

Relationships between pre-bedtime technology use and sleep in adolescents

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Introduction

The effect of technology use on sleep is a topic that has been oft-explored in recent literature. Screen-based technologies are theorized to have an effect on sleep-wake cycles, sleep duration, and sleep quality. Sleep and technology have a demonstrable linkage which has been explored in sleep research, given the all-pervasiveness of technology in human life. Because teenagers are constantly inundated with blue light associated with screen-based technologies, sleep is thought to be of a worse quality and lesser duration. Sleeplessness can be attributed to a variety of psychological, physiological, and social consequences -- all of which are in need of addressing for the nurturance of the developing teenage brain. This paper will illuminate the linkage between sleep and technology use for adolescents. The studies I will discuss in this paper include findings from various researchers, which explore the relationship between screen time and sleep among school-aged children and adolescents (Hale & Guan, 2015), along with an exploration of this relationship as it relates to various demographics (Christensen et al., 2016), sleep quality (Bruