children's Mental, Behavioral, or Developmental Disorders, Demographic, Neighborhood, and Family Factors to Short Sleep Duration, National Survey of Children's Health, United States, 2016–2019

Variable	Short sleep duration,[a] adjusted prevalence ratio (95% CI)[b]
1	1.19 (1.13–1.25)
2	1.22 (1.15–1.30)
3	1.25 (1.15–1.35)
≥4	1.28 (1.19–1.39)

Abbreviation: ACEs, adverse childhood experiences; FPL, federal poverty level.

[a] For children aged 3–5 years: "During the past week, how many hours of sleep did this child get during an average day (count both nighttime sleep and naps)?" For children aged 6–17 years for 2018–2019: "During the past week, how many hours of sleep did this child get on most weeknights." The question in 2016–2017 asked about "an average weeknight." Short sleep duration was defined as <10 h for children aged 3–5 years, <9 h for children aged 6–12 years, and <8 h for children aged 13–17 years.

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[c] A response of yes to current mental, behavioral, or developmental disorder (includes attention-deficit/hyperactivity disorder), behavior problems, anxiety, depression, learning disability, developmental delay, intellectual disability, speech and language disorder, autism spectrum disorder, and Tourette syndrome.

[d] If missing, this variable was imputed by using hot-deck imputation methods.

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ORIGINAL RESEARCH

Parental Perspectives of Sleep in the Home: Shaping Home–School Partnerships in School-Based Sleep Promotion Initiatives

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PEER REVIEWED

Summary

What is already known on this topic?

Improving sleep behaviors among children promotes positive health outcomes. Schools are a critical setting where children learn healthy behaviors, which are translated to the home environment. How parents perceive school-based sleep promotion, and how they support the translation of learning at home, is not well understood.

What is added by this report?

Parents were responsive to school-based sleep promotion and valued a collaborative approach to support child sleep health. Parents cited barriers (busy lifestyle, parents as poor role models) to healthy sleep hygiene and school-based sleep promotion.

What are the implications for public health practice?

Findings support the implementation of school-based sleep promotion through strategies that can improve parent and school collaboration related to sleep.

Abstract

Introduction

Sleep is a critical component of child health and the prevention of chronic disease. Children may benefit from school-based sleep promotion; however, parents need to be involved for healthy sleep strategies learned at school to be translated to the home. The objective of this study was to explore parental perspectives on sleep behaviors and responsiveness to school-based sleep promotion.

Methods

Twenty-five parents of school-aged children were purposively sampled for interviews from July 2019 through April 2020 in Alberta, Canada. Descriptive qualitative methodology was used, and data were generated through semistructured interviews and researcher field notes. Interviews were transcribed and themes were identified by using latent content analysis.

Results

Three themes emerged from analysis: 1) sleep is valued and supported, 2) barriers to healthy sleep exist, and 3) schools are allies in promoting sleep. Parents perceived that sleep was essential for their child's health, facilitated healthy sleep practices in the home, and highlighted barriers (busy schedules and poor parental role models) that affected sleep. Parents supported and expressed value in school-based sleep promotion and noted factors that affected the success of school-based sleep promotion.

Conclusion

Parents are responsive to school-based sleep promotion. Promotion efforts should include resources that engage and involve parents in the school community. Throughout the development of resources to support school-based sleep promotion, additional consideration of parent-reported barriers to promoting healthy sleep in the home should be included.

Introduction

Sleep is an essential component of a healthy lifestyle among children; however, declines in child sleep status warrant investigation and promotion of interventions (1). Without quality sleep, children are at risk of short- and long-term health consequences, including developing chronic diseases (1–7). Improving sleep practices through settings-based health promotion can promote health among children (8). Comprehensive school health, or its equivalencies (9), is an approach that prioritizes school, home, and com-

munity partnerships to reinforce healthy behaviors, including healthy sleep behaviors, across environments where children live, learn, and play (10). Although school-based interventions have been effective in improving healthy eating, active living, and academic outcomes (11), sleep has received minimal research attention (12). Parental participation is essential in sleep promotion; families substantially shape beliefs about sleep and can either reinforce or hinder healthy sleep practices at home (13–15). Whether parents support school-based sleep promotion and the translation of this knowledge to the home is unknown. Therefore, it is important to explore parents' perceptions of sleep, their view on the role of the school in promoting sleep, and ways that parents facilitate or hinder their children's sleep.

Engagement of parents in health promotion interventions aids in successful implementation (10,16). The comprehensive school health approach explores school-based sleep promotion, and home–school collaboration is a key component to its implementation (16). Such research will contribute to the field of school-based sleep promotion. Assessing parents' knowledge about the importance of children's sleep and their receptiveness to school-based sleep promotion allows for the informed development of strategies, ensuring that parental uptake is more likely, thus improving the likelihood of success. The objective of this research was to explore parental perspectives on sleep behaviors and how parenting practices facilitate and support or hinder their children's healthy sleep behaviors.

Methods

This study used a descriptive qualitative method. A method of naturalistic inquiry, the descriptive qualitative method aims to understand experiences, events, or processes in human experiences (17). Qualitative descriptive research has descriptive and interpretive validity because the researcher stays close to the data through summarization of participant experiences (18). This approach was used to explore parental perspectives of sleep behavior in the home to provide clear information to enhance school-based sleep promotion. Descriptions are in-depth narratives that help the reader understand a setting or situation. These rich descriptions can easily be understood by key community members, implementing partners, and knowledge users.

Participants

Twenty-five parents of school-aged children (aged 5–12 y) were purposively sampled in Alberta, Canada. This project was part of a larger initiative aiming to improve how school-based sleep promotion programs could address sleep health in Alberta. We used maximum variation sampling, a form of purposeful sampling (differing geographic location and grade of students), to allow for phenomenal variation to represent diversity across the sample accurately (19). This process allowed for representation of parents from multiple school jurisdictions across the province with students in kindergarten through grade 6. Parental participation was not limited to those whose children had participated in a school-based sleep promotion program. Recruitment occurred as part of a larger project, Sleeping Soundly (https://www.katestorey.com/our-projects/sleeping-soundly), whereby information about this study was shared with parents through existing school connections and provincial partner networks, including APPLE Schools and Alberta Health Services. All participants who were recruited (N = 25) completed interviews. Recruitment methods included posters, newsletters, online postings, and word of mouth. Each parent read and signed the information letter and consent form before participating in the research project. Ethical approval was granted through the Human Research Ethics Board at the University of Alberta.

Procedure

Each parent participated in a one-on-one semistructured interview in a public space or over the telephone. Interviews were conducted from July 2019 through April 2020. The interview guide was developed by University of Alberta researchers and other experts in school-based health promotion (Table). Interviews centered on parental perspectives and sleep practices in the home and the role of schools in promoting healthy sleep habits. Field notes and observations were also used in combination with interviews to contribute to the richness of the data and to align with a descriptive qualitative method.

Data analysis

Interviews were audio-recorded and transcribed verbatim by a professional transcriptionist. Transcribed interviews and researcher field notes were imported into NVivo version 12 qualitative organizational software (QSR International). Data were analyzed after each parent interview, and initial thoughts and interpretations were recorded. Field notes provided essential information about the contextual environment of participants' experiences and were incorporated into data analysis procedures. Latent content analysis was used to identify meaning units and to describe parental understanding of sleep behavior in the home and school-based sleep promotion. Transcripts were read and reread to identify meaning units and then assigned individual codes, each with descriptive inclusion criteria. Codes were then categorized and recategorized to reveal relationships within the data (20). Transcripts were read to ensure subcategories and codes were consistent with the theme meaning, and categories were separated when distinct ideas were identified. All data analysis was conducted by the researcher who was debriefed by a member of the research team throughout the analysis process to ensure accuracy of interpretations.

Results

Parents resided in Northern Alberta (Edmonton, Peace River, Grande Prairie) and Southern Alberta (Calgary, Drumheller). All 25 participants were women; the average (SD) age was 39.0 (4.6) years. Their children were in grades kindergarten to grade 6; the average (SD) age was 8.3 (2.0) years. Parent-reported average child bedtime was 8 PM on weekdays and 8:30 PM on weekends. Average wake-up time was 6:45 AM on weekdays and 7:15 AM on weekends. Children's sleep duration averaged 10.8 hours on weekdays and 10.6 hours on weekends.

The following themes emerged from the analysis: 1) sleep is valued and supported, 2) barriers to healthy sleep exist, and 3) schools are allies in promoting sleep. Parents perceived that sleep was essential for their child's health and facilitated healthy sleep practices in the home but explained potential barriers that affected sleep in families.

Theme 1: Sleep is valued and supported

Parents strongly emphasized the value of healthy sleep practices and described their experiences supporting their child's sleep. Parents explained that sleep was important for their child to function in everyday life and believed that sleep was important for their child to do well in school and to manage their emotions.

Subtheme: Parents recognize the importance of sleep. Parents believed that their child's sleep was important and illustrated how sleep had positive effects on their children. Sleep was perceived to affect children's learning, attention, focus, and mood, and in turn, affected their child's ability to function in school and in everyday life. One parent summarized this concept below:

> Their brains are growing so fast they need to like, regroup and you know be able to absorb all that knowledge and grow, and be well rested, and I think it just affects everything. I think that sleep is just as important as eating healthy, right across the board they need proper sleep, cause if you don't have it, you're tired and you're cranky. And then you can't, you know, focus, perform well at school, or you just feel like crap. (Parent 47)

Parents observed that poor sleep affects a child's ability to function and pay attention and voiced that well-rested children can focus better in school and pay attention to the concepts they are learning in class. Parents described their children as cranky, moody, quick to anger, and unable to regulate their emotions when they did not get enough sleep.

Subtheme: Parenting practices support healthy sleep behaviors. Parents identified practices that facilitated healthy sleep behaviors in their children. These practices included setting and enforcing rules and establishing a consistent bedtime routine. Parents indicated that setting and enforcing rules was crucial in developing healthy sleep practices for their children. As well, parents described that children who had clear rules and expectations understood what they should do when preparing for bed and could have more independence with their sleep routines. One parent used a Groclock (a sleep trainer clock for young children) to help their children understand when to go to bed and when to get up:

> They have a Groclock in their room, so they have to stay in there — in their bedrooms until in the morning, until their Groclock comes up. Yeah, it works great, so yeah, that's kind of — that's the rule. Once they're in bed they stay in bed until the clock goes off. (Parent 36)

Parents recalled that establishing a consistent bedtime routine helped to facilitate their children's healthy sleep behaviors. One parent mentioned that to set their child up for success they needed to "have a routine . . . and consistency in what they do for the routine" (Parent 40). The bedtime routine was viewed as easier if their child could anticipate what their routine leading to bedtime would look like and would cue the children to relax and prepare for sleeping.

Theme 2: Barriers to healthy sleep exist

Although parents valued sleep behaviors in the home and carried out practices to support sleep in their children, they described lifestyle factors that negatively contributed to healthy sleep hygiene in the home. These lifestyle factors were described as having a busy lifestyle and not prioritizing sleep as a parent.

Subtheme: Busy lifestyle. Parents described that there are "times where we're just go, go, go, and we've been so busy in the evening" (Parent 13), and this busy schedule caused their child(ren) to go to bed at a later time. Parents indicated that it is "chaotic when there are [commitments] after school, and by the time you get home, have dinner, it's just a little bit later" (Parent 52). Having a busy schedule was a barrier to establishing a routine sleep behavior in children because it tends to keep children up later.

Subtheme: Parents as poor role models. Parental lifestyle was recognized as a barrier to healthy sleep habits in the home. Parents described that their sleep practices were often very different from their children's. One parent recalled that: "We're probably very bad role models. We tend to stay up later and wake up at the last moment" (Parent 31). One parent indicated that parents do not set a good example to their children and described the effect this may have on their children's sleep behavior:

> There's not one person that I know that's a parent that sets a good example of sleep. The fact that kids they do what they see, as op-

> posed to what they hear. So unless they actually understand why they need sleep, and unless they can actually understand the difference that makes in their own life and see it themselves. They may not always listen, and it may be harder for them to get to sleep. (Parent 20)

Parents also felt that they did not have "a good routine going to sleep" and were "always so busy getting stuff done" (Parent 28) that they do not have time to wind down and have a sleep routine. Many parents cited having a television in their room was negative role modeling. Parents indicated that they knew "a lot of adults don't follow the 'no technology rule' before bed" (Parent 13).

Theme 3: Schools are allies in promoting sleep

Parents viewed sleep promotion in schools as a valuable tool to reach children and provide education on sleep and believed that children could learn about sleep in school and transfer this knowledge to their family members in the home. However, parents believed that school-based sleep promotion initiatives required support from both the school and the home to be successful.

Subtheme: Sleep promotion in school is valuable to reach children. Parents felt that sleep promotion in schools was valuable and could help children learn how to improve their sleep. Parents described that learning about sleep in school could become "a habit that would be good and healthy for them" (Parent 22). Parents thought that if students were not "learning about [sleep] at home, then school would be a good place for them to hear it" (Parent 39). One parent noted how sleep promotion in school is important to support families and the community:

> But when you have parental and family structures like we do and we're seeing more and more, with double working families, or things like that — the community, especially the school has a bigger role to play. . . . I think if we're putting things like sleep or nutrition, these things as part of our health unit, it's really important. (Parent 16)

One parent mentioned their view on the importance of integrating sleep into the classroom as a mechanism to reach more children:

> I think it should kind of be something that gets mentioned, I mean they have health classes and stuff like that, so I think it's definitely something that they can discuss in school 'cause not all parents are going to discuss that with their kids. . . . I know that a lot of kids don't get that from their parents, so I know that if the school were to help out a little bit teaching that, I think that it would — it would be very good. (Parent 52)

Subtheme: Sleep promotion at school can translate to the home. Parents believed that students who learned about sleep at school could bring this information home and foster healthier sleep habits in the home. Parents noted that sleep promotion in schools would help reinforce the importance of sleep. Parents suggested that students could then bring awareness of healthy sleep practices back to the home and engage the family:

> I think, just school's role in having those discussions, and setting that value for sleep, can help, right, can help students. If teachers are saying how important it is, and things like that, maybe that helps bring that conversation out to the home, so that their awareness is better that every — every — it's important for everyone and everyone's doing it. (Parent 31)

Parents needed to support their children to achieve healthier sleep behaviors in partnership with the school:

> I mean it's on both. We've had this conversation at work where other people are like, "Oh, they're not learning that in school. Well then, it's the parents job to teach them some of these like life skills." Right, so, I think it's both. I mean it needs to be coming from both sources, parents — parents need to sort of reinforce maybe what's coming home from school — but I mean it's both school and parents. (Parent 44)

Discussion

Parents valued and supported healthy sleep practices, recognized barriers to healthy sleep in the home, and identified schools as allies in promoting sleep. Parents shape their children's sleep practices in the home from a young age and continue to influence their children through their elementary years (21). Parenting practices and parent–child relationships affect child sleep (22), while differing views of problematic sleep behavior (23) may cause chronically inadequate sleep and health consequences. In our study, parents demonstrated an accurate knowledge of the effect of inadequate sleep on their children. Parents appeared to be aware of the potentially harmful effects of inadequate sleep on their children and were motivated to improve their children's sleep behaviors. Parents reported that they thought sleep was valuable for their children's learning, development, attention, focus, energy, mood, academic achievement, and coping and resiliency; these outcomes have been substantiated in the literature (24). Overall, parents were knowledgeable of the effect of inadequate sleep on their children.

Parents cited barriers to achieving healthy sleep habits in the home and reported that their family's busy lifestyle limited their ability to establish a consistent bedtime routine and bed/wake times. Both extracurricular commitments and a busy schedule were previously identified as barriers to child sleep (25). Our study showed that parents recognize themselves as poor role models for healthy sleep

behavior. Although some literature indicates the importance of parents as role models for physical activity (26) and healthy eating (27), the effect of parent role modeling on sleep practices is not strongly demonstrated. However, one study suggested that parents may decrease their children's screen time by reducing their own screen times (28). Because screen time use before bed is negatively correlated with a child's sleep quality (29), parents may indirectly improve their child's sleep behavior through role modeling by reducing their own screen time. Additional research is needed to explore the effect of parent role modeling on their children's healthy sleep practices and investigate viable strategies to address parent-reported barriers to healthy sleep habits.

Since this research was conducted, the Canadian Sleep and Circadian Network released a national strategy to integrate sleep research priorities and policy into public health and identified school-based sleep promotion as a target (30). However, exploration and evidence of parent receptivity to school-based sleep promotion are limited. Parents have been found to support school policy changes that promote healthy eating habits (31). Studies that evaluate parent perspectives of comprehensive school health interventions have not included sleep and tended to focus on physical activity, nutrition, and sedentary behavior, with most parents viewing that these behaviors are a collective responsibility of both the school and home (32). Thus, our study provides new insight: parents are supportive of school-based sleep promotion, are willing to be involved in school-based sleep promotion, and view it as a strategy to reach families with diverse needs who may not promote sleep at home due to social and economic influences. It is promising that parents believed their children would share information at home and cause changes in the family. This study demonstrates that parents view school-based sleep promotion as a viable option for improving child sleep and are supportive of their children's school-based learning about sleep health. Thus, it is likely that school-based sleep promotion interventions will be successful.

Limitations and strengths

This study has several limitations. First, all of the participants identified as women. It is well established that mothers influence child sleep, but other family members (eg, fathers, grandparents, siblings, guardians) and caregivers can also influence sleep behaviors. Second, 8 of the 25 parents were interviewed during the early onset of the COVID-19 pandemic. Lifestyle changes caused by the pandemic may have shifted their attitudes toward child sleep, and their responses may have been different had they been interviewed before the pandemic. Third, researchers used a Westernized lens and promoted sleep practice guidelines that best suit a Eurocentric viewpoint. The diverse cultural heterogeneity in the Canadian population demonstrates that various sociopolitical and environmental factors (eg, socioeconomic status, race and ethnicity, sex and gender, cultural and family traditions) affect sleep, and some perceptions of sleep may not be fully represented by this research project. A strength of this research was the purposeful sampling of parents to include participants from across multiple jurisdictions in Alberta, which allowed for diversity across the sample.

