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Suboptimal Sleep in Adolescents: Socio-Cultural Risk Factors to Consider

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Introduction

Chronic sleep problems, such as sleep loss and disrupted sleep, are associated with poor health outcomes and continue to contribute to the nation's public health burden. Growing incidence of sleep problems among adolescents suggests that the nation's youth may be at increased risk for short- and long-term health consequences. The intent of this brief commentary is to increase public awareness of the complex context that shapes the quality and quantity of adolescent sleep, to underscore the conclusion that adolescence is a particularly salient developmental period for prevention and intervention research, and to highlight the findings that adolescents of color may be at particularly high risk for negative health outcomes related to suboptimal sleep.

Sleep and Adolescents

Roughly 70 million Americans suffer from chronic sleep problems [1]. Suboptimal sleep not only affects an individual's physicals safety and quality of life, but is also linked to a variety of psychiatric and somatic disorders (e.g. depression, obesity), elevated stress, and increased mortality [2,3]. Although the precise mechanisms underlying the complex relation between mammalian sleep and health outcomes are unclear, the importance of studying sleep patterns and behavior remain widely appreciated [4,5].

Adults with sleep problems commonly report that their sleep disturbances began in adolescence [4,6]. This is not particularly surprising, in that sleep profiles naturally change across each major developmental period [7,8]. Adolescence, however, is a particularly vulnerable period during which youth experience significant changes in sleep patterns and behaviors, reductions in total sleep time, and instances of sleep disruption (e.g., difficulty falling asleep, difficulty staying asleep) [8-10]. These changes in sleep are often attributed to later bedtimes, partially resulting from decreased parental supervision, more societal demands (e.g., early school start times, increased academic requirements), and increased stress (e.g., interpersonal difficulties, academic demands) [11,12].

In adolescents, insufficient amounts of sleep is linked to poorer overall health, altered sleep architecture, greater day time sleepiness, increased risk-taking activities, and decreased emotion regulation, as compared to those

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receiving adequate sleep [9,10]. Furthermore, sleep loss and the associated deficits in emotion regulation is linked to the predisposition for, and increased severity of, internalizing and externalizing disorders(e.g. depression, aggression) that may persist well in to adulthood [9,13,14].

An important step toward the intervention and prevention of health consequences related to poor sleep is a greater understanding of the social, cultural, and environmental factors that impact sleep behavior during the particularly malleable period of adolescence. Below is a brief overview of the impact of five external factors on adolescent sleep, as well as a short discussion on the potential for race/ethnicity and socioeconomic environments to moderate the relation between sleep and health outcomes.

External Factors that Impact Adolescent Sleep

Electronic media and technology

The integral role of electronic media and technology in the lives of adolescents has increased over the last few decades [15,16]. And unfortunately, this increased consumption has contributed to a disruption in sleep patterns and behaviors. In fact, recent reviews conclude that prolonged use of media and technology is associated with delayed bedtimes, longer sleep onset latency (taking longer to fall asleep), and shorter overall sleep time in children and adolescents [17,18].

These findings make sense, in that late night use of media and technology opposes the biological processes of circadian timing and sleep pressure, and contributes to states of wakefulness and arousal, largely as are salt of sustained light exposure. When activated, a vast number of media devices emit steady waves of blue light [19,20]. The mammalian circadian system is maximally sensitive to the blue spectrum of light (peaksensitivity~460nm) [21]. Blue light exposure during night hours can suppress the secretion of the "sleep hormone," melatonin [22,23]. And exacerbate sleep delay. Moreover, night time exposure to light can increase core body temperature and heart rate and enhance acute alertness [24,25].

Interestingly, evidence suggests that adolescents' relationship with sleep and media and technology can be bi-directional, meaning that adolescents with sleep problems may also seek out these electric devices to serve as a sleep aid [10]. Regardless of the direction of the relationship, studies suggest that with chronic repetition, seemingly unimportant habits or behaviors at bedtime can influence outcomes of sleep and have detrimental consequences on an individual's health and well-being [26].

Caffeine

Caffeine is a known stimulant and energy enhancer. Over the last few decades, there has been a steady increase in the intake of caffeinated drinks throughout the day and into the evening among youth [15,27,28]. Unfortunately, the "coolness factor" of energy drinks and coffee shop sippy cups has simply become the new norm. Not surprisingly, caffeine impacts sleep. Caffeine is a central nervous system stimulant that increases then euro transmission of excitatory factors (e.g. glutamate, epinephrine) and results in feelings of wakefulness and alertness [29]. Moderate doses of caffeine advance REM sleep, reduce overall slow-wave sleep, and disrupt sleep continuity [27,30]. Moreover, there is a 2-fold increase in sleep disturbances and a significant decrease in over all sleep time in adolescents who reported high caffeine intake, as compared to those whose intake levels were low [15,28].