Conclusions

This research was conducted to explore parent responsiveness to school-based sleep promotion that uses a comprehensive school health approach. This study found that participating parents were well-informed of the importance of adequate sleep in their children and perceived that sleep was valuable and supported in the home. Parents viewed school-based sleep promotion as a strategy to promote awareness of healthy sleep among children who may not learn about sleep at home. Parents recognized that their own sleep behaviors affected the promotion of healthy sleep in the home. A range of behavioral change strategies is needed to address sleep on various socioecologic levels. For example, parents noted the effect of social and economic influences on health and noted that schools can be environments to address health inequalities. Grounded in the comprehensive school health approach, the school is an organizational component that can address individual and interpersonal factors. This research underscores the importance of home–school partnerships in promoting children's sleep. It is recommended that future school-based sleep promotion include options that support families with diverse needs, including free or low-cost pathways to health supports and services. In elementary grade levels, educators can incorporate lesson plans that actively engage the whole family, such as interactive games or home sleep challenges to raise awareness of the importance of sleep in the home. Additional consideration of parent-reported barriers to promoting healthy sleep in the home is required in future school-based programs for tailored, effective sleep promotion. Overall, the results of this study demonstrate that parents view school-based sleep promotion as a viable option for improving child sleep. Additional research should explore educator, administrative, and division-level perspectives in implementing school-based sleep promotion that uses a comprehensive school health approach.

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Table

Table. Interview Guide to Determine Parental Perspectives on Sleep Behaviors and Responsiveness to School-Based Sleep Promotion, Alberta, Canada, July 2019–April 2020

Topic	Questions
Parenting	How would you describe your overall approach to parenting?
	Do you parent differently in different situations?
	Has your parenting approach changed over the years?
	Do you parent different children in different ways?
Sleep	Describe the sleeping environment at home.
	Where do children and adults sleep? How many people in each bed? Are there pets in the room? Is there technology in the room?
	Do you feel that sleep is important for your child? Would you describe your child as a good sleeper?
	Are you concerned about your child's sleep? If so, what concerns you?
	Do you ever seek out information to support sleep behaviors in your home environment? Where and who do you get this information from?
	Do you feel you could change your child's sleep behaviors?
	How would you do this if you wanted to change your child's sleep behaviors?
	Have you ever tried to change your child's sleep behaviors? How did you do this?
	Describe any specific bedtime routines in your home.
	Explain any rules around your child's sleep behaviors.
	In what ways does your sleep routine differ from that of your child?
	Do you believe that other health behaviors affect sleep?
School-based sleep education	What things does your child learn at school and share with your family at home? Has this impacted any changes in the home environment?
	Has your child ever shared information about any campaigns at school to promote healthy sleep with you? If so, did it impact any changes in your home?
	What role do you think your child's school has in teaching healthy sleep behaviors?
	What role do schools play in teaching children about healthy sleep habits? Is this the responsibility of the school or the parents? Or a collaborative effort?
	In what ways do you think the whole family could use sleep education learned at school? What are some ways that this process can be improved?
	Are you aware that your child attends an APPLE School? Can you tell me about some of the initiatives that have occurred due to being in an APPLE School? (if applicable)
	What would an ideal bedtime routine look like for you and your child?
	What is the biggest barrier to a good night's sleep?

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ORIGINAL RESEARCH

Association Between Insufficient Sleep, Depressive Symptoms, and Suicidality Among Florida High School Students

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PEER REVIEWED

Summary

What is already known on this topic?

Emerging studies suggest a connection between insufficient sleep and suicidal ideation; however, additional research is needed to further investigate the relationship between sleep and mental health among adolescents.

What is added by this report?

This study uses timely, representative, state-level data to examine the relationship between insufficient sleep, suicidal ideation, and depressive symptoms among high school students. After adjustments, we observed disparities in mental health between adolescents with and without insufficient sleep.

What are the implications for public health practice?

Findings underscore the importance of addressing the role of sleep as a modifiable risk factor contributing to mental health difficulties among adolescents. Suicide prevention efforts should consider adolescents experiencing chronic sleep deprivation.

Abstract

Introduction

Emerging research suggests insufficient sleep can heighten the risk of poor mental health among adolescents. We examined the relationship between sleep, depressive symptoms, and suicidal thoughts and behaviors among Florida high school students.

Methods

Data were from the 2021 Florida High School Youth Risk Behavior Survey, a statewide representative sample of students in grades 9 to 12. We estimated prevalence of 1 indicator of depressive symptoms — feeling sad or hopeless for 2 or more weeks — and 2 indicators of suicidality — having considered attempting suicide and making a suicide plan — by insufficient sleep status (<8 h of sleep on an average school night). Multivariate logistic regressions were used to calculate odds ratios measuring the association between insufficient sleep, poor mental health, and suicidality.

Results

Compared with students reporting sufficient sleep, those with insufficient sleep were more likely to feel sad or hopeless (42.7% vs 28.1%), have considered suicide (19.1% vs 12.5%), or have made a suicide plan (14.8% vs 9.6%). In adjusted multivariate models, compared with students with sufficient sleep, students with insufficient sleep had higher odds of feeling sad or hopeless (adjusted odds ratio [AOR] = 1.83; 95% CI 1.54–2.17), and having made a plan about how they would attempt suicide (AOR = 1.32; 95% CI, 1.00–1.74), but did not have significantly higher odds of having seriously considered suicide.

Conclusion

Increased attention to sleep as a modifiable risk factor for mental health among adolescents is particularly important because of the many less modifiable factors that contribute to mental health difficulties in this population. Adolescent mental health programs should consider sleep an important factor in suicide prevention.

Introduction

Depression and suicidality among adolescents are significant public health concerns. Prevalence estimates from the national 2019 Youth Risk Behavior Survey (YRBS) show that 36.7% of high school students in the US felt sad or hopeless, 18.8% seriously considered attempting suicide, and 15.7% made a suicide plan (1) compared with 33.7%, 15.6%, and 11.8% in Florida, respectively (2). Given that suicide is a leading cause of death among adoles-

cents and young adults (3), it is important to examine potentially modifiable risk factors to decrease future illness and death in this population.

One modifiable risk factor receiving increased attention from researchers is insufficient sleep. Studies have shown that serious health consequences of insufficient sleep among adolescents range from increased risk-taking behaviors, such as substance use and impaired driving, to decreased physical well-being and perceived quality of life (4–6). Other studies found that the consequences of sleep deprivation extend to negative effects on mental health (7,8). One study examined potential links between sleep difficulties and suicidality among high school students and found that adolescents who slept less than 8 hours a night were approximately 3 times more likely to attempt suicide than those who slept 9 or more hours (adjusted odds ratio [AOR] = 2.89; 95% CI, 1.07–7.81) (7). A study using 2017 national YRBS data on adolescents aged 14 years or older found that insufficient sleep, defined as less than 8 hours on an average school night, was associated with increased risk of suicidal ideation (AOR = 1.35; 95% CI, 1.16–1.58) (8).

The relationship between mood disorders and insufficient sleep is known to be bidirectional in adults, and emerging literature suggests a similar pattern may exist among adolescents (9,10): depressive symptoms and suicidal thoughts and behaviors may lead to poor sleep, and poor sleep can increase the risk of depressive symptoms and suicidality. However, recent longitudinal studies among adolescents found that shorter sleep duration at baseline increased the presence of depressive symptoms at follow-up, providing evidence that sleep deprivation precedes mental health difficulties (11,12). This pattern is concerning because the number of US adolescents who get the recommended 8 hours of sleep per night decreased significantly, from 31.1% in 2007 to 22.1% in 2019 (1).

Although studies have documented significant associations between insufficient sleep and suicidal behaviors among adolescents, additional timely research is needed to explore the connections between insufficient sleep and mental health overall, particularly given the recent decline in sufficient sleep among high school students (1) and the increase in depressive symptoms (13,14). The 2021 Florida High School Youth Risk Behavior Survey (FL-YRBS) provided a unique opportunity to use very recent, representative, state-level data to explore the relationship between sleep, depressive symptoms, and suicidal thoughts and behaviors. Such data can help local public health officials better understand these relationships and enable more timely suicide prevention efforts among adolescents.

Methods

The FL-YRBS is a statewide, school-based, confidential survey of Florida's public high school students in grades 9 to 12 that collects data on priority health-risk behaviors that contribute substantially to leading causes of death, disability, and social problems among adolescents that may extend into adulthood. The 2021 FL-YRBS was conducted in partnership with the Centers for Disease Control and Prevention (CDC), whose institutional review board approved the protocol for the national YRBS. The FL-YRBS uses a complex, 2-stage cluster probability sample design. First, a random sample of public high schools is selected for participation. Second, within each selected school, a random sample of classrooms is chosen, and all students in the selected classroom sample are eligible to participate. Student participation is voluntary and anonymous. Consent processes vary by school district; however, in 2021, all participating districts obtained parental consent through passive opt-out permission forms. The biennial FL-YRBS was first administered in 2001. In 2021, the most recent year of survey administration, 4,766 students participated, yielding 4,672 completed questionnaires with usable data. The school response rate was 99%, and the student response rate was 64% for an overall response rate of 64%. All responses were weighted to obtain a representative sample of Florida public high school students in grades 9 to 12 (15).

We used 4 survey questions to examine the association between insufficient sleep, depressive symptoms, and suicidality among Florida high school students. Sleep duration was assessed by asking respondents how many hours of sleep they got on an average school night, with response options of 4 hours or less, 5 hours, 6 hours, 7 hours, 8 hours, 9 hours, and 10 or more hours. Following recommendations from CDC and the American Academy of Sleep Medicine, insufficient sleep was defined as reporting less than 8 hours of sleep on an average school night (16,17). Three mental health questions asked respondents whether, in the past 12 months, they 1) felt so sad or hopeless almost every day for 2 weeks in a row or more that they stopped doing usual activities, 2) seriously considered attempting suicide, and 3) made a plan about how they would attempt suicide. The mental health questions were assessed by using dichotomous yes and no response options.

We adjusted for the following demographic characteristics in multivariate models: sex, race or ethnicity, and grade level. Sex was coded dichotomously with male serving as the reference category. Participant race or ethnicity was collapsed into the following categories: non-Hispanic White, non-Hispanic Black, Hispanic or multiple Hispanic (includes Hispanic in addition to one or more races), and non-Hispanic Other. Grade level was coded into 9th, 10th, 11th, and 12th, with 9th grade serving as the reference cat-

egory. In subsequent multivariate models, we controlled for 4 additional possible risk factors for poor mental health (bullying victimization, electronic bullying victimization, current alcohol use, and current marijuana use) and 1 potential protective factor (physical activity). Bullying victimization and substance use indicators were selected for inclusion as risk factors because studies have found school bullying (18), cyberbullying (19), alcohol use (20), and marijuana use (21) to be associated with increased risk of depression and suicidality among adolescents. Physical activity was selected as a protective factor because existing literature has shown that participating in physical activity is associated with decreased odds of depressive symptoms among adolescents (22). Bullying victimization was defined as an affirmative response to the question, "During the past 12 months, have you ever been bullied on school property?" Electronic bullying victimization was defined as an affirmative response to the question, "During the past 12 months, have you ever been electronically bullied? (Count being bullied through texting, Instagram, Facebook, or other social media.)." Current alcohol and marijuana use were defined as use during the 30 days before the survey. Physical activity engagement was based on response to the question, "During the past 7 days, on how many days were you physically active for a total of at least 60 min per day? (Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time.)." Respondents who reported physical activity on 5 or more days were coded as physically active.

We conducted univariate, bivariate, and multivariate analyses to examine the relationship between insufficient sleep and mental health. First, descriptive statistics were calculated for all study variables to examine the distribution of sample characteristics. Then we used Rao-Scott modified χ^2 tests to analyze bivariate associations between insufficient sleep and the 3 mental health indicators. Lastly, the 3 mental health indicators were regressed separately on insufficient sleep by using 2 nested sets of binary logistic regressions. The first set of models controlled for demographic factors, and the second set added in controls for risk and protective factors for poor mental health. To adjust for the strong association between depression and suicidality we controlled for the effects of feeling sad and hopeless on having seriously considered suicide and making a suicide plan in the second set of models. We reported adjusted odds ratios (aORs) and corresponding 95% CIs. Statistical tests were considered significant if *P* values were <.05. We used SAS version 9.4 (SAS Inc) to perform all analyses. SAS survey procedures were used to account for the complex YRBS sampling design and population weights in all analyses.

Results

In our sample of Florida public high school students in 2021, 39.3% reported having felt so sad or hopeless almost every day for 2 weeks or more in a row that they stopped doing usual activities, 17.7% seriously considered suicide, and 13.8% made a suicide plan (Table 1). Most students (78.4%) reported insufficient sleep on an average school night. The sample was nearly evenly split between males (50.9%) and females (49.1%) and by grade level, with 26.5% in 9th grade, 25.5% in 10th grade, 24.3% in 11th grade, and 23.6% in 12th grade. Non-Hispanic White students made up the largest group (37.5%), followed by Hispanic or multiple Hispanic students (34.3%), non-Hispanic Black students (21.4%), and non-Hispanic Other students (6.7%). Approximately 1 of every 8 students reported in the past 12 months experiencing bullying on school property (12.7%) and 12.9% reported experiencing electronic bullying. Almost 1 in 4 (23.7%) reported current alcohol use, and 17.2% reported current marijuana use. Nearly two-thirds of students (60.7%) were classified as physically inactive.

Significant differences were found when we analyzed all 3 depressive symptoms and suicidality indicators by sleep status (Table 2). Compared with students reporting sufficient sleep (≥8 h), students who reported insufficient sleep (<8 h) were more likely to report feeling so sad or hopeless almost every day for 2 weeks or more in a row that they stopped doing usual activities (42.7% vs 28.1%; $P < .001$). Students with insufficient sleep were more likely to report having seriously considered attempting suicide (19.1% vs 12.5%; $P < .001$) and having made a plan about how they would commit suicide (14.8% vs 9.6%; $P < .001$), compared with those reporting sufficient sleep.

We used 2 sets of models to perform multivariate analyses of the association between insufficient sleep, depressive symptoms, and suicidality (Table 3). After controlling for demographic characteristics, Model 1 showed that students who reported insufficient sleep had higher odds of feeling so sad or hopeless almost every day for 2 weeks or more in a row that they stopped doing usual activities (AOR = 1.82; 95% CI, 1.50–2.21), having seriously considered attempting suicide (aOR = 1.59; 95% CI, 1.30–1.95), and having made a suicide attempt plan (AOR = 1.61; 95% CI, 1.29–2.03) compared with students who reported sufficient sleep. After introducing risk and protective factors in Model 2, associations between insufficient sleep and 2 of the 3 outcomes — feeling sad or hopeless and making a suicide plan — remained significant. Compared with students reporting sufficient sleep on an average school night, students who reported insufficient sleep had 1.83 times higher odds (95% CI, 1.54–2.17) of feeling sad or hopeless almost every day for 2 weeks or more in a row and 1.32

times higher odds (95% CI, 1.00–1.74) of having made a suicide plan. However, students who reported insufficient sleep did not have significantly higher odds of having seriously considered suicide compared with their peers who reported sufficient sleep.

Discussion

Our findings extend previous research on the relationship between sleep and mental health among adolescents by exploring the association between insufficient sleep and 3 indicators of depression and suicidality — feeling sad or hopeless, having seriously considered suicide, and having made a suicide attempt plan — among a current cohort of Florida high school students. We found that over three-quarters (78.4%) of students did not achieve 8 or more hours of sleep during an average school night. Furthermore, more than 1 in 3 students (39.3%) felt so sad or hopeless they stopped doing usual activities, 17.7% seriously considered suicide, and 13.8% made a suicide plan. Our models demonstrated that insufficient sleep remained a significant predictor of depressive symptoms and suicide planning after controlling for student characteristics and risk and protective factors. These findings are particularly concerning given the large number of students in our sample reporting insufficient sleep.

Our study builds on research reported in a recent study by using national YRBS data documenting significant associations between suicidal thoughts and insufficient sleep (8) by including measures of depressive symptoms and suicide planning. Yet, unlike that study, insufficient sleep was not significantly associated with seriously considering suicide in our sample after adjusting for risk and protective factors. This finding aligns with past studies demonstrating that depressive symptoms explained the relationship between insufficient sleep and suicidal ideation (4,23). Given these inconsistent findings, additional research capturing a broader range of outcomes, including anxiety and resilience, is needed to fully investigate the implications of insufficient sleep on mental health. Increased attention to the effect of insufficient sleep as an adjustable risk factor is particularly important because of the many less-modifiable factors that contribute to mental health difficulties. High school students are at particular risk of habitual sleep loss resulting from unhealthy sleep behaviors, such as excessive caffeine intake, electronic media use, and environmental factors, particularly early school start times (9). Adjusting school start times may help address the relationship between insufficient sleep and poor mental health among young people. Research has demonstrated that students attending schools with early start times have higher odds of attempting suicide (24), whereas delaying school start times significantly increased sleep length on school nights (9,24). Public health practitioners should consider the importance of modifying school start times when reviewing the effects of insufficient sleep on mental health.

Our study had several limitations. First, our data are cross-sectional, which limits the ability to draw causal inferences between insufficient sleep, depressive symptoms, and suicidality. Given the bidirectional nature of the relationship between insufficient sleep and poor mental health, depression, or suicidal ideation may exacerbate sleep problems among adolescents, with insufficient sleep manifesting as a symptom or a separate co-occurring condition. Thus, some students may experience poor mental health before the onset of sleep problems. However, recent longitudinal studies exploring the temporal nature of the relationship have demonstrated that sleep loss can increase risk of depression among adolescents, documenting that shorter sleep durations increased depressive symptoms at follow-up (11,24). Future studies using longitudinal and prospective methods are warranted to fully examine the multiple pathways from insufficient sleep to depressive symptoms and suicidality among adolescents. Second, FL-YRBS data are self-reported, which has the potential of response and recall bias. Students may respond inaccurately to questions — especially sensitive questions regarding suicidal ideation and mental health — for various reasons, including a desire to provide socially desirable answers, fear of disclosing mental health concerns, or an inaccurate recollection of previous emotional states or events. This could lead to underreporting of depressive symptoms and suicidality; however, all data were collected anonymously to reduce bias. Third, although we adjusted for several important factors known to influence depressive symptoms and suicidality, we were unable to adjust for other possible confounders, such as family structure and socioeconomic status, because FL-YRBS does not collect these data. Lastly, findings can only be generalized to the overall population of Florida students attending public high schools.

In summary, our study demonstrates that Florida high school students who regularly experience inadequate sleep on an average school night are significantly more likely to experience poor mental health, including increased odds of feelings of sadness and hopelessness and suicide planning — a pattern that persisted even after controlling for demographic and other known risk and protective factors. These findings can inform population-based approaches to promote sleep health among adolescents and may represent an important aim in suicide prevention initiatives.

Acknowledgments

The reference source used in the study, https://www.floridahealth.gov/statistics-and-data/survey-data/florida-

youth-survey/youth-risk-behavior-survey/index.html, is not currently available. For references 2 and 15, an alternative data source from CDC is provided with the same data set as the one used in the study. No financial support was received for this work. No copyrighted materials were used in this article.

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Tables

Table 1. Sample Characteristics of Participants (N = 4,672), 2021 Florida Youth Risk Behavior Survey[a]

Variable	N	Weighted % (95% CI)
Felt sad or hopeless[b]		
Yes	1,783	39.3 (36.8–41.8)
No	2,829	60.7 (58.2–63.2)
Seriously considered suicide[c]		
Yes	805	17.7 (16.0–19.4)
No	3,798	82.3 (80.6–84.0)
Made suicide plan[c]		
Yes	632	13.8 (12.5–15.2)
No	3,966	86.2 (84.8–87.5)
Insufficient sleep[d]		
Yes	3,449	78.4 (76.8–80.1)
No	979	21.6 (19.9–23.2)
Sex		
Male	2,452	50.9 (49.1–52.8)
Female	2,189	49.1 (47.2–50.9)
Race or ethnicity		
Non-Hispanic White	1,749	37.5 (32.4–42.6)
Non-Hispanic Black	786	21.4 (17.3–25.5)
Hispanic or multiple Hispanic[e]	1,675	34.3 (29.7–39.0)
Non-Hispanic Other[f]	410	6.7 (5.6–7.8)
Grade level		
9	1,600	26.5 (23.6–29.4)
10	1,208	25.5 (23.4–27.7)
11	1,015	24.3 (22.1–26.6)
12	800	23.6 (20.4–26.8)
Bullying victimization[g]		
Yes	595	12.7 (11.1–14.3)
No	4,054	87.3 (85.7–88.6)
Electronic bullying victimization[h]		
Yes	603	12.9 (11.4–14.3)

[a] The reference source used in the study, https://www.floridahealth.gov/statistics-and-data/survey-data/florida-youth-survey/youth-risk-behavior-survey/index.html,is not currently available. For references 2 and 15 (2,15), an alternative data source from CDC is provided with the same data set as the one used in the study.
[b] Almost every day for 2 or more weeks in a row during the past 12 months.
[c] During the past 12 months.
[d] Defined as less than 8 h on an average school night.
[e] Multiple Hispanic includes Hispanic in addition to one or more races.
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[i] Use during previous 30 days before survey administration.
[j] Defined as having been physically active for 60 min or more per day on 5 or more days during the past 7 days.

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Table 1. Sample Characteristics of Participants (N = 4,672), 2021 Florida Youth Risk Behavior Survey[a]

Variable	N	Weighted % (95% CI)
No	4,043	87.1 (85.7–88.6)
Current alcohol use[i]		
Yes	1,001	23.7 (21.4–25.9)
No	3,497	76.3 (74.1–78.6)
Current marijuana use[i]		
Yes	712	17.2 (15.7–18.7)
No	3,843	82.8 (81.3–84.3)
Physical activity[j]		
Yes	1,772	39.3 (37.0–41.5)
No	2,691	60.7 (58.5–63.0)

[a] The reference source used in the study, https://www.floridahealth.gov/statistics-and-data/survey-data/florida-youth-survey/youth-risk-behavior-survey/index.html,is not currently available. For references 2 and 15 (2,15), an alternative data source from CDC is provided with the same data set as the one used in the study.
[b] Almost every day for 2 or more weeks in a row during the past 12 months.
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[i] Use during previous 30 days before survey administration.
[j] Defined as having been physically active for 60 min or more per day on 5 or more days during the past 7 days.

Table 2. Depressive Symptoms and Suicidality Outcomes by Sample Characteristics Among Participants (N = 4,672), 2021 Florida Youth Risk Behavior Survey[a]

Characteristic	Felt sad or hopeless[b]		Seriously considered suicide[c]		Made suicide plan[c]	
	N (weighted %) [95% CI]	*P* value	N (weighted %) [95% CI]	*P* value	N (weighted %) [95% CI]	*P* value
Insufficient sleep[d]						
Yes	1,442 (42.7) [39.9–45.5]	<.001	648 (19.1) [17.2–20.9]	<.001	504 (14.8) [13.2–16.4]	<.001
No	264 (28.1) [24.2–32.0]		119 (12.5) [10.4–14.6]		90 (9.6) [7.6–11.6]	
Sex						
Male	653 (27.3) [25.2–29.4]	<.001	271 (11.3) [9.9–12.7]	<.001	209 (8.4) [7.2–9.6]	<.001
Female	1,116 (51.6) [47.8–55.3]		523 (24.1) [21.0–27.1]		416 (19.3) [17.2–21.5]	
Race or ethnicity						
Non-Hispanic White	665 (39.5) [35.8–43.1]	.02	299 (18.0) [15.6–20.4]	.002	209 (12.5) [10.5–14.6]	.02
Non-Hispanic Black	272 (35.0) [31.5–38.6]		117 (14.5) [11.9–17.1]		100 (12.6) [10.0–15.3]	
Hispanic or multiple Hispanic[e]	655 (41.4) [38.4–44.4]		281 (18.1) [15.7–20.5]		237 (15.0) [12.9–17.2]	
Non-Hispanic other[f]	174 (42.8) [36.3–49.3]		100 (24.3) [19.2–29.3]		80 (19.0) [14.4–23.6]	
Grade level						
9	597 (37.5) [33.7–41.3]	.16	282 (18.1) [15.7–20.5]	.78	236 (15.9) [13.1–18.6]	.03
10	487 (41.4) [38.1–44.6]		213 (18.1) [15.6–20.7]		174 (15.2) [12.7–17.7]	
11	397 (40.7) [37.6–43.9]		173 (17.7) [14.7–20.6]		118 (12.0) [9.8–14.1]	
12	285 (37.8) [33.7–41.9]		124 (16.5) [13.5–19.5]		91 (11.7) [9.0–14.4]	
Bullying victimization[g]						
Yes	395 (67.4) [63.2–71.6]	<.001	233 (38.9) [34.2–43.7]	<.001	197 (33.1) [28.9–37.3]	<.001
No	1,377 (35.1) [32.7–37.5]		569 (14.6) [13.1–16.1]		431 (11.0) [9.7–12.3]	
Electronic bullying victimization[h]						
Yes	399 (67.8) [63.0–72.7]	<.001	237 (40.4) [36.2–44.5]	<.001	193 (32.1) [27.9–36.3]	<.001
No	1,376 (35.0) [32.6–37.5]		567 (14.4) [12.9–15.9]		437 (11.2) [9.9–12.4]	
Current alcohol use[I]						
Yes	528 (53.3) [49.2–57.4]	<.001	308 (30.7) [26.9–34.6]	<.001	244 (24.0) [20.5–27.5]	<.001
No	1,190 (34.8) [32.4–37.3]		472 (13.7) [12.1–15.2]		359 (10.4) [9.2-11.6]	
Current marijuana use[I]						
Yes	420 (58.2) [54.5–61.9]	<.001	239 (32.0) [28.2–35.7]	<.001	200 (26.9) [23.1–30.7]	<.001
No	1,333 (35.5) [33.3–37.8]		544 (14.5) [13.1–15.9]		414 (10.9) [9.8–12.1]	
Physical activity[J]						
Yes	563 (32.3) [29.2–35.4]	<.001	234 (13.0) [11.2–14.7]	<.001	172 (9.1) [7.5–10.8]	<.001
No	1,150 (43.9) [40.9–47.0]		539 (20.7) [18.4–22.9]		427 (16.5) [14.5–18.5]	

[a] The reference source used in the study, https://www.floridahealth.gov/statistics-and-data/survey-data/florida-youth-survey/youth-risk-behavior-survey/index.html,is not currently available. For references 2 and 15 (2,15), an alternative data source from CDC is provided with the same data set as the one used in the study.
[b] Almost every day for 2 or more weeks in a row during the past 12 months.
[c] During the past 12 months.
[d] Defined as less than 8 hours on an average school night.
[e] Multiple Hispanic includes Hispanic in addition to one or more races.
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[i] Use during previous 30 days before survey administration.
[j] Defined as having been physically active for 60 minutes or more per day on 5 or more days during the past 7 days.

Table 3. Characteristics of Two Models, Depressive Symptoms and Suicidality Outcomes by Sample Characteristics Among Participants (N = 4,672), 2021 Florida Youth Risk Behavior Survey[a]

Characteristic	Felt sad or hopeless[b] AOR (95% CI)	Seriously considered suicide[c] AOR (95% CI)	Made suicide plan[c] AOR (95% CI)
Model 1: Demographic controls			
Insufficient sleep[d]			
Yes	1.82 (1.50–2.21)	1.59 (1.30–1.95)	1.61 (1.29–2.03)
No	1 [Reference]	1 [Reference]	1 [Reference]
Sex			
Female	2.82 (2.40–3.31)	2.49 (1.96–3.16)	2.80 (2.32–3.38)
Male	1 [Reference]	1 [Reference]	1 [Reference]
Race or ethnicity			
Non-Hispanic Black	0.77 (0.61–0.97)	0.70 (0.55–0.91)	0.89 (0.66–1.21)
Hispanic/Multiple Hispanic	1.04 (0.88–1.23)	0.95 (0.74–1.21)	1.16 (0.89–1.50)
Non-Hispanic Other[e]	1.07 (0.83–1.36)	1.35 (1.00–1.82)	1.55 (1.14–2.11)
Non-Hispanic White	1 [Reference]	1 [Reference]	1 [Reference]
Grade level			
10	1.23 (0.99–1.52)	0.99 (0.77–1.28)	0.98 (0.68–1.41)
11	1.13 (0.97–1.33)	0.93 (0.73–1.20)	0.72 (0.52–0.98)
12	0.98 (0.81–1.19)	0.84 (0.63–1.12)	0.67 (0.46–0.98)
9	1 [Reference]	1 [Reference]	1 [Reference]
Model 2: Demographic controls and risk/protective factors			
Insufficient sleep[d]			
Yes	1.83 (1.54–2.17)	1.19 (0.90–1.57)	1.32 (1.00–1.74)
No	1 [Reference]	1 [Reference]	1 [Reference]
Sex			
Female	2.52 (2.14–2.95)	1.37 (1.07–1.76)	1.62 (1.29–2.04)
Male	1 [Reference]	1 [Reference]	1 [Reference]
Race or ethnicity			
Non-Hispanic Black	0.88 (0.71–1.09)	0.85 (0.64–1.12)	1.08 (0.80–1.46)
Hispanic/Multiple Hispanic[e]	1.14 (0.95–1.37)	1.00 (0.74–1.34)	1.20 (0.89–1.63)
Non-Hispanic other[f]	1.08 (0.85–1.37)	1.40 (0.93–2.09)	1.50 (1.03–2.19)

Abbreviation: AOR, adjusted odds ratio.

[a] The reference source used in the study, https://www.floridahealth.gov/statistics-and-data/survey-data/florida-youth-survey/youth-risk-behavior-survey/index.html,is not currently available. For references 2 and 15 (2,15), an alternative data source from CDC is provided with the same data set as the one used in the study. Values are AOR (95% CI).

[b] Almost every day for 2 weeks or more in a row during the past 12 months.

[c] During the past 12 months.

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[i] Use in 30 days before survey administration.

[j] Included as dependent variable.

[k] Defined as having been physically active for 60 minutes or more per day on 5 or more days during the past 7 days.

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Table 3. Characteristics of Two Models, Depressive Symptoms and Suicidality Outcomes by Sample Characteristics Among Participants (N = 4,672), 2021 Florida Youth Risk Behavior Survey[a]

Characteristic	Felt sad or hopeless[b]	Seriously considered suicide[c]	Made suicide plan[c]
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Non-Hispanic White	1 [Reference]	1 [Reference]	1 [Reference]
Grade level			
10	1.23 (0.99–1.54)	0.85 (0.64–1.12–	0.88 (0.59–1.30)
11	1.15 (0.99–1.34)	0.83 (0.62–1.11)	0.61 (0.42–0.87)
12	0.92 (0.75–1.13)	0.77 (0.53–1.12)	0.60 (0.39–0.92)
9	1 [Reference]	1 [Reference]	1 [Reference]
Bullying victimization[g]			
Yes	2.61 (2.03–3.37)	1.56 (1.16–2.09)	1.91 (1.42–2.56)
No	1 [Reference]	1 [Reference]	1 [Reference]
Electronic bullying victimization[h]			
Yes	2.11 (1.57–2.84)	1.69 (1.30–2.20)	1.33 (0.98–1.81)
No	1 [Reference]	1 [Reference]	1 [Reference]
Current alcohol use[i]			
Yes	1.54 (1.27–1.86)	1.68 (1.26–2.24)	1.62 (1.19–2.21)
No	1 [Reference]	1 [Reference]	1 [Reference]
Current marijuana use[i]			
Yes	1.95 (1.66–2.29)	1.44 (1.12–1.85)	1.60 (1.14–2.23)
No	1 [Reference]	1 [Reference]	1 [Reference]
Felt sad or hopeless[b]			
Yes	—[j]	13.38 (9.51–18.83)	8.50 (5.48–13.18)
No	—[j]	1 [Reference]	1 [Reference]
Physical activity[k]			
Yes	0.71 (0.59–0.86)	0.77 (0.61–0.98)	0.70 (0.53–0.93)
No	1 [Reference]	1 [Reference]	1 [Reference]

Abbreviation: AOR, adjusted odds ratio.
[a] The reference source used in the study, https://www.floridahealth.gov/statistics-and-data/survey-data/florida-youth-survey/youth-risk-behavior-survey/index.html,is not currently available. For references 2 and 15 (2,15), an alternative data source from CDC is provided with the same data set as the one used in the study. Values are AOR (95% CI).
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PREVENTING CHRONIC DISEASE
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RESEARCH BRIEF

Sleep Duration, Mental Health, and Increased Difficulty Doing Schoolwork Among High School Students During the COVID-19 Pandemic

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PEER REVIEWED

Summary

What is already known on this topic?

Insufficient sleep among adolescents has been associated with lower academic grades, increased health risk behaviors, and poorer physical and mental health.

What is added by this report?

Most high school students were not sleeping enough during the COVID-19 pandemic, which was correlated with poor mental health. Students who experienced short sleep duration were more likely to report greater difficulty doing schoolwork during the pandemic than before the pandemic.

What are the implications for public health practice?

Schools can consider including policies and practices known to improve sleep duration within a broader strategy to bolster adolescent mental health and learning.

Abstract

We estimated the prevalence of short sleep duration (<8 h/average school night) among high school students (grades 9–12) during the COVID-19 pandemic by using data from the Adolescent Behaviors and Experiences Survey (January–June 2021; N = 7,705). An adjusted logistic regression model predicted prevalence ratios for more difficulty doing schoolwork during the pandemic compared with before the pandemic. Most (76.5%) students experienced short sleep duration, and two-thirds perceived more difficulty doing schoolwork. Students who slept less than 7 hours per school night or experienced poor mental health were more likely to report increased difficulty doing schoolwork. Addressing students' sleep duration could complement efforts to bolster their mental health and learning.

Objective

The COVID-19 pandemic has disrupted daily life in many ways, including changes that could either improve or impede sleep duration among adolescents. Periods of remote learning may have provided opportunities for adolescents to sleep late; findings from some small studies suggest adolescents may have shifted to later bedtimes and wake times and slept longer (1–3). Short sleep duration among adolescents is linked to higher risk of injury, worse metabolic and mental health, and difficulty focusing (4). The prevalence of short sleep duration and its association with difficulty doing schoolwork and poor mental health during the COVID-19 pandemic have yet to be explored in a nationally representative sample. Examining this association and estimating the co-occurrence of short sleep duration with poor mental health might provide schools with an additional rationale to adopt policies that lead to improvements in sleep duration within a comprehensive approach to support student academic achievement and mental health.

Methods

We used data from the Adolescent Behaviors and Experiences Survey (ABES) — a one-time, nationally representative, cross-sectional survey of high school students (grades 9–12) — fielded from January through June 2021 (N = 7,705). The overall ABES response rate during the study period was 18% (school response rate [38%] × student response rate [48%]) (5). Details on ABES are available elsewhere (www.cdc.gov/healthyyouth/data/abes.htm). ABES was reviewed and approved by institutional review boards at the Centers for Disease Control and Prevention and ICF International (5).

Data on sleep duration were derived from the question "On an average school night, how many hours of sleep do you get?" (Table

1). To align with American Academy of Sleep Medicine recommendations (8–10 h for ages 13–18 y) (4), we restricted analyses to participants who reported their age as 13 years or older. We combined the response options for 8, 9, and 10 or more hours into a single category (≥8 h), which resulted in 5 categories (≤4, 5, 6, 7, or ≥8 h). We defined short sleep duration as sleeping ≤4, 5, 6, or 7 hours and ≥8 hours as meeting sleep recommendations. Data on the primary outcome was derived from the question "Do you agree or disagree that doing your schoolwork was more difficult during the COVID-19 pandemic than before the pandemic started?" with "strongly agree" and "agree" coded as experiencing "more difficulty doing schoolwork" vs "not sure," "disagree," or "strongly disagree."