Cigarette smoking

The Surgeon General reports that nearly 90 percent of adult smokers started smoking by age 18 [31]. In addition, since 2011, there has been a marked increase in the use of e-cigarette among middle and high school students [32].These statistics on use suggest that adolescents are a vulnerable population for the short- and long-term effects of nicotine on sleep patterns and behavior. A side from the well-known associations with cancer, cigarette smoking is also tightly linked to deficits in sleep quality and duration in adults [33]. The nicotine within cigarettes activates a wide range of cholinergic-driven processes, the most relevant to this discussion is the cholinergic regulation of sleep architecture (e.g., REM stage) [34,35]. Individuals who smoke display lower levels of sleep quality (e.g. more sleep apneas, leg movements, less restorative sleep)and significant changes in sleep architecture (shorter sleep period time, longer sleep latency, higher rapid eye movement (REM) sleep density), as compared to healthy non-smokers [34,36]. The chronic ingestion of nicotine may be, in part, one mechanism linking smoking to the observed changes in sleep patterns.

It remain sun clear as to whether direct exposure to nicotine (or another particular product within the tobacco)disrupts optimal sleep, but studies using only nicotine patches on healthy nonsmokers reveal disruptions in sleep behavior (e.g. decreased total sleep time, reduction in REM sleep) similar to those in sleep studies with smokers [37,38]. Thus, nicotine usage, or possibly the overnight withdraw all from nicotine, may contribute to suboptimal sleep [39,40]. These are notable findings when considering the short- and long-term effects of nicotine in youth populations.

Alcohol

Adolescence is a unique developmental period characterized by growing behavioral autonomy, decreasing parental supervision, and increasing access to, and exploration of, risk- taking activities, such as alcohol consumption [41]. According to reports from the Centers for Disease Control and Prevention (CDC), alcohol is the most commonly abused drug by youths within the United States, above recent rates of tobacco usage [42]. Alcohol, a depressive drug that activates the inhibitory GABA system, impairs alertness during the day and alters sleep profiles at night [43,44]. Empirical tests on the effects of alcohol use and abuse on adolescent sleep are limited; therefore, researchers largely rely on subjective surveys and adult studies. Resoundingly, sleep studies in adults report that occasional alcohol use may improve sleep [45]. However, moderate excessive use of alcohol increases the latency to fall asleep, produces a dose-dependent alteration in REM sleep, and disrupts sleep continuity (increased waking periods), particularly during the second half of nightly sleep, following them metabolism of the ingested alcohol [45,46]. Given the extent of alcohol use among youth, the relation between alcohol use and sleep problems is an important public health issue with wide spread health implications.

Obesity

For youth (ages 2-19), rates of obesity have increased over the last 20 years. Recent data from the CDC's National Health and Nutrition Examination Survey estimates that roughly20 percent of youth are obese. Also in these data, are striking disparities in obesity rates across race/ethnicity? For example, 14 percent of non-Hispanic White youths are obese, as compared to roughly 22 percent of African-American youths and roughly 26 percent of His panic youth [47]. Given these recent trends (particularly for youths of color), there have been increased concerns regarding the associations between weight, sleep and health.

Studies in adolescents, using both subjective and objective measures, demonstrate a negative association between obesity and sleep duration and deficiency [48,49]. The association between sleep loss and the high risk for obesity is thought to be due to the effects of sleep debt on normative metabolic processes [50]. The secretion of metabolic factors (e.g., glucose, leptin, ghrelin) - important in appetite and feeding behavior-follow distinct circadian rhythm profiles that are sensitive to levels of sleep loss or sleep deprivation [51].

For example, sleep loss alters night time insulin and glucose profiles, promotes increases in ghrelin (an appetite-stimulating hormone), and reduces glucose tolerance and leptin (a satiety-stimulating hormone) levels [52,53]. Additionally, following sleep restriction in healthy young adults, Spiegel et al. [51] found decreases in glucose clearance, lower insulin responses to glucose, decreased carbohydrate tolerance, and higher glucose levels after eating, as compared to individuals for whom sleep time was extended. Furthermore, these metabolic changes contribute to an increased preference for high caloric foods, increased food intake, changes in day time energy use, and are well-recognized precursors of obesity or insulin resistance (type-2diabetes) [54,55].