Bivariate analyses (χ^2 tests, Pearson correlation) and univariate logistic regression models (Wald F test) assessed the associations between difficulty doing schoolwork, short sleep duration, and selected covariates (poor mental health, high level of screen time [≥5 h/d], and self-reported sex, race and ethnicity, grade, and hunger). An adjusted logistic regression model predicted prevalence ratios (PRs) for experiencing more difficulty doing schoolwork, including the covariates. We tested whether poor mental health modified the association between sleep duration and more difficulty doing schoolwork (interaction term: sleep duration × poor mental health). Analyses were conducted in SAS-callable SUDAAN version 11.0.3 (RTI International) and used sample weights to account for complex sampling and nonresponse. Statistical significance was set at $P < .05$.

Results

The sample was evenly distributed across sex and grade and racially and ethnically diverse; no racial or ethnic group comprised a majority (Table 2). Most high school students (76.5%) experienced short sleep duration, and 66.6% reported more difficulty doing schoolwork during the COVID-19 pandemic than before the pandemic.

Overall, 37.1% reported poor mental health during the pandemic, which correlated with short sleep duration (Pearson correlation $r = 0.22$, $P < .001$; $\chi^2_4 = 347.48$, $P < .001$). Among students who met sleep recommendations, 25.2% reported poor mental health. About half of students who slept 5 (49.1%) or 4 hours or less (55.9%) reported poor mental health ($P < .001$).

The unadjusted models confirmed the hypothesized association between short sleep duration and greater difficulty doing schoolwork, which remained robust after adjusting for covariates (Table 3). Students who slept less than 7 hours during an average school night had a significantly greater prevalence of experiencing more difficulty doing schoolwork during the COVID-19 pandemic compared with students who met sleep duration recommendations (6 h sleep: PR = 1.17 [95% CI, 1.08–1.27]; 5 h sleep: PR = 1.18 [95% CI, 1.09–1.28]; ≤4 h sleep: PR = 1.20 [95% CI, 1.08–1.33] vs ≥8 h sleep).

Students who experienced poor mental health had 17% higher prevalence of more difficulty doing schoolwork compared with students who did not report poor mental health (PR = 1.17; 95% CI, 1.10–1.25). Poor mental health did not moderate the association between short sleep duration and more difficulty doing schoolwork. Students with 5 or more hours of screen time were slightly less likely to report more difficulty doing schoolwork than students who spent less than 5 hours per day using screens (PR = 0.95; 95% CI, 0.91–0.997). Self-reported sex, grade, and hunger were not associated with more difficulty doing schoolwork in the adjusted model. Hispanic or Latino students were more likely to report more difficulty doing schoolwork than White students.

Discussion

Before the COVID-19 pandemic, short sleep duration was becoming more prevalent among US high school students (74.6% [73.1%–76.0%] in 2017 and 77.9% [76.3%–79.4%] in 2019, $P < .001$) (6). We found that short sleep duration remained widespread during the COVID-19 pandemic, affecting roughly three-quarters of students. Students who slept less than 7 hours during an average school night were more likely to report greater difficulty doing schoolwork during the pandemic compared with before the pandemic, as were those who experienced poor mental health. This study contributes to the literature by highlighting the co-occurrence of short sleep duration and poor mental health during the COVID-19 pandemic. Teachers have identified behavioral and mental health challenges among the leading barriers to addressing learning gaps during the 2022–2023 school year (7). Policies known to improve sleep duration among students, including later school start times and family practices, such as good sleep habits and parent-set bedtimes, might help support both learning and mental health (8,9).

Previously noted limitations to ABES include the low response rate and the inability to draw causal inferences about the impact of the COVID-19 pandemic (5). We note additional limitations. The recall period differed across some of the items: the sleep and screen time questions reference the average school day or night, whereas items about mental health and greater difficulty doing schoolwork reference "during the COVID-19 pandemic." We do not know how students interpretated "average school day." Rapid survey development during the COVID-19 pandemic precluded item validation and testing. Previous univariate models confirmed small significant associations in the expected direction between

short sleep duration, self-reported hunger (10), and poor mental health (4), which suggests concurrent validity. We cannot account for some potential confounders, such as socioeconomic status and school instruction modality (eg, remote, hybrid, in-person). The latter may have influenced wake times and sleep duration, even if school start times were unchanged. Instruction modality may also have influenced self-reported screen time; the question excludes time doing schoolwork but does not specify whether to count time using screens to *attend* school. This may help explain the counter-intuitive finding that a high level of screen time was inversely associated with greater difficulty doing schoolwork. ABES addressed a single dimension of sleep; we could not assess sleep quality, sleep schedules, or sleep disorders.

Nevertheless, our findings show that most students were not sleeping enough and that many students concurrently experienced poor mental health and insufficient sleep. Schools can consider addressing sleep duration within a broader strategy to bolster adolescent mental health and learning, including addressing protective factors (11,12).

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. No copyrighted materials were used in this article.

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Tables

Table 1. Analytic Variables Derived from the Adolescent Behaviors and Experiences Survey, United States, January–June 2021

Type	Variable name	Survey item	Variable construction
Primary outcome	More difficulty doing schoolwork during pandemic	Do you agree or disagree that doing your schoolwork was more difficult during the COVID-19 pandemic than before the pandemic started?	More difficulty doing schoolwork: strongly agree or agree vs not sure or disagree or strongly disagree
Primary predictor	Sleep duration	On an average school night, how many hours of sleep do you get?	• ≤4 hours • 5 hours • 6 hours • 7 hours • Meets recommended ≥8 hours (8 hours, 9 hours, or ≥10 hours)
Covariate	Self-reported hunger	During the COVID-19 pandemic, how often did you go hungry because there was not enough food in your home?	Experienced self-reported hunger: always or most of the time or sometimes vs never or rarely
	Poor mental health	During the COVID-19 pandemic, how often was your mental health not good? (Poor mental health includes stress, anxiety, and depression.)	Experienced poor mental health: always or most of the time vs sometimes or rarely or never
	High screen time	On an average school day, how many hours do you spend in front of a TV, computer, smart phone, or other electronic device watching shows or videos, playing games, accessing the Internet, or using social media (also called "screen time")? (Do not count time spent doing schoolwork.)	• High level of screen time (≥5 hours/day)[a] • <5 hours/day (<1 hour/day, 1 hour/day, 2 hours/day, 3 hours/day, or 4 hours/day)
	Sex	What is your sex?	• Female • Male
	Grade	In what grade are you?	• 9th grade • 10th grade • 11th grade • 12th grade • Ungraded or other grade
	Race and ethnicity	Developed from Q4. Are you Hispanic or Latino? Q5. What is your race? (Select 1 or more responses.)	• Hispanic • Non-Hispanic Black • Non-Hispanic White • Non-Hispanic American Indian or Alaska Native; Asian, Native Hawaiian or Other Pacific Islander, and multiracial

[a] Rather than setting a time limit, the American Academy of Pediatrics recommends placing consistent limits on the time spent using media and the types of media for adolescents and ensuring that media does not take the place of adequate sleep, physical activity, and other behaviors essential to health. From previous studies, we defined high level of screen time by using the largest response category: ≥5 hours per day.

Table 2. Demographic Characteristics, Behaviors, and Experiences of Participants in Adolescent Behaviors and Experiences Survey (ABES) (N = 7,705), United States, January–June 2021[a]

Characteristic	No. of participants	% (95% CI)
Sex		
Female	7,677	50.4 (46.9–53.9)
Male		49.6 (46.1–53.1)
Race and ethnicity		
Hispanic or Latino	7,632	25.4 (20.1–31.6)
Non-Hispanic AIAN, Asian, NHPI, and multiracial		11.9 (8.3–16.9)
Non-Hispanic Black		12.9 (9.3–17.5)
Non-Hispanic White		49.8 (41.5–58.1)
Grade		
9	7,682	26.7 (24.0–29.6)
10		25.5 (23.1–28.0)
11		24.3 (22.3–26.4)
12		23.5 (21.2–26.1)
Perceived more difficulty doing schoolwork than before the pandemic started[b]	7,171	66.6 (64.5–68.6)
Sleep duration on average school night, h		
≤4	7,074	11.6 (9.8–13.7)
5		13.9 (12.5–15.4)
6		24.8 (23.3–26.3)
7		26.2 (24.8–27.6)
≥8 (met sleep recommendation)		23.5 (21.6–25.7)
Experienced self-reported hunger during the COVID-19 pandemic[c]	7,181	8.4 (7.2–9.8)
Experienced poor mental health during the COVID-19 pandemic[d]	7,207	37.1 (34.6–39.6)
High level of screen time (≥5 h on average school day)[e]	7,210	48.6 (46.1–51.2)

Abbreviations: AIAN, American Indian or Alaska Native; NHPI, Native Hawaiian or Other Pacific Islander.
[a] Ns are unweighted, percentages are weighted.
[b] Respondents answered "agree" or "strongly agree."
[c] Respondents answered "always," "most of the time," or "sometimes."
[d] Respondents answered "always" or "most of the time."
[e] Hours of screen time encompass time spent "in front of a TV, computer, smart phone, or other electronic device watching shows or videos, playing games, accessing the Internet, or using social media (also called *screen time*)," not including time spent doing schoolwork.

Table 3. Association Between High School Students' Sleep Duration and Greater Difficulty Doing Schoolwork During the COVID-19 Pandemic — Adolescent Behaviors and Experiences Survey, United States, January–June 2021

Variable	Unadjusted[a,b] prevalence ratio (95% CI)	Adjusted[b,c] prevalence ratio (95% CI)
Sex		
Female	1.08 (1.03–1.13)[d]	1.03 (0.98,1.09)
Male	Reference	Reference
Race and ethnicity		
Hispanic or Latino	1.06 (1.00–1.13)[d]	1.08 (1.01–1.15)[d]
Non-Hispanic AIAN, Asian, NHPI, and multiracial	0.99 (0.91–1.09)	0.98 (0.89,1.08)
Non-Hispanic Black	1.03 (0.96–1.11)	1.03 (0.96–1.1)
Non-Hispanic White	Reference	Reference
Grade		
9	Reference	Reference
10	1.01 (0.94–1.07)	1.00 (0.94–1.07)
11	0.98 (0.92–1.05)	0.97 (0.90–1.04)
12	1.00 (0.92–1.08)	0.98 (0.91–1.05)
Sleep duration on average school night, h		
≤4	1.26 (1.14–1.38)[d]	1.20 (1.08–1.33)[d]
5	1.21 (1.12–1.31)[d]	1.18 (1.09–1.28)[d]
6	1.19 (1.10–1.28)[d]	1.17 (1.08–1.27)[d]
7	1.08 (1.00–1.18)	1.08 (1.00–1.18)
≥8 (met sleep recommendation)	Reference	Reference
Self-reported hunger during the COVID-19 pandemic		
Always/most of the time/ sometimes	1.11 (1.04–1.19)[d]	1.07 (0.99–1.16)
Rarely/never	Reference	Reference
Poor mental health during COVID-19 pandemic		
Always/most of the time	1.21 (1.14–1.27)[d]	1.17 (1.10–1.25)[d]
Sometimes/rarely/never	Reference	Reference
High level of screen time on average school day		
Yes (≥5 h)	0.99 (0.95–1.04)	0.95 (0.91–1.00[e])
No (<5 h)	Reference	Reference

Abbreviations: AIAN, American Indian or Alaska Native; NHPI, Native Hawaiian or Other Pacific Islander.
[a] Models present prevalence ratios calculated from predicted marginals from univariate logistic regressions. Each row presents the value from a regression model specific to that variable.
[b] Sample size fluctuates for univariate models and is smaller for the fully adjusted model (N = 6,903) because of missing values.
[c] Single model adjusted for self-reported hunger, poor mental health, screen time, sex, race or ethnicity, and grade.
[d] $P < .05$ as indicated by Wald F test in logistic regression models.
[e] Nonrounded value is 0.997, $P = .03$.

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ORIGINAL RESEARCH

Psychosocial Correlates of Insomnia Among College Students

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PEER REVIEWED

Summary

What is already known on this topic?

Despite the well-known prevalence of insomnia among college students, its association with mental health remains a topic of considerable interest, particularly among this vulnerable population constantly adapting to the demands of the academic world.

What is added by this report?

We show that at least a quarter of college students experience insomnia, and we uncover its predominant association with attention deficit hyperactivity disorder and depression.

What are the implications for public health practice?

The implications demand a serious consideration of mental health during attempts to improve students' sleep quality.

Abstract

Introduction

Among college students, insomnia remains a topic of research focus, especially as it pertains to its correlates and the extent of its association with mental conditions. This study aimed to shed light on the chief predictors of insomnia among college students.

Methods

A cross-sectional survey on a convenience sample of college students (aged ≥18 years) at 2 large midwestern universities was conducted from March 18 through August 23, 2019. All participants were administered validated screening instruments used to screen for insomnia, depression, and attention deficit hyperactivity disorder (ADHD). Insomnia correlates were identified by using multivariate logistic regression.

Results

Overall, 26.4% of students experienced insomnia; 41.2% and 15.8% had depression and had ADHD symptoms, respectively. Students with depression (adjusted odds ratio, 9.54; 95% CI, 4.50–20.26) and students with ADHD (adjusted odds ratio, 3.48; 95% CI, 1.48–8.19) had significantly higher odds of insomnia. The odds of insomnia were also significantly higher among employed students (odds ratio, 2.10; 95% CI, 1.05–4.18).

Conclusion

This study showed an association between insomnia and mental health conditions among college students. Policy efforts should be directed toward primary and secondary prevention programs that enforce sleep education interventions, particularly among employed college students and those with mental illnesses.

Introduction

The National Sleep Foundation and the American Academy of Sleep Medicine and Sleep Research Society guidelines recommend 7 to 9 hours of sleep for young adults (1). However, at least 60% of college students have poor quality sleep and garner, on average, 7 hours of sleep per night (2). Previous research showed that up to 75% of college students reported occasional sleep disturbances, while 15% reported overall poor sleep quality (3). In another work, among a sample of 191 undergraduate students, researchers found that 73% of students exhibited some form of sleep problem, with a higher frequency among women than men (4).

Direct consequences of poor sleep among college students include increased tension, irritability, depression, confusion, reduced life satisfaction, or poor academic performance (4). Evidence abounds of the positive correlation between academic failure, low grade point average, negative academic performance, and poor sleep quality patterns (5). As these complications arise early in the life

of these students, they might develop into serious ailments as they grow older (high blood pressure, diabetes, stroke) and thereby create an even bigger public health problem. Because insomnia weakens physical and mental functions in addition to academic performances, reduced sleep quality could also lead to mental issues or vice versa (6).

Erratic schedules and lifestyle adjustments coupled with the strain of daily occupation are partly to blame for the general dissatisfaction with sleep quality and duration, because work obligations reduce hours of sleep among college students (2). However, in light of these consequences, it behooves the scientific community to identify modifiable factors associated with insomnia among college students that could help spur countermeasures or design lifestyle interventions to ameliorate the overall well-being of college students. In this study, we strived to identify environmental, mental, and behavioral factors affecting insomnia among college students. The intersection between behavioral factors and mental health is also evaluated in this work because physical activity, particularly, has been shown to mitigate insomnia (7). Because the relationship between insomnia and some of the understudied mental conditions could be bidirectional and given that cause-and-effect will not be established in this study, insomnia was labeled a criterion variable.

Methods

Study design, sampling, eligibility criteria

A cross-sectional design was used for this study. Convenience and snowball sampling strategy methods were used for sampling. West Virginia University and Marshall University students aged 18 years or older and able to read and write in English were eligible to participate. Study approval was acquired from the Institutional Review Board of West Virginia University. Consent for participation and anonymity were emphasized before the questionnaire's distribution, along with instructions for completion. No incentives were provided for participants in this study.

Instruments and measures

Demographic characteristics included sex (male, female), age, race (White; All others, which included Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, and any other racial group), marital status (married, not married), educational level (undergraduate, professional or graduate), employment status (employed, unemployed), physical activity (<2 d/wk, ≥2 d/wk), caffeine consumption (<6 cups/d, ≥6 cups/d, because previous research established a daily upper limit of 6 cups to maintain a healthy heart and blood pressure [8]), alcohol use (never, some days or every day), smoking status (yes, no), and the number of chronic non–mental health conditions (guided by the US Health and Human Services' strategic framework [9], and included arthritis, asthma, cancer, chronic obstructive pulmonary disease, Crohn disease, cystic fibrosis, diabetes, epilepsy, heart disease, HIV/AIDS, and multiple sclerosis).

The criterion variable in this study was a diagnosis of insomnia as assessed by the Insomnia Severity Index (ISI). The ISI uses 7 items to evaluate the severity of insomnia. The first 3 items assess severity of sleep onset, sleep maintenance, and early morning awakening problems, and the last 4 examine sleep satisfaction, sleep disturbance, sleep worry, and sleep interference in daily life (10). Each item is graded on a 0 to 4 Likert scale, and the total score is calculated as the sum of each item, yielding minimum and maximum values of 0 and 28, respectively. Total score categories are as follows: 0 to 7 = no clinically significant insomnia; 8 to 14 = subthreshold insomnia; 15 to 21 = clinical insomnia (moderate severity); 22 to 28 = clinical insomnia (severe). In this study, ISI scores were divided into 2 categories based on a cutoff point of 15: patients with clinically significant insomnia (cutoff point of 15 or more) and participants with no clinically significant insomnia (cutoff point less than 15). This threshold point was motivated by the validity of this scale as a primary care diagnostic tool at a cutoff score of 14 (11).

Instruments to screen for depression and attention deficit hyperactivity disorder (ADHD) were used to evaluate mental health. For depression, we used the Patient Health Questionnaire (PHQ-9), a self-reported questionnaire that contains 9 items incorporating the Diagnostic and Statistical Manual of Mental Disorders (DSM) IV criteria for probable major depressive disorder. Each item can be scored from 0 through 3, and total scores can vary from 0 to 27, with cutoff points of 5, 10, 15, and 20, corresponding respectively to diagnoses of mild, moderate, moderately severe, and severe depressive symptoms. Given the high correlation observed in the literature between the third item of the PHQ-9 (also assessing sleep disturbance) and various sleep scales (12,13), we removed this item before calculating the overall score. PHQ-9 scores were divided into 2 categories: participants with clinically significant depressive symptoms (cutoff point of 8 or more) and participants with no clinically significant depressive symptoms (cutoff point less than 8). This was dictated by the sensitivity and specificity of the PHQ-9 at this cutoff score as a satisfactory diagnostic tool for depression in primary and secondary care settings (14).

For ADHD, Part A of the Adult ADHD Self-Report Scale (ASRS) was used. Only Part A of the questionnaire contains the 6 predictive measures of ADHD symptom severity (15). Items use a Likert scale (never, rarely, sometimes, often, very often). For items 1 to 3, ratings of sometimes, often, or very often were assigned 1 point (ratings of never or rarely were assigned 0 points). For the remain-

ing items, ratings of often or very often were assigned 1 point (ratings of never, rarely, or sometimes were assigned 0 points). A sum of scores of 4 or more indicated ADHD symptoms. Diagnosis of anxiety was established using an item that elicited from participants a recent diagnosis of anxiety or current medication regimen for anxiety. The criterion variable and predictors in this study were collected using a 3-part questionnaire, including demographics, insomnia screening, and mental health screening.

Survey procedure

The online survey was administered using the Qualtrics (Qualtrics) web-based survey tool. The invitation letter to participate in this survey was sent to participants through the listserve to students and social media outlets (Facebook and Twitter) from March 18 through August 23, 2019.

Data analysis

During the analysis, we omitted responses with half or more missing information (75 incomplete and missing responses were excluded from the final sample) from the criterion variable (insomnia) and predictors (ie, ADHD, anxiety, depression, chronic non–mental health conditions, employment status, sex, race and ethnicity, sex, education level, physical activity status, alcohol and caffeine consumption, and smoking). Descriptive statistics were used to describe the study participants. Cell sizes with fewer than 5 were conflated with the next immediate encompassing category. Significant differences in outcomes among predictive factors were determined by using independent *t* tests. Differences were labeled significant at an α level less than or equal to .05. Were used χ^2 tests of independence to compare the distribution of dependent categorical or nominal variables and the distribution in the criterion variable (for large cell sizes). Fisher tests were used for the same purpose, albeit for smaller cell sizes (~ n = 5). We did not apply any statistical adjustments (eg, Bonferroni adjustments) for multiple comparisons on the same sample out of concern for the substantial reduction in the statistical power of rejecting an incorrect Ho in each test (16).

Multivariable logistic regression models were built to model a relationship between predictors and insomnia. We included logistic regression models analyzing the interaction between different mental conditions and between physical activity and mental health (diagnosis of anxiety, depression, or ADHD). Model 1 regressed the dependent variable on all independent variables. Models 2 through 4 added 2-way interactions between mental conditions, namely anxiety, ADHD, and depression, respectively, and physical activity. From each of these models, odds ratios were derived. The analysis was conducted by using SPSS version 26 (IBM Corp).

Validity and reliability

To validate the use of the foregoing instruments in a college population, we conducted confirmatory factor analyses. Results indicated loading patterns consistent with the structure of the adopted scales. Our method of choice was principal component analysis with varimax rotation. The ISI was a unidimensional scale with factor loading ranging from 0.375 to 0.876. The unidimensional PHQ-9 factor loadings oscillated between 0.627 and 0.881. The ASRS, also unidimensional, had factor loadings ranging from 0.462 to 0.803. The reliability of the ISI, PHQ-9, and ASRS, as assessed using the Cronbach α (0.857, 0.909, 0.768, respectively), was excellent. The degree of concordance between the ISI and the nonsleep scales (divergent validity) was evaluated by using correlation coefficients. We found a weak to moderate magnitude of correlation ($r < 0.7$), based on a widespread threshold from the literature (17).

Results

A total of 330 responses were included in our analysis (Table 1). The mean age of participants was 24.4 years old. Across the entire sample, most participants were women (67.0%), White (89.7%), not married (94.2%), undergraduate students (62.4%), and with no chronic non–mental health conditions (69.7%). Based on the screening questionnaires, the prevalences of anxiety, depression, ADHD, and insomnia were 28.5%, 41.2.%, 15.8%, and 26.4%, respectively.

Among the participants with insomnia, most were women (81.6%), White (83.9%), undergraduate students (65.5%), physically active on 2 or more days during the week (79.3%), consumed less than 6 cups of caffeine per day (88.5%), at least occasionally consumed alcohol (67.8%), were nonsmokers (93.1%), had no chronic conditions (58.6%), were not anxious constantly (63.2%), were depressed (78.2%), and had no symptoms of ADHD (62.1%). In general, participants without insomnia followed the same trend, except that most did not have depression (71.2%). Employment status in both groups (participants with and those without insomnia) was roughly similar. Sex, race, the number of chronic non–mental health conditions, depression, and ADHD symptoms were found to be significant correlates of insomnia (Table 1).

Findings from models 2 and 4 were not significant. In model 3, the multiple logistic regression model indicated that psychosocial factors such as employment status, depression, and ADHD significantly increased the odds of insomnia (Table 2). Employed students had 2.10 times higher odds of insomnia compared with unemployed students. In addition, the odds of insomnia were 9.54 and 3.48 times higher for students with depression and ADHD, re-

spectively. Anxiety was not significantly associated with insomnia (adjusted odds ratio: 1.71, $P = .13$). Physical activity was a significant effect modifier in the association between ADHD and insomnia (adjusted odds ratio: 12.1, $P = 0.012$). The strength of the association between ADHD symptoms and insomnia was lower among students who exercised 2 or more days a week compared with those who exercised less.

Discussion

In this study, we identified factors associated with insomnia among college students. ADHD, depression, and employment status were significantly associated with insomnia. We reported a 26.4% prevalence of insomnia among college students, a finding consistent with existing literature. A previous meta-analysis reported an overall insomnia prevalence of 18.5% (95% CI, 11.2%–28.8%) among university students; our estimate fell within this reported CI (6). Another study found that insomnia prevalence was 26.7% among university nursing students (18). Taylor and coworkers reported an insomnia prevalence of 9.5% among a cohort of 1,039 college students by using the ISI and the Pittsburgh Sleep Quality Index (PSQI) (19); their operational definition of chronic insomnia was established over 3 months as opposed to 1 month in our study. In our work, small cell sizes restricted the categorization of insomnia into moderate, mild, or severe. This explains the deviation of our results from those of past researchers that used the ISI systematic classification of different degrees of insomnia. For instance, Gress-Smith et al found that 47% of college students had mild insomnia and 22.5% had moderate to severe insomnia (20). In another ISI-based study, 12% of students endorsed a diagnosis of clinical insomnia, and 45% met the criteria for subclinical insomnia (21). All these intricacies cement our results within the current pool of research.

Our findings indicated that 78.2% of students with insomnia also experienced depression, and the odds of insomnia were 9.54 times higher among students with depression than students without depression. Olufsen et al reported a prevalence of depression among college students with insomnia of 30% to 38%, using the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) (22). Another research concluded that depressive symptoms, assessed using criteria of the DSM-IV, were associated with increased insomnia complaints among college students (odds ratio, 1.09) (23). These findings lend credence to the bidirectional relationship between insomnia and depression. Thus, it is typical of patients with insomnia to exhibit psychological profiles (poor coping skills, poor health status, ruminative traits) that herald the onset of depression. Ubiquitous characteristics of insomnia, such as fatigue, irritability, and cognitive impairment, which are well-known derivatives of insomnia among students, exacerbate depressive symptoms (24).

In our sample, 15.8% had ADHD, and the odds of insomnia were 3.48 times higher for students with ADHD than those without ADHD. The prevalence of clinically significant cases of ADHD varies between 2% and 8% of the college student population (25). A previous study showed a similar ADHD prevalence to ours at ~19% (26). In the same study, the authors also reported that students with ADHD had a risk of insomnia 2.7 times greater than those without ADHD (26). These observations indicate the importance of examining symptom clusters that involve both sleep and mental and emotional components when investigating and treating insomnia, depression, or ADHD.

Physical activity mitigated the effect of mental health on insomnia. As regular physical activity helps improve sleep quality (7) and has psychological benefits (27), it was not surprising to find that among those with mental conditions, those who exercised more often (in this case, 2 or more days per week) seemed to have better sleep quality than those who exercised less. Students are often hesitant to seek help for mental health and insomnia concerns; therefore, interventions need to be youth-friendly, acceptable, feasible, and nonstigmatizing (28). Young people view physical activity as helpful in mitigating mental conditions as well as being nonstigmatizing (29). Although most university campuses offer physical activity–based wellness programs, research exploring students' perceptions of on-campus physical activity initiatives as alternatives to mental health and insomnia management strategy is limited (30).

We found that employment was significantly associated with sleep problems among college students. Similarly, previous research has linked employment to insomnia. A meta-analysis found job demand to be negatively correlated with sleep quality, whereas job control was positively correlated (31). Students, most of whom held part-time jobs and thus had less job control yet high job demands, might understandably experience substantial sleep difficulties and reduced sleep quality in general. Also, the competing demands to complete academic requirements and maintain employment may also serve as structural barriers to adequate sleep.

Strengths and limitations

This study had several strengths. First, we evaluated factors susceptible to accompany a diagnosis of insomnia in a sample of college students. Further, we used established instruments that we validated psychometrically across a new population. However, this study had a few limitations. First, the data were collected from 2 universities, namely West Virginia and Marshall University, thus limiting the generalizability of the findings. Information on study

majors was not collected, yet could have influenced the prevalence and the uncovered associations of insomnia and mental conditions. Further, we used a cross-sectional design and could only establish association, not causality. Finally, small cell sizes restricted the stratification of insomnia, which would have enriched our results.

Our results indicate that better mental health and insomnia must be addressed concomitantly as their association is not random. Addressing these issues entails better time management skills dedicated to studying, work, and leisure. Such skills should be at the fingertips of college students to help them cope with the increasing demands of university life. These findings should also be communicated to the employers of college students who in turn should prioritize the overall well-being of their employees. As a future direction for our work, we endeavor to measure health services utilization among students with mental conditions that tie directly to sleep quality; this, in a bid, to inform policy on the need to improve mental health services access for college students.

Conclusion

The burden of insomnia among college students is one that must be readily addressed as its spillover effects decrease substantial traits that are crucial for college life. Mental health, specifically depression and ADHD, and employment are salient contributors to the high levels of insomnia. Addressing these associations could help improve the experience and well-being of college students. Further, the promotion on campuses of healthy behaviors such as physical activity could yield significant improvements vis-à-vis the lifestyle of college students, as physical activity, in this study, has been shown to mitigate the effect of mental health on insomnia or vice versa.

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Tables

Table 1. Descriptive Statistics of Predictive Factors and Criterion Variable Among College Students, 2 Midwestern Universities, 2019[a]

Variable	Total	No Insomnia	Insomnia	*P* value
Total	**330 (100)**	**243 (73.6)**	**87 (26.4)**	**NA**
Age, mean (SD), y	24.4 (4.4)	25.1 (4.6)	23.7 (3.7)	.084[b]
Sex				
Male	109 (33.0)	93 (38.3)	16 (18.4)	.001[c,d]
Female	221 (67.0)	150 (61.7)	71 (81.6)	
Race				
White	296 (89.7)	223 (91.8)	73 (83.9)	.04[c,e]
All others[f]	34 (10.3)	20 (8.2)	14 (16.1)	
Marital status				
Not married	311 (94.2)	226 (93.0)	85 (97.7)	.29[g]
Married	19 (5.8)	17 (7.0)	2 (2.3)	
Level of education				
Undergraduate	206 (62.4)	149 (61.3)	57 (65.5)	.49[c]
Professional or graduate	124 (37.6)	94 (38.7)	30 (34.5)	
Employed				
No	178 (53.9)	132 (54.3)	46 (52.9)	.82
Yes	152 (46.1)	111 (45.7)	41 (47.1)	
Physical activity				
<2 d/wk	48 (14.5)	30 (12.3)	18 (20.7)	.06[c]
≥2 d/wk	282 (85.5)	213 (87.7)	69 (79.3)	
Caffeine consumption				
<6 cups/d	298 (90.3)	221 (90.9)	77 (88.5)	.56[g]
≥6 cups/d	20 (6.1)	16 (6.6)	4 (4.6)	
Alcohol use				
Not at all	116 (35.2)	88 (36.2)	28 (32.2)	.19
Some days or every day	214 (64.8)	155 (63.8)	59 (67.8)	
Smoking status				

Abbreviations: ADHD, attention deficit hyperactivity disorder; NA, not applicable.
[a] Data are number (percentage) unless otherwise specified. Numbers may not add to total because of missing data.
[b] Independent *t* test.
[c] Pearson χ^2.
[d] *P* value between .001 and <.01.
[e] *P* value between .01 and <.05.
[f] All other races included Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, and any other racial group.
[g] Fisher exact test.
[h] *P* < .001.

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Table 1. Descriptive Statistics of Predictive Factors and Criterion Variable Among College Students, 2 Midwestern Universities, 2019[a]

Variable	Total	No Insomnia	Insomnia	*P* value
Not at all	310 (93.9)	229 (94.2)	81 (93.1)	.49[g]
Every day and some days	20 (6.1)	14 (5.8)	6 (6.9)	
Chronic non–mental health conditions				
0	230 (69.7)	179 (73.7)	51 (58.6)	<.001[c,h]
1	72 (21.8)	52 (21.4)	20 (23.0)	
≥2	28 (8.5)	12 (4.9)	16 (18.4)	
Anxiety				
No	236 (71.5)	181 (74.5)	55 (63.2)	.05[c,e]
Yes	94 (28.5)	62 (25.5)	32 (36.8)	
Depression				
No	192 (58.2)	173 (71.2)	19 (21.8)	<.001[c,h]
Yes	136 (41.2)	68 (28.0)	68 (78.2)	
ADHD				
No	276 (83.6)	222 (91.4)	54 (62.1)	<.001[c,h]
Yes	52 (15.8)	21 (8.6)	31 (35.6)	
Depression and ADHD				
No	286 (86.7)	227 (93.4)	59 (67.8)	< .001[c,h]
Yes	40 (12.1)	14 (5.8)	26 (29.9)	
Depression and anxiety				
No	280 (84.8)	217 (89.3)	63 (72.4)	<.001[c,h]
Yes	48 (14.5)	24 (9.9)	24 (27.6)	
Anxiety and ADHD				
No	314 (95.2)	239 (98.4)	75 (86.2)	.001[c,d]
Yes	14 (4.2)	4 (1.6)	10 (11.5)	

Abbreviations: ADHD, attention deficit hyperactivity disorder; NA, not applicable.
[a] Data are number (percentage) unless otherwise specified. Numbers may not add to total because of missing data.
[b] Independent *t* test.
[c] Pearson χ^2.
[d] *P* value between .001 and <.01.
[e] *P* value between .01 and <.05.
[f] All other races included Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, and any other racial group.
[g] Fisher exact test.
[h] *P* < .001.

Table 2. Adjusted Association of Predictors With Insomnia, 2 Midwestern Universities, 2019

Predictor	Adjusted Odds Ratio (95% CI)	*P* value
Age, y	1.07 (0.95–1.20)	.26
Sex		
Male	1 [Reference]	.09
Female	1.93 (0.90–4.17)	
Race		
All others[a]	1 [Reference]	.35
White	0.61 (0.21–1.73)	
Marital status		
Not married	1 [Reference]	.19
Married	1.51 (0.82–2.80)	
Level of education		
Undergraduate	1 [Reference]	.96
Professional or graduate	0.98 (0.39–2.48)	
Employment		
No	1 [Reference]	.04[b]
Yes	2.10 (1.05–4.18)	
Physical activity		
<2 d/wk	1 [Reference]	.88
≥2 d/wk	0.94 (0.38–2.31)	
Caffeine consumption		
<6 cups/d	1 [Reference]	.17
≥6 cups/d	0.33 (0.07–1.60)	
Alcohol use		
Never or some days	1 [Reference]	.87
Every day	0.81 (0.07–9.54)	
Smoking status		
No	1 [Reference]	.36
Yes	1.55 (0.61–3.96)	
Number of chronic non–mental health conditions	1.65 (1.08–2.52)	.02[b]
Anxiety		
No	1 [Reference]	.13
Yes	1.71 (0.85–3.42)	
Depression		

[a] All other races included Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, and any other racial group.
[b] *P* value between .01 and <.05.
[c] *P* < .001.
[d] *P* value between .001 and <.01.

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Table 2. Adjusted Association of Predictors With Insomnia, 2 Midwestern Universities, 2019

Predictor	Adjusted Odds Ratio (95% CI)	*P* value
No	1 [Reference]	<.001[c]
Yes	9.54 (4.50–20.26)	
Attention deficit hyperactivity disorder		
No	1 [Reference]	.004[d]
Yes	3.48 (1.48–8.19)	

[a] All other races included Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, and any other racial group.
[b] *P* value between .01 and <.05.
[c] *P* < .001.
[d] *P* value between .001 and <.01.

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ORIGINAL RESEARCH

The Mediating Role of Sleep Disturbance on the Association Between Stress and Self-Rated Health Among Chinese and Korean Immigrant Americans

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PEER REVIEWED

Summary

What is already known on this topic?

Racial and ethnic minority populations in the US experience heightened stress, which leads to racial and ethnic disparities in chronic disease.

What is added by this report?

Sleep disturbance is a crucial mediator, explaining part of the associations between stress and poor health among Chinese and Korean immigrants in the US.

What are the implications for public health practice?

Improving sleep health can help to decrease the effects of heightened stress on chronic disease outcomes among racial and ethnic minority populations.

Abstract

Introduction

Disturbed sleep may be a factor that links stress with poor health, especially among groups experiencing high levels of stress caused by racial and ethnic minority and nativity status. The objective of this study was to describe the potential mediating role of sleep disturbance in the associations between various types of stress and self-rated health among Chinese and Korean Americans.

Methods

Our cross-sectional study consisted of 400 Chinese and Korean immigrants aged 50 to 75 years recruited from August 2018 through June 2020 from physicians' clinics in the Baltimore–Washington, DC, metropolitan area. We used the Patient Reported Outcomes Measurement Information System (PROMIS) short-form questionnaire to measure sleep disturbance. Linear regression analyses examined associations between 3 types of stress (acculturative stress, perceived stress, and distress) and self-rated health, accounting for demographic, socioeconomic, and health insurance factors. The Karlson–Holm–Breen method was used to estimate the total and direct effects of stresses on self-rated health and the indirect effects of stresses on health through sleep disturbance.