On the other hand, obesity also identified as an important risk factor for sleep loss [56]. Sleep-related breathing disorders (e.g., sleep apnea) are common in over weight individuals, and may be due to a compromised respiratory structure and/or function [57]. Patients with sleep apnea often report difficulty falling asleep, staying asleep, waking un refreshed, and decreased day time physical activity. Importantly although inadequate sleep is not the sole cause of obesity [58]. Evidence indicates that weight loss can reduce episodes of sleep-related apnea and improve health outcomes [59]. Thus, identifying risk factors that contribute to suboptimal sleep can help guide the construction of early intervention programs that aim to ameliorate or prevent the onset of associated health problems.

Potential Modulators of the Relation Between Adolescent sleep and health outcomes

Adolescents of a particular race, ethnic background, or socioeconomic status (SES) may be at especially high risk for the development of suboptimal sleep and negative health outcomes, as compared to their peers. Here, we highlight the importance of considering race/ethnicity and SES when examining the relation between sleep and health outcomes. Race is a complex term that describes a categorization of people. There is ongoing debate concerning the relation of biological race to health outcomes [e.g.,74], but in this commentary, the complex term "race" refers to a self-identified cultural group that is not based on a particular genetic makeup. The construct of SES is a marker of location within the social structure or class and is composed of a number of variables including property ownership, occupation, education, income, number of house hold occupants, and marital status. It is important to note that the operationalization of SES tends to vary across studies and sometimes is comprised of only one SES variable [60]. Such limitations can lead to difficulties in compiling and comparing results across studies. Importantly, although race and SES are commonly correlated in health research, each factor has been found to

relate somewhat differently to sleep processes and behaviors [61,62]. And therefore should be studied separately in relation to sleep loss and morbidity [63].

Adolescents of color

The demographic makeup of the nation has changed over the last 50 years. Today, the demographics of the nation's youth have transitioned to a non-White majority and will only continue to grow more diverse [64]. These changes provide a new sense of urgency and responsibility to conduct research using diverse subject populations[1]. As an example, studies show that there are racial/ethnic differences in sleep processes and behaviors [e.g., 76-80]. Studies with African-American subject populations reveal that African-American youth have shorter total sleep times, higher levels of disrupted sleep, and more reported sleep problems than non- Hispanic White youth, even after controlling for SES [62,65,66]. There are also racial/ethnic differences in the daily levels of electronic media consumption [16]. And as described in a previous section, differences in the rates of obesity, all of which serve as risk factors for sleep problems. From this, we emphasize that all future research will need to have an intentional focus on including populations, particularly youth populations, from diverse racial, ethnic, and cultural backgrounds.

Socioeconomic environment

Residence within socioeconomically disadvantaged home environments early in life is associated with emotional, social, and biological hard ships, and predicts future negative health outcomes [67,68]. Relatedly, there also is a significant association between low SES and poor sleep, in that adolescents living in disadvantaged neighborhoods have a greater incidence of adverse sleep behaviors(e.g., insufficient sleep) [69,70]. Specifically, individuals from low SES backgrounds report higher rates of sleep disturbance, problematic bed time behaviors, shorter total sleep time, and poorer quality sleep [61,71,72].

Outcomes of poor sleep have been associated with a factor found in low SES environments. For example, low-income or urban housing accommodations are often over crowded or have thin walls separating the living quarters. This may increase residents' exposure to environmental noise, and thereby contribute to shortened or fragmented sleep. In addition, pervasive environment al light exposure (e.g., street lamps) has demonstrated effects on circadian processes and contribute to adverse sleep behavior [71,73]. And there is also some evidence to suggest that low-income neighborhood stand to be less safe, both inside and outside of the home [74,75]. Thus, living, working, and playing in certain environments may create elevated levels of threat and distress in certain youth populations. Such chronic adversity can activate biological stress responses (e.g., release of epinephrine, cortisol), promoteill-time darousal, and contribute to difficulties in falling or staying sleep [75].

Sleep behaviors of adolescents in rural communities should also to be considered. In certain districts, many children commute, often by bus, to and from their school locations for up to 4hours a day [76,77]. The burdens of early school start times and long commutes can result in significant reduction in overall sleep time [10,78]. External factors such as these may have cumulative effects on sleep patterns and short- and long-term health outcomes; however, the precise timing and duration of exposure necessary to produce these effects remain unknown.

Conclusions

There are complex social, cultural, and environmental factors that shape the quality and quantity of adolescent sleep and have the potential to create a lasting impact on the health outcomes of our nation. For the sake of brevity, this commentary did not present an exhaustive list of risk factors for sub-optimal sleep, nor was there an extensive review of the overlapping relations among the factors-although there would be value in doing so in future publications.

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[1]It is important to note that race/ethnicity may serve as a marker, but not as an explanation of group differences. That is, it is not yet clear as to whether the risk for suboptimal sleep in adolescents is due to a specific ethnic identity, a unique set of cultural influences, or some other variable.

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