Results

Greater acculturative stress (β = 0.08; 95% CI, 0.01–0.14), perceived stress (β = 0.05; 95% CI, 0.03–0.08), and distress (β = 0.09; 95% CI, 0.05–0.13) were all associated with poorer self-rated health. Sleep disturbance was a partial mediator, with sleep disturbance accounting for 21.7%, 14.9%, and 18.7% of the associations between acculturative stress, perceived stress, and distress and self-rated health, respectively.

Conclusion

Because sleep disturbance partially mediates the associations between stress and poor self-rated health, future interventions and research may consider mitigating sleep disturbances and stress among racial and ethnic minority populations to address health disparities.

Introduction

Stress is a major contributor to health disparities among racial and ethnic populations in the US. Because of socioeconomic disadvantages and discriminatory experiences linked to historical and continued structural racism, racial and ethnic minority populations are more exposed to and susceptible to stress than are non-Hispanic White people (1,2). Asian, Black, and Hispanic or Latino populations in the US report higher levels of stress than the US non-Hispanic White population in several domains such as occupation, finances, childhood adversity, racial bias, and neighbor-

hoods (1). Racial and ethnic differences in stress contribute to disparities in emotional strain, cardiovascular disease, and all-cause mortality (1,3). Research has focused on some of the pathways linking experiences of stress to health disparities among racial and ethnic minority populations, including allostatic load (cumulative burden of chronic stress) and maladaptive behaviors such as substance use and unhealthy diet (4,5). Less attention has been paid to the role of disturbed sleep to explain the relationship between stress and poor health.

This study focused on the mediating role of sleep disturbance in the association between stress and self-rated health among a sample of Chinese and Korean immigrants in the US. Self-rated health is a commonly used metric of overall health, and it has been applied in diverse populations, including immigrant Chinese and Korean Americans (6). Prior research provided empirical evidence that poor sleep mediated the associations between perceived stress and depression (7). Studies have additionally found disturbed sleep to mediate associations between stress and overall health and well-being among mothers and children experiencing trauma (8,9). Research suggests that many Asian Americans likely somaticize stressful experiences into physical symptoms such as sleep disturbances (10,11). Sleep disturbances lead to poor mental and physical functioning, including greater risk of inflammation, chronic diseases, and multimorbidity (12–14).

The current study contributes to this literature by examining the mediating role of sleep in the association between 3 types of stress (acculturative stress, perceived stress, and distress) and health. The sample consisted of Chinese and Korean immigrants, a group prone to experiencing these types of stress. Immigrants may experience acculturative stress — defined as the psychological impact, or stress reaction, of adapting to a new cultural context (15). Previous research suggests that acculturative stress is significantly associated with sleep disturbance or poor sleep quality among immigrant Chinese and Korean Americans (16). Furthermore, levels of perceived stress and reported distress may similarly be associated with poor sleep and subsequent poor health among Chinese and Korean immigrants in the US (6). To our knowledge, this is the first study to examine the role of sleep disturbance to explain the associations between stresses and health among Asians in the US. We first hypothesized that higher levels of acculturative stress, perceived stress, and distress would be associated with worse self-rated health. We also hypothesized that sleep disturbance would partially mediate the associations between stress and self-rated health.

Methods

Study sample

We used data from a randomized controlled trial to increase colorectal cancer screening among 400 Chinese and Korean Americans (200 Chinese and 200 Korean). Study participants were originally from China or Korea, aged 50 to 75 years, and living in the US for an average of 23 years. Participants were recruited in the Baltimore–Washington, DC, metropolitan area from primary care physicians' clinics. The baseline survey data were collected from August 2018 through June 2020. Participants completed the survey either in person or by telephone in their preferred language (Mandarin, Korean, or English) after signing informed consent forms. Most (89%) participants completed a self-administered questionnaire in person; 11% of participants completed a research assistant–led telephone survey because of the COVID-19 outbreak in March 2020. This study was approved by the institutional review boards of the University of Maryland, College Park, and the University of California, Irvine.

Measures

Self-rated health was the dependent variable, which was assessed by using the question "Would you say that in general your health is excellent, very good, good, fair, or poor?" Prior studies found self-rated health to be a valid measure of overall physical and mental health among Chinese and Korean populations in their respective languages (17,18). In this study, we used it as a continuous variable ranging from 1 (excellent) to 5 (poor), with higher scores indicating worse self-rated health.

Our independent variables of interest were 3 types of stress: acculturative stress, perceived stress, and distress. We assessed acculturative stress by using a 9-item scale from the National Latino and Asian American Study intended to measure stressors associated with the experience of being an immigrant in a US cultural and sociopolitical context; this scale has been widely used in the Chinese and Korean languages (15). Responses to the 9 items were dichotomous (yes = 1; no or not applicable = 0) and included the following: 1) feeling guilty for leaving family or friends in a home country, 2) receiving the same level of respect in the US as in a home country, 3) having limited contact with family or friends outside home country, 4) having difficulty in interactions with others because of English proficiency, 5) being treated badly because of speaking English poorly, 6) having difficulty in finding work because of Asian descent, 7) being questioned about legal status, 8) having concern about being deported if one were to go to a social or government agency, and 9) avoiding seeking

health services due to fear of immigration officials. Item 2 was reverse-coded. We calculated acculturative stress as the sum of all 9 items (range, 0–9). Higher scores indicate greater acculturative stress.

We used a modified version of the Perceived Stress Scale to measure perceived stress (19). The Perceived Stress Scale has been validated in both the Chinese and Korean languages (20,21). This modified scale included 10 of the 14 items that measured self-reported stress over the past month: 1) how often have you been upset because of something that happened unexpectedly; 2) how often have you felt that you were unable to control the important things in your life; 3) how often have you felt nervous and stressed; 4) how often have you dealt successfully with irritating life hassles; 5) how often have you felt that you were effectively coping with important changes that were occurring in your life; 6) how often have you felt confident about your ability to handle your personal problems; 7) how often have you felt that things were going your way; 8) how often have you found that you could not cope with all the things that you had to do; 9) how often have you been able to control irritations in your life; 10) how often have you felt that you were on top of things. We coded each response on a range from 0 ("never") to 4 ("very often"). Items 4, 5, 6, 7, 9, and 10 were reverse-coded. We calculated perceived stress as the sum of all 10 items (range, 0–40). Higher scores indicate greater perceived stress.

We measured distress by using a distress "thermometer" numbered from 0 at the bottom ("no distress") to 10 at the top ("extreme distress") (22). Respondents circled the number that best described how much distress they had been experiencing in the past week. Distress was a continuous variable (range, 0–10). Higher scores indicated greater distress.

Sleep disturbance was a potential mediator of the associations between stress and self-rated health. We assessed sleep disturbance by using the short-form version of the Sleep Disturbance Questionnaire from the Patient Reported Outcomes Measurement Information System (PROMIS), a validated and reliable measure of sleep disturbance (23). It included 8 items to measure self-reported perceptions of sleep quality, depth, and restoration during the past 7 days: 1) my sleep was restless; 2) I was satisfied with my sleep; 3) my sleep was refreshing; 4) I had difficulty falling asleep; 5) I had trouble staying asleep; 6) I had trouble sleeping; 7) I got enough sleep; and 8) my sleep quality was [very poor, poor, fair, good, or very good]. Respondents rated each item on a 5-point Likert scale, and we summed ratings to obtain a total raw score ranging from 8 to 40. Following the PROMIS guidelines for categorizing sleep disturbance, we converted the total raw score to a standardized T-score using conversion tables, with higher scores indicating greater sleep disturbances (23). Then, we recoded T-scores into a binary variable, with T-scores less than 55 indicating no or slight sleep disturbance and T-scores of 55 or more indicating mild, moderate, or severe sleep disturbance.

Sociodemographic characteristics included age (continuous years), sex (male or female), Asian subgroup (Chinese or Korean), marital status (married or cohabitating, or not currently married or cohabitating), education (less than high school, high school graduate or GED [General Educational Development], business or vocational school or some college, college graduate, or attended graduate or professional school), annual household income (<$20,000, $20,000–$39,999, $40,000–$59,999, $60,000–$79,999, $80,000–$99,999, or ≥$100,000), employment (full time, part time, or not employed), and health insurance status (private health insurance, Medicare or Medicaid, or no health insurance) based on self-report.

Statistical analysis

First, we conducted a descriptive analysis for the sample overall and stratified by risk of sleep disturbance. We calculated means and SDs for all continuous variables, frequencies, and percentages for all categorical variables. To compare the differences between subgroups, we conducted 2-sample *t* tests for continuous variables and χ^2 tests for categorical variables. Second, we used linear regression models to estimate associations between acculturative stress, perceived stress, distress, and self-rated health. We conducted 3 regression models for each exposure: Model 1 included the stress variable, adjusting for age; Model 2 added sex, Asian subgroup, marital status, education, annual household income, employment status, and health insurance status to Model 1; and Model 3 added sleep disturbance to Model 2. We then used the Karlson–Holm–Breen method (24) to conduct mediation analyses to estimate the degree to which sleep disturbance explained the association between stress and self-rated health. Using this method, we decomposed the total effect of stress on self-rated health into the direct (unmediated) effect of stress on self-rated health and indirect (mediated) effect of stress on self-rated health through sleep disturbance. This method also calculates percentages of the total effects of stress on self-rated health caused by sleep disturbance. We also created a simple conceptual model of the mediating role of sleep disturbance between stress and health.

We calculated these effects accounting for all sociodemographic covariates. We conducted analyses using Stata version 14 (StataCorp LLC).

Results

Of the 400 participants, 327 (81.8%) had no or slight sleep disturbance, while 73 (18.2%) had mild, moderate, or severe sleep disturbance (Table 1). Participants with mild, moderate, or severe sleep disturbance had worse self-rated health and higher acculturative stress, perceived stress, and distress compared with participants with no or slight sleep disturbance. Additionally, participants with mild, moderate, or severe sleep disturbance were more likely to be female (vs male), Korean (vs Chinese), and not currently married or cohabitating (vs married or cohabitating) relative to participants with no or slight sleep disturbance.

Linear regression models of the association between stresses and self-rated health, adjusting for covariates, showed that higher acculturative stress, perceived stress, and distress were associated with worse self-rated health across all models (Table 2). A 1-unit increase in acculturative stress was associated with worse self-rated health by 0.14 (95% CI, 0.07–0.20) in Model 1, which adjusted for age. This association was attenuated but still in the same direction when adjusted for covariates in Model 2. In other words, at the lowest acculturative stress level of 0, the predicted self-rated health was 2.9, and at the highest level of acculturative stress of 8.0, the predicted self-rated health was 4.1, accounting for sociodemographic characteristics. When sleep disturbance was added to Model 3, the association between acculturative stress and self-rated health was further attenuated, but still in the same direction. A 1-unit increase in perceived stress was associated with worse self-rated health by 0.08 (95% CI, 0.06–0.10) in Model 1, and the association was attenuated in Model 2. At the lowest perceived stress level of 2.0, the predicted self-rated health was 2.6, and at the highest perceived stress level of 26.0, the predicted self-rated health was 3.7, accounting for sociodemographic covariates. This association was slightly attenuated in Model 3 with the inclusion of sleep disturbance. Higher distress was also associated with worse self-rated health by 0.10 (95% CI, 0.06–0.14) and 0.11 (95% CI, 0.07–0.15) for every 1-unit increase in distress in Model 1 and Model 2, respectively. Accounting for sociodemographic factors, the predicted self-rated health was 2.8 at the lowest distress level of 0, and the predicted self-rated health was 3.8 at the highest distress level of 10.0. This association was attenuated, but still in the same direction accounting for sleep disturbance in Model 3.

The mediation analyses using the Karlson–Holm–Breen method showed the total effects of each stress on self-rated health, the decomposed direct (unmediated) effects of each stress on self-rated health, and the indirect (mediated) effects of each stress on self-rated health through sleep disturbance, accounting for covariates (Table 3). The total effect of acculturative stress on self-rated health was 0.10. A direct effect of acculturative stress on self-rated health ($\beta = 0.08$) remained independent of the potential mediator. The indirect effect of acculturative stress on self-rated health through sleep disturbance was 0.02, and 21.7% of total effect was due to sleep disturbance alone accounting for all covariates. The total and direct effects of perceived stress on self-rated health were 0.06 and 0.05, while the indirect effect mediated by sleep disturbance was 0.01. Sleep disturbance accounted for 14.9% of the total effect of perceived stress on self-rated health. For the association between distress and self-rated health, the total, direct, and indirect effects were 0.11, 0.09, and 0.02, respectively. Sleep disturbance accounted for 18.7% of the total effect of distress on self-rated health. A conceptual model (Figure) visually outlines the various relationships.

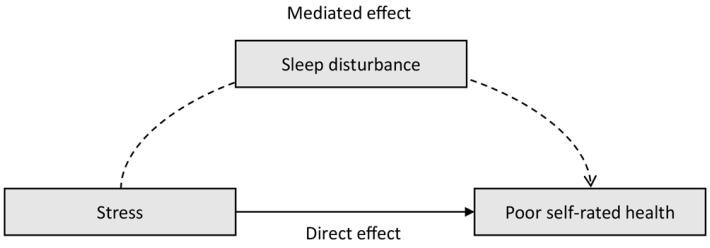

Figure. Conceptual model of the mediating role of sleep disturbance between stress and self-rated health.

Discussion

This study tested the mediating role of sleep in the relationship between 3 types of stress and health. Specifically, we studied whether acculturative stress, perceived stress, and distress were associated with self-rated health, and whether this could be partly explained by higher stress increasing the odds of having sleep disturbance and higher sleep disturbance contributing to worse self-rated health. The results indicated that higher levels of acculturative stress, perceived stress, and distress were associated with worse self-rated health, which supported our first hypothesis. We also found that sleep disturbance was a partial mediator of these associations, supporting the second hypothesis. Sleep disturbance explained 21.7%, 14.9%, and 18.7% of the associations of acculturative stress, perceived stress, and distress with self-rated health, respectively. We evaluated the 3 types of stress separately in this analysis, because they likely overlap and influence one another. For example, people with high levels of acculturative stress likely experience and report more distress as well. Nevertheless, it is notable that all 3 forms of stress were associated with self-rated health, and sleep disturbance was a mediator for all stress types to slightly different degrees.

Our findings align with previous empirical evidence that sleep quality was a mediator between stress and poor health outcomes. Lee and Hsu found that poor sleep quality mediated the association between stress and poor mental health among US mothers of infants with a low birth weight (8). Similarly, Steffen and Bowden showed that sleep quality mediated the relationship between perceived racism and depression among US Latinos (25). In China, a study demonstrated that the association between perceived stress and depression was partly mediated by sleep quality among older populations (7). A review suggested evidence for sleep's mediating role in the relationship between traumatic stress and health outcomes among people in the US who experienced specific adverse life events such as HIV diagnosis, war, hurricane, or death of a spouse (9). Our results indicated that acculturative stress, perceived stress, and distress functioned in similar ways to other chronic or traumatic stress in contributing to worse health via sleep disturbance among Chinese and Korean immigrants in the US. Sleep disturbance is a salient intermediary between stress and other health outcomes, potentially explaining one-fifth of this relationship. Therefore, sleep disturbance may be a signal to health providers of underlying experiences of stress and potential for future worsened health. In 2022, the American Heart Association added healthy sleep to its checklist of important health and lifestyle factors for cardiovascular health (26). Future interventions to lower stress, and subsequently, promote sleep hygiene could be considered to prevent cardiovascular disease for racial and ethnic minority populations.

Herein we presented a framework for the mediating role of sleep linking stress to health. First, stress could predispose people to sleep disturbances by stimulating the hypothalamic-pituitary-adrenal axis to release attention- and arousal-related hormones such as cortisol, noradrenaline, and adrenaline as part of the sympathetic nervous system's fight-or-flight response (27). These hormones interfere with the body's ability to maintain quality sleep (27). Poor sleep health may then result in risk of inflammatory disease by increasing the levels of C-reactive protein and interleukin-6 (12). Another mechanism linking poor sleep to disease risk is decreased serotonin, a neurotransmitter that regulates normal circadian rhythms and is also at low levels in people with depression (14). These mechanisms link stress to poor sleep, and poor sleep to worse health outcomes, including poor physical functioning, depression, and chronic disease (13,14).

To our knowledge, ours is the first study to demonstrate the mediating role of sleep in the association between stress and health among a sample of Asian Americans. Although Asian Americans are the fastest-growing racial and ethnic group in the US (28), they are less represented than other racial groups in stress-related research. This may be because Asian Americans have historically been stereotyped as a "model minority" whose perceived success in the US leads to the incorrect assumption that they do not experience stress caused by discrimination or low socioeconomic status (11). This myth obscures the struggles of many Asian Americans, especially those who have low incomes. Currently, Asians in the US have the largest income gap of any racial group in the country, with the top 10% earning more than 6 times that of the bottom 10% of Asian Americans (3). Furthermore, Asian Americans are extremely diverse, representing people from more than 50 countries, and many subgroups encounter stressful events that do not gain adequate attention. Asian Americans have been depicted as perpetual foreigners and outsiders while experiencing racial discrimination and pressure to conform to the model minority myth (11). Moreover, two-thirds of Asian Americans are non–US born, which exposes them to unique stressors such as acculturative stress (28). When experiencing several stressful challenges, Asian Americans may have difficulty in coping, which manifests in sleep disturbance. The few studies on sleep health for this racial minority group have shown that Asian Americans are more likely to report short sleep duration, greater daytime sleepiness, and have more sleep disordered breathing than White populations in the US (29,30). Among Asian Americans, experiences of racial discrimination and acculturative stress have been associated with greater sleep disturbance (10,16). Notably, the prevalence of sleep disturbance in our sample of Chinese and Korean Americans was similar to that found in the general US population (23). Sleep disturbance may be an even greater problem among Asian American subgroups experiencing heightened levels of stress.

Although our study demonstrates novel findings, we have the following limitations to highlight. First, the cross-sectional nature of the data set did not enable us to establish causal mechanisms. Associations may be in the other direction: worse self-rated health may lead to sleep disturbance, which then increases stress. Therefore, our findings on the mediating role of sleep should be considered preliminary. Nevertheless, our proposed mechanism aligns with previous longitudinal work linking stress to sleep and sleep to health outcomes (10,12–14). Second, our study used a unique sample of Chinese and Korean immigrants aged 50 to 75 years living in the Baltimore–Washington, DC, metropolitan area. Our findings are not generalizable to all Asian Americans or to other immigrant groups. The middle-aged and older adults in our study sample were likely experiencing more health issues related to aging and have different types of life stressors than younger people. To improve generalizability, future studies should include both US-born and non–US-born populations in a broader age range who are from diverse racial and ethnic backgrounds. Furthermore, more research that includes other disaggregated Asian subgroups who experience other types or levels of stress is needed. Last, we used only a single retrospective (ie, during the past 7

days) self-reported measure to assess sleep disturbance. This measure may not be the most accurate measure although it is widely used, valid, and reliable in diverse populations. Future studies could use other validated, objective measures of sleep disturbance, such as actigraphy, to confirm these findings.

Despite some limitations, our study has crucial implications for preventing chronic disease. There is a need to design and implement intervention programs tailored for Asian Americans and other racial and ethnic minority populations that could reduce stress and address sleep disturbance, which are significant risk factors for health. For example, clinicians could develop therapeutic interventions to bolster protective factors that mitigate stress and sleep disorders among Asian immigrants. These interventions can offer mental health or behavioral health services that provide patients with tools to manage stress and improve sleep hygiene. Sleep health can be an important focus for prevention-oriented interventions given the current findings that sleep disturbance is a symptom of stress that has a strong link to self-rated health. Future research could examine whether improving sleep health promotes resilience and buffers against the negative effects of stress on health among racial and ethnic minority populations experiencing heightened stress.

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Tables

Table 1. Characteristics of 400 Chinese and Korean Immigrants Aged 50 to 75 Years Recruited From Physicians' Clinics in the Baltimore–Washington, DC, Metropolitan Area, August 2018–June 2020

Characteristic	Total (N = 400)	Sleep disturbance		*P* value
		None/slight	Mild/moderate/severe	
No. (%) of participants	400 (100.0)	327 (81.8)	73 (18.2)	—
Self-rated health, mean (SD)[a]	3.1 (1.0)	3.0 (1.0)	3.8 (0.9)	<.001
Acculturative stress, mean (SD)[b]	1.6 (1.5)	1.5 (1.5)	2.2 (1.8)	.002
Perceived stress, mean (SD)[c]	15.6 (4.3)	15.2 (4.3)	17.5 (3.9)	<.001
Distress, mean (SD)[d]	3.6 (2.4)	3.3 (2.3)	5.0 (2.4)	<.001
Age, mean (SD), y	58.4 (6.4)	58.4 (6.5)	58.4 (5.7)	.93
Sex, n (%)				
Female	211 (52.8)	163 (49.8)	48 (65.8)	.01
Male	189 (47.3)	164 (50.2)	25 (34.2)	
Asian subgroup, n (%)				
Chinese	200 (50.0)	173 (52.9)	27 (37.0)	.01
Korean	200 (50.0)	154 (47.1)	46 (63.0)	
Marital status, n (%)				
Not currently married or cohabitating	59 (14.8)	41 (12.5)	18 (24.7)	.008
Married/cohabiting	341 (85.3)	286 (87.5)	55 (75.3)	
Education, n (%)				
Less than high school	43 (10.8)	35 (10.7)	8 (11.0)	.22
High school graduate or GED	91 (22.8)	73 (22.3)	18 (24.7)	
Business/vocational school/some college	68 (17.0)	59 (18.0)	9 (12.3)	
College graduate	101 (25.3)	76 (23.2)	25 (34.2)	
Attended graduate/professional school	97 (24.3)	84 (25.7)	13 (17.8)	
Household income, n (%), $				
<20,000	62 (15.5)	46 (14.1)	16 (21.9)	.52
20,000–39,999	64 (16.0)	54 (16.5)	10 (13.7)	
40,000–59,999	85 (21.3)	68 (20.8)	17 (23.3)	
60,000–79,999	49 (12.3)	40 (12.2)	9 (12.3)	
80,000–99,999	32 (8.0)	26 (8.0)	6 (8.2)	
≥100,000	108 (27.0)	93 (28.4)	15 (20.5)	
Employment status, n (%)				

Abbreviations: —, does not apply; GED, General Educational Development.
[a] Scale for self-rated health ranged from 1 (excellent) to 5 (poor).
[b] Scale consisted of 9 dichotomous (yes = 1; no or not applicable = 0) items. Scale ranged from 0 to 9, with higher scores indicating greater acculturative stress.
[c] A 10-item modified version of the Perceived Stress Scale (19) was used; scale ranged from 0 to 40, with higher scores indicating greater perceived stress.
[d] Measured by a distress "thermometer" numbered from 0 at the bottom (no distress) to 10 at the top (extreme distress). Respondents circled their response; scale ranged from 0 to 10, with higher scores indicating greater distress.

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Table 1. Characteristics of 400 Chinese and Korean Immigrants Aged 50 to 75 Years Recruited From Physicians' Clinics in the Baltimore–Washington, DC, Metropolitan Area, August 2018–June 2020

Characteristic	Total (N = 400)	Sleep disturbance		*P* value
		None/slight	Mild/moderate/severe	
Working full time	231 (57.8)	190 (58.1)	41 (56.2)	.67
Working part time	84 (21.0)	66 (20.2)	18 (24.7)	
Not currently working	85 (21.3)	71 (21.7)	14 (19.2)	
Health insurance status, n (%)				
Private health insurance	243 (60.8)	200 (61.2)	43 (58.9)	.94
Medicare/Medicaid	74 (18.5)	60 (18.3)	14 (19.2)	
No health insurance	83 (20.8)	67 (20.5)	16 (21.9)	

Abbreviations: —, does not apply; GED, General Educational Development.
[a] Scale for self-rated health ranged from 1 (excellent) to 5 (poor).
[b] Scale consisted of 9 dichotomous (yes = 1; no or not applicable = 0) items. Scale ranged from 0 to 9, with higher scores indicating greater acculturative stress.
[c] A 10-item modified version of the Perceived Stress Scale (19) was used; scale ranged from 0 to 40, with higher scores indicating greater perceived stress.
[d] Measured by a distress "thermometer" numbered from 0 at the bottom (no distress) to 10 at the top (extreme distress). Respondents circled their response; scale ranged from 0 to 10, with higher scores indicating greater distress.

Table 2. Associations of Acculturative Stress, Perceived Stress, and Distress With Self-Rated Health[a] in Linear Regression Analysis of Data From 400 Chinese and Korean Immigrants Aged 50 to 75 Years Recruited From Physicians' Clinics in the Baltimore–Washington, DC, Metropolitan Area, August 2018–June 2020

Variable	Self-rated health to β (95% CI)								
	Acculturative stress[b]			Perceived stress[c]			Distress[d]		
	Model 1[e]	Model 2[f]	Model 3[g]	Model 1[e]	Model 2[f]	Model 3[g]	Model 1[e]	Model 2[f]	Model 3[g]
Stress	0.14 (0.07 to 0.20)	0.10 (0.03 to 0.16)	0.08 (0.01 to 0.14)	0.08 (0.06 to 0.10)	0.06 (0.04 to 0.09)	0.05 (0.03 to 0.08)	0.10 (0.06 to 0.14)	0.11 (0.07 to 0.15)	0.09 (0.05 to 0.13)
Age	0.01 (−0.01 to 0.03)	−0.01 (−0.03 to 0.01)	−0.01 (−0.02 to 0.01)	0.01 (−0.01 to 0.03)	0 (−0.02 to 0.02)	0 (−0.02 to 0.02)	0.01 (0 to 0.03)	0 (−0.02 to 0.01)	0 (−0.02 to 0.02)
Sex									
Female	—	0.22 (0.01 to 0.43)	0.16 (−0.04 to 0.37)	—	0.21 (0.01 to 0.42)	0.16 (−0.04 to 0.36)	—	0.19 (−0.01 to 0.40)	0.15 (−0.05 to 0.35)
Male	—	Reference	Reference	—	Reference	Reference	—	Reference	Reference
Asian subgroup									
Chinese	—	−0.21 (−0.43 to 0.02)	−0.14 (−0.36 to 0.07)	—	−0.14 (−0.36 to 0.08)	−0.09 (−0.31 to 0.12)	—	−0.21 (−0.43 to 0.01)	−0.16 (−0.38 to 0.05)
Korean	—	Reference	Reference	—	Reference	Reference	—	Reference	Reference
Marital status									
Not currently married	—	0.13 (−0.15 to 0.42)	0.07 (−0.21 to 0.34)	—	0.13 (−0.14 to 0.41)	0.07 (−0.20 to 0.34)	—	0.12 (−0.15 to 0.40)	0.07 (−0.20 to 0.34)
Married or cohabiting	—	Reference	Reference	—	Reference	Reference	—	Reference	Reference
Education									
Less than high school graduate	—	0.18 (−0.23 to 0.59)	0.19 (−0.21 to 0.59)	—	0.17 (−0.23 to 0.57)	0.18 (−0.21 to 0.57)	—	0.37 (−0.03 to 0.76)	0.34 (−0.06 to 0.73)
High school graduate or GED	—	0.35 (0.01 to 0.69)	0.36 (0.03 to 0.69)	—	0.35 (0.02 to 0.69)	0.36 (0.04 to 0.68)	—	0.51 (0.18 to 0.84)	0.49 (0.16 to 0.81)
Business/vocational school/some college	—	0.40 (0.06 to 0.74)	0.42 (0.09 to 0.76)	—	0.41 (0.08 to 0.75)	0.43 (0.11 to 0.76)	—	0.49 (0.15 to 0.82)	0.49 (0.16 to 0.82)
College graduate	—	0.35 (0.04 to 0.67)	0.32 (0.01 to 0.62)	—	0.33 (0.02 to 0.64)	0.30 (0 to 0.60)	—	0.42 (0.11 to 0.73)	0.38 (0.07 to 0.68)
Attended graduate/ professional school	—	Reference	Reference	—	Reference	Reference	—	Reference	Reference
Annual household income, $									
<20,000	—	0.57 (0.17 to 0.98)	0.49 (0.09 to 0.88)	—	0.44 (0.04 to 0.84)	0.38 (−0.01 to 0.77)	—	0.57 (0.18 to 0.96)	0.50 (0.11 to 0.89)
20,000–39,999	—	0.44 (0.07 to 0.81)	0.46 (0.10 to 0.81)	—	0.28 (−0.09 to 0.64)	0.31 (−0.04 to 0.67)	—	0.40 (0.04 to 0.76)	0.42 (0.07 to 0.77)
40,000–59,999	—	0.22 (−0.11 to 0.55)	0.22 (−0.10 to 0.54)	—	0.17 (−0.16 to 0.49)	0.17 (−0.15 to 0.48)	—	0.18 (−0.14 to 0.50)	0.18 (−0.13 to 0.50)

[a] Scale for self-rated health ranged from 1 (excellent) to 5 (poor).
[b] Scale consisted of 9 dichotomous (yes = 1; no or not applicable = 0) items. Scale ranged from 0 to 9, with higher scores indicating greater acculturative stress.
[c] A 10-item modified version of the Perceived Stress Scale (19) was used; scale ranged from 0 to 40, with higher scores indicating greater perceived stress.
[d] Measured by a distress "thermometer" numbered from 0 at the bottom (no distress) to 10 at the top (extreme distress). Respondents circled their response; scale ranged from 0 to 10, with higher scores indicating greater distress.
[e] Model 1: Stress + age.
[f] Model 2: Model 1 + sex, Asian subgroup, marital status, education, household income, employment status, health insurance status.
[g] Model 3: Model 2 + sleep disturbance.

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(continued)

Table 2. Associations of Acculturative Stress, Perceived Stress, and Distress With Self-Rated Health[a] in Linear Regression Analysis of Data From 400 Chinese and Korean Immigrants Aged 50 to 75 Years Recruited From Physicians' Clinics in the Baltimore–Washington, DC, Metropolitan Area, August 2018–June 2020

Variable	Self-rated health to β (95% CI)								
	Acculturative stress[b]			Perceived stress[c]			Distress[d]		
	Model 1[e]	Model 2[f]	Model 3[g]	Model 1[e]	Model 2[f]	Model 3[g]	Model 1[e]	Model 2[f]	Model 3[g]
60,000–79,999	—	0.08 (−0.30 to 0.46)	0.08 (−0.29 to 0.45)	—	0.01 (−0.37 to 0.38)	0.01 (−0.35 to 0.38)	—	0.01 (−0.36 to 0.38)	0.02 (−0.35 to 0.38)
80,000–99,999	—	−0.10 (−0.52 to 0.32)	−0.10 (−0.51 to 0.30)	—	−0.23 (−0.64 to 0.19)	−0.21 (−0.62 to 0.19)	—	−0.19 (−0.59 to 0.22)	−0.17 (−0.57 to 0.23)
≥100,000	—	Reference	Reference	—	Reference	Reference	—	Reference	Reference
Employment status									
Working part time	—	−0.01 (−0.28 to 0.26)	0 (−0.26 to 0.26)	—	0.07 (−0.20 to 0.33)	0.07 (−0.19 to 0.32)	—	0.07 (−0.19 to 0.33)	0.06 (−0.19 to 0.32)
Not currently working	—	0.05 (−0.24 to 0.34)	0.09 (−0.19 to 0.37)	—	0.06 (−0.22 to 0.34)	0.09 (−0.18 to 0.37)	—	0.11 (−0.17 to 0.39)	0.13 (−0.15 to 0.40)
Working full time	—	Reference	Reference	—	Reference	Reference	—	Reference	Reference
Health insurance status									
Medicare/Medicaid	—	−0.05 (−0.37 to 0.26)	−0.04 (−0.35 to 0.26)	—	−0.10 (−0.40 to 0.21)	−0.08 (−0.38 to 0.22)	—	−0.13 (−0.44 to 0.18)	−0.11 (−0.41 to 0.19)
No health insurance	—	0.11 (−0.16 to 0.37)	0.11 (−0.15 to 0.37)	—	0.10 (−0.16 to 0.37)	0.10 (−0.15 to 0.36)	—	0.12 (−0.13 to 0.38)	0.12 (−0.13 to 0.38)
Private health insurance	—	Reference	Reference	—	Reference	Reference	—	Reference	Reference
Sleep disturbance									
Mild, moderate, or severe	—	—	0.61 (0.36 to 0.86)	—	—	0.55 (0.30 to 0.80)	—	—	0.49 (0.24 to 0.75)
None to slight	—	—	Reference	—	—	Reference	—	—	Reference

[a] Scale for self-rated health ranged from 1 (excellent) to 5 (poor).
[b] Scale consisted of 9 dichotomous (yes = 1; no or not applicable = 0) items. Scale ranged from 0 to 9, with higher scores indicating greater acculturative stress.
[c] A 10-item modified version of the Perceived Stress Scale (19) was used; scale ranged from 0 to 40, with higher scores indicating greater perceived stress.
[d] Measured by a distress "thermometer" numbered from 0 at the bottom (no distress) to 10 at the top (extreme distress). Respondents circled their response; scale ranged from 0 to 10, with higher scores indicating greater distress.
[e] Model 1: Stress + age.
[f] Model 2: Model 1 + sex, Asian subgroup, marital status, education, household income, employment status, health insurance status.
[g] Model 3: Model 2 + sleep disturbance.

Table 3. Sleep Disturbance Mediating the Association Between Stresses and Self-Rated Health Among 400 Chinese and Korean Immigrants Aged 50 to 75 Years Recruited From Physicians' Clinics in the Baltimore–Washington, DC, Metropolitan Area, August 2018–June 2020[a]

Decomposition of effects	β (SE)	*P* value	Percentage of total effect due to sleep disturbance
Total effect of acculturative stress on self-rated health	0.10 (0.03)	.002	21.6
Direct (unmediated) effect of acculturative stress on self-rated health	0.08 (0.03)	.02	
Indirect (mediated) effect of acculturative stress on self-rated health through sleep disturbance	0.02 (0.01)	.02	
Total effect of perceived stress on self-rated health	0.06 (0.01)	<.001	14.9
Direct (unmediated) effect of perceived stress on self-rated health	0.05 (0.01)	<.001	
Indirect (mediated) effect of perceived stress on self-rated health through sleep disturbance	0.01 (0)	.005	
Total effect of distress on self-rated health	0.11 (0.02)	<.001	18.7
Direct (unmediated) effect of distress on self-rated health	0.09 (0.02)	<.001	
Indirect (mediated) effect of distress on self-rated health through sleep disturbance	0.02 (0.01)	.002	

[a] All effects were calculated by accounting for the following covariates: age, sex, Asian subgroup, marital status, education, household income, employment status, and health insurance status.

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RESEARCH BRIEF

Prevalence and Geographic Patterns of Self-Reported Short Sleep Duration Among US Adults, 2020

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PEER REVIEWED

Summary

What is already known on this topic?

Short sleep duration (<7 hours for adults) is associated with an increased risk of chronic conditions, yet one-third of US adults report short sleep duration.

What is added by this report?

Disparities in the prevalence of short sleep duration were identified across age, sex, race and ethnicity, marital status, education, income, and urbanicity. Counties with the highest model-based estimates clustered in the Southeast and along the Appalachian Mountains.

What are the implications for public health practice?

Findings highlight subgroups and geographic areas in which disparities in short sleep duration exist. Combining model-based local estimates of short sleep duration with neighborhood-level data and context can inform the development and implementation of tailored efforts to promote sleep health.

Abstract

We estimated the prevalence of short sleep duration (<7 hours per day) among US adults aged 18 years or older by using 2020 Behavioral Risk Factor Surveillance System data. Nationally, 33.2% of adults reported short sleep duration. We identified disparities across sociodemographic characteristics, including age, sex, race and ethnicity, marital status, education, income, and urbanicity. Counties with the highest model-based estimates of short sleep duration clustered in the Southeast and along the Appalachian Mountains. These findings identified subgroups and geographic areas in which tailored strategies for promotion of optimal sleep duration (≥7 hours per night) are most needed.

Objective

Short sleep duration (sleeping <7 hours per 24-hour period) is associated with an increased risk of chronic conditions (eg, obesity, diabetes, hypertension, heart disease, stroke, anxiety, depression) (1). Increasing the proportion of adults who get enough sleep is a Healthy People 2030 objective (2). Yet in 2014, one-third of US adults reported short sleep duration (3). The prevalence of short sleep duration can vary by state, with a higher prevalence clustered in the southeastern US (3); however, less is known about trends by urbanicity and the clustering of short sleep duration at the county level. We examined the prevalence of short sleep duration among adults aged 18 years or older nationally by sociodemographic characteristics (ie, age, sex, race and ethnicity, marital status, education, and annual household income) and geographic characteristic (urban–rural classification) and identified geographic patterns of short sleep duration at the county level.

Methods

We analyzed data from the 2020 Behavioral Risk Factor Surveillance System (BRFSS) to estimate crude and age-adjusted (4) short sleep duration prevalence nationally (50 states and the District of Columbia) and by age group, sex, race and ethnicity, marital status, education, annual household income, and urban–rural classification. BRFSS is an annual, state-based, random-digit–dialed landline and cell phone survey used to monitor health conditions and behaviors of noninstitutionalized adults aged 18 years or older in all 50 states, the District of Columbia, and participating US territories (5). The median response rate for the 50 states and the District of Columbia was 47.6% (range, 34.5%–67.2%) in 2020. We considered responses of less than 7 hours to the question "On average, how many hours of sleep do

you get in a 24-hour period?" as reporting short sleep duration. We included data from respondents surveyed in all 50 states and the District of Columbia; information on sleep was reported by 390,193 (98.8%) respondents. We obtained Federal Information Processing Series codes for county of residence through a data-use agreement with BRFSS. Counties were classified into 6-level urban–rural classifications by using the National Center for Health Statistics 2013 classification scheme (6). We used trend tests to determine associations between the prevalence of short sleep duration and annual household income and urban–rural classification. We used pairwise *t* tests to compare the prevalence between subgroups across other characteristics. All comparisons reported were significant at $P < .05$.

We estimated the county-level crude and age-adjusted (4) prevalence of short sleep duration in 3,143 counties by using multilevel logistic regression and poststratification (MRP) and the Centers for Disease Control and Prevention's PLACES approach (7,8). We constructed a multilevel regression model using 2020 BRFSS individual-level data on sex, age, race and ethnicity, and education level, and county-level data on those living below 150% of the poverty threshold from the 5-year 2016–2020 American Community Survey as well as state- and nested county-level random effects (8). We then applied predicted probabilities to county populations by using Census Vintage 2020 population estimates to generate the final predicted county-level prevalence estimates of short sleep duration. Estimates were validated by comparing crude model-based estimates with weighted direct survey estimates from counties with a sample size of 500 or more (n = 183) in BRFSS; the Pearson correlation coefficient was 0.90. We visualized the distribution of county-level prevalence estimates by quintiles. We used SAS version 9.4 (SAS Institute Inc) and SAS-callable SUDAAN version 11.0.3 (RTI International) to conduct all analyses. We used Esri ArcMap version 10.8.1 to create maps.

Results

Overall, an age-adjusted 33.2% of adults reported short sleep duration in 2020 (Table). By age, adults aged 25 to 44 years; by sex, men; by education, those with some college; and by marital status, those who were divorced, widowed, or separated had the highest prevalence of short sleep duration. Non-Hispanic Native Hawaiian or Pacific Islander and non-Hispanic Black adults had a higher prevalence of short sleep duration compared with non-Hispanic White, non-Hispanic Asian, and Hispanic adults. The prevalence of short sleep duration increased with decreasing annual household income, from 29.3% (≥$75,000) to 38.1% (<$15,000), and decreasing urbanicity, from 32.0% (large central metropolitan counties) to 35.0% (noncore counties).

Model-based age-adjusted county-level estimates of short sleep duration prevalence ranged from 23.8% (crude, 23.2%) in Boulder County, Colorado, to 48.4% (crude, 46.4%) in Greene County, Alabama. Overall, counties with crude and age-adjusted prevalence in the highest quintile were clustered in the Southeast and along the Appalachian Mountains (Figure).

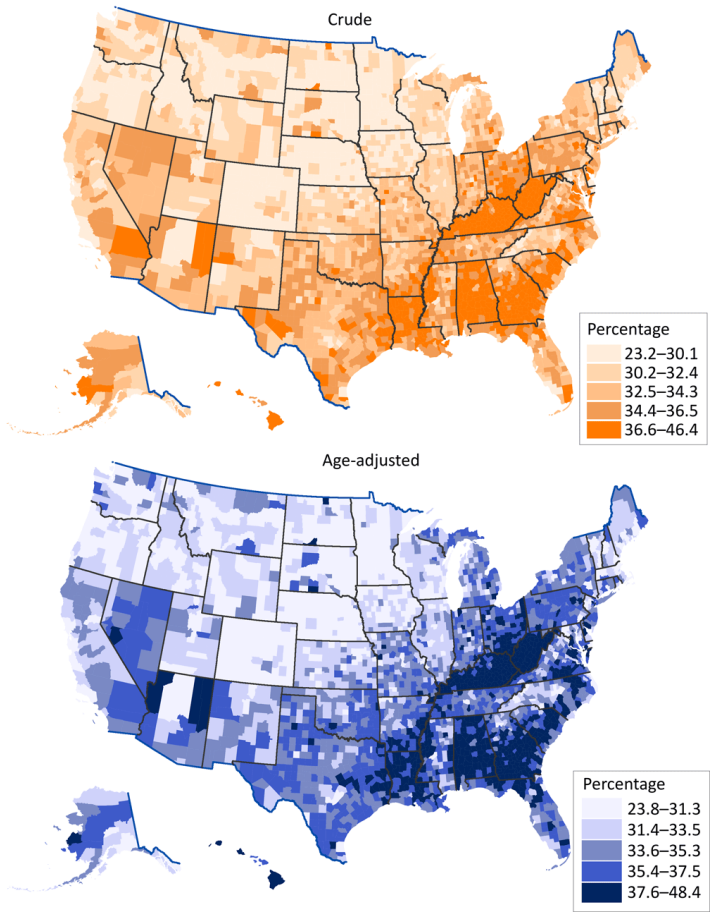

Figure. Model-based crude and age-adjusted county-level prevalence estimates of short sleep duration (<7 hours per 24-hour period) among adults aged 18 years or older, by quintile, United States, 2020. Urban–rural classification was defined by the National Center for Health Statistics 2013 urban–rural classification scheme (6). Age-adjusted estimates were standardized to the 2000 projected US population aged 18 years or older in 13 groups (18–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, ≥80) (4). Data source: Centers for Disease Control and Prevention (7).

Discussion

In 2020, one-third of US adults reported short sleep duration. Differences identified across sociodemographic characteristics, including age, race and ethnicity, education, and marital status, were

similar to those identified in a previous study (3) and highlight the continued need for tailored strategies to address these disparities. By geographic characteristic, prevalence increased with decreasing urbanicity. In contrast to our study, a study using BRFSS data did not find urban–rural differences in the prevalence of sufficient sleep (9), but that study used data from 2013 and a definition of sleep duration that was different from ours. Similar to our results on sleep duration across the urban–rural continuum, previous studies found that the prevalence of health risk behaviors such as cigarette smoking and not meeting physical activity guidelines increased with decreasing urbanicity (9,10). Rural health may benefit from efforts that promote multiple health behaviors. For example, promoting regular physical activity can help establish healthy sleep habits and improve sleep duration (11).

Counties with the highest model-based prevalence of short sleep duration were clustered in the Southeast and along the Appalachian Mountains. The county-level geographic pattern of short sleep duration is similar to patterns of model-based estimates for the prevalence of diabetes, hypertension, heart disease, stroke, and depression, as well as mortality from heart disease and stroke (7,12). This similarity suggests that the geographic differences in short sleep duration may partially reflect geographic patterns of other chronic conditions, for which short sleep duration is a risk factor (1). Model-based estimates at the county level have been shown to be reliable (8) and are a valuable planning tool, especially when direct local data are unavailable. Our estimates offer a starting point for identifying and understanding geographic disparities, but additional neighborhood-level data and context can be incorporated into developing local efforts to promote sleep health. For example, examining and understanding the role of household and neighborhood factors (eg, sleeping conditions, safety, noise, light exposure) on sleep health (13) can help guide local public health practitioners in developing and implementing effective and tailored prevention activities, programs, and policies.

This study has several limitations. First, direct estimates were based on self-reported data and depended on accurate recall. Second, our results may have been influenced by nonresponse bias; we reduced this bias through the application of sampling weights. Third, the COVID-19 pandemic may have affected 2020 BRFSS data collection and potentially influenced estimates (5). Lastly, county-level estimates of short sleep duration were estimated by using MRP, which could introduce bias from the surveys (eg, recall, sampling) and modeling approach. Detailed limitations and strengths of MRP are addressed elsewhere (8).

Our findings suggest that promotion of sufficient sleep duration is needed in subgroups and geographic areas with a higher prevalence of short sleep duration. Combining model-based local estimates of short sleep duration with neighborhood-level data and context can further inform the development and implementation of tailored efforts to promote sleep health.

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Table

Table. Crude and Age-Adjusted Prevalence of Short Sleep Duration Among Adults Aged ≥18 Years, by Sociodemographic and Geographic Characteristics, Behavioral Risk Factor Surveillance System, US, 2020[a]

Characteristic	Unweighted no. of respondents	Crude prevalence, % (95% CI)	Age-adjusted prevalence, % (95% CI)
Overall	390,193	32.7 (32.4–33.1)	33.2 (32.8–33.6)
Age group, y[b]			
18–24	24,891	29.8 (28.7–31.0)	NA
25–44	93,327	36.4 (35.8–37.1)	NA
45–64	136,052	34.5 (33.9–35.1)	NA
≥65	135,923	26.0 (25.4–26.6)	NA
Sex[c]			
Female	211,071	32.1 (31.6–32.6)	32.6 (32.0–33.1)
Male	179,122	33.3 (32.8–33.9)	33.8 (33.3–34.3)
Race and ethnicity[d]			
Hispanic	30,885	32.1 (30.9–33.3)	32.0 (30.8–33.3)
Non-Hispanic American Indian or Alaska Native	6,787	38.5 (35.6–41.4)	38.5 (35.7–41.4)
Non-Hispanic Asian	9,396	30.5 (28.3–32.8)	30.8 (28.5–33.3)
Non-Hispanic Black	29,597	43.5 (42.4–44.6)	43.6 (42.4–44.7)
Non-Hispanic Native Hawaiian or Pacific Islander	1,246	46.5 (41.2–52.0)	46.5 (41.0–52.1)
Non-Hispanic White	294,308	30.7 (30.3–31.0)	31.8 (31.4–32.2)
Non-Hispanic multiracial	8,054	39.5 (37.2–41.9)	39.8 (37.5–42.3)
Non-Hispanic other	3,488	36.8 (33.5–40.2)	36.6 (33.2–40.1)
Marital status[e]			
Married or member of an unmarried couple	217,202	30.3 (29.8–30.8)	31.0 (30.4–31.5)
Divorced, widowed, or separated	99,926	37.4 (36.7–38.2)	41.6 (40.0–43.2)

Abbreviation: NA, not applicable.

[a] Crude and age-adjusted prevalence and 95% CIs were directly estimated by using sampling weights. Includes data from the 50 US states and the District of Columbia. Age-adjusted estimates were standardized to the 2000 projected US population aged ≥18 years in 4 groups (18–24, 25–44, 45–64, ≥65) for all characteristics except age group (https://www.cdc.gov/nchs/data/statnt/statnt20.pdf). Categories may not sum to sample total because of missing responses.

[b] Significant difference in crude prevalence across all age-group comparisons assessed by pairwise *t* tests; $P < .05$ considered significant.

[c] Significant difference in crude and age-adjusted prevalence between male and female assessed by pairwise *t* tests; $P < .05$ considered significant.

[d] Significant differences in crude and age-adjusted prevalence found for most pairwise comparisons across racial and ethnic subgroups (assessed by pairwise *t* tests and $P < .05$ considered significant). Pairwise differences were not significant for the comparison of crude and age-adjusted prevalence for non-Hispanic White compared with non-Hispanic Asian; non-Hispanic Black compared with non-Hispanic Native Hawaiian or Pacific Islander; Hispanic compared with non-Hispanic Asian; non-Hispanic multiracial compared with American Indian or Alaska Native and non-Hispanic Other; and non-Hispanic American Indian or Alaska Native compared with non-Hispanic Other. Comparison of the age-adjusted prevalence was not significant, while the comparison of the crude prevalence was significant for non-Hispanic White compared with Hispanic.

[e] Significant difference in crude and age-adjusted prevalence across all marital status subgroup comparisons assessed by pairwise *t* tests ($P < .05$ considered significant).

[f] Significant differences in crude and age-adjusted prevalence found for most pairwise comparisons across education subgroups (assessed by pairwise *t* tests, $P < .05$ considered significant). Pairwise differences were not significant for the comparison of crude prevalence for "less than high school diploma" with "high school graduate."

[g] Significant linear and quadratic trend in crude and age-adjusted prevalence using orthogonal polynomial contrasts trend tests ($P < .05$ considered significant). Indicates a nonlinear variation in addition to an overall increase as income attainment decreases.

[h] Urban–rural classification defined by the National Center for Health Statistics 2013 urban–rural classification scheme (www.cdc.gov/nchs/data_access/urban_rural.htm). Significant linear trend in crude and age-adjusted prevalence using orthogonal polynomial contrasts trend tests ($P < .05$).

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Table. Crude and Age-Adjusted Prevalence of Short Sleep Duration Among Adults Aged ≥18 Years, by Sociodemographic and Geographic Characteristics, Behavioral Risk Factor Surveillance System, US, 2020[a]

Characteristic	Unweighted no. of respondents	Crude prevalence, % (95% CI)	Age-adjusted prevalence, % (95% CI)
Never married	69,484	34.5 (33.7–35.3)	36.4 (35.5–37.3)
Education[f]			
Less than high school diploma	24,634	33.7 (32.4–35.0)	33.7 (32.4–35.1)
High school graduate	103,526	34.6 (34.0–35.3)	35.8 (35.1–36.5)
Some college	108,508	35.8 (35.2–36.5)	36.8 (36.1–37.6)
College graduate or higher	151,840	27.2 (26.7–27.8)	27.0 (26.5–27.6)
Annual household income, $[g]			
<15,000	24,361	38.0 (36.4–39.5)	38.1 (36.5–39.7)
15,000 to <25,000	46,410	37.1 (36.1–38.2)	37.9 (36.8–39.0)
25,000 to <35,000	30,426	35.2 (33.8–36.5)	36.3 (34.9–37.7)
35,000 to <50,000	42,969	35.1 (34.0–36.2)	36.3 (35.2–37.5)
50,000 to <75,000	51,738	33.7 (32.6–34.7)	34.1 (33.1–35.2)
≥75,000	117,658	29.7 (29.1–30.3)	29.3 (28.6–29.9)
Missing	76,631	30.2 (29.5–30.9)	31.3 (30.5–32.1)
Urban-rural classification[h]			
Large central metropolitan	58,174	32.0 (31.2–32.8)	32.0 (31.2–32.9)
Large fringe metropolitan	76,295	32.7 (32.0–33.3)	33.2 (32.5–33.9)
Medium metropolitan	80,761	33.0 (32.3–33.6)	33.7 (33.0–34.4)
Small metropolitan	54,457	33.4 (32.5–34.3)	34.5 (33.6–35.5)
Micropolitan	61,818	33.6 (32.9–34.4)	34.8 (34.0–35.7)
Noncore	58,688	33.6 (32.6–34.5)	35.0 (33.9–36.0)

Abbreviation: NA, not applicable.

[a] Crude and age-adjusted prevalence and 95% CIs were directly estimated by using sampling weights. Includes data from the 50 US states and the District of Columbia. Age-adjusted estimates were standardized to the 2000 projected US population aged ≥18 years in 4 groups (18–24, 25–44, 45–64, ≥65) for all characteristics except age group (https://www.cdc.gov/nchs/data/statnt/statnt20.pdf). Categories may not sum to sample total because of missing responses.

[b] Significant difference in crude prevalence across all age-group comparisons assessed by pairwise *t* tests; $P < .05$ considered significant.

[c] Significant difference in crude and age-adjusted prevalence between male and female assessed by pairwise *t* tests; $P < .05$ considered significant.

[d] Significant differences in crude and age-adjusted prevalence found for most pairwise comparisons across racial and ethnic subgroups (assessed by pairwise *t* tests and $P < .05$ considered significant). Pairwise differences were not significant for the comparison of crude and age-adjusted prevalence for non-Hispanic White compared with non-Hispanic Asian; non-Hispanic Black compared with non-Hispanic Native Hawaiian or Pacific Islander; Hispanic compared with non-Hispanic Asian; non-Hispanic multiracial compared with American Indian or Alaska Native and non-Hispanic Other; and non-Hispanic American Indian or Alaska Native compared with non-Hispanic Other. Comparison of the age-adjusted prevalence was not significant, while the comparison of the crude prevalence was significant for non-Hispanic White compared with Hispanic.

[e] Significant difference in crude and age-adjusted prevalence across all marital status subgroup comparisons assessed by pairwise *t* tests ($P < .05$ considered significant).

[f] Significant differences in crude and age-adjusted prevalence found for most pairwise comparisons across education subgroups (assessed by pairwise *t* tests, $P < .05$ considered significant). Pairwise differences were not significant for the comparison of crude prevalence for "less than high school diploma" with "high school graduate."

[g] Significant linear and quadratic trend in crude and age-adjusted prevalence using orthogonal polynomial contrasts trend tests ($P < .05$ considered significant). Indicates a nonlinear variation in addition to an overall increase as income attainment decreases.

[h] Urban–rural classification defined by the National Center for Health Statistics 2013 urban–rural classification scheme (www.cdc.gov/nchs/data_access/urban_rural.htm). Significant linear trend in crude and age-adjusted prevalence using orthogonal polynomial contrasts trend tests ($P < .05$).

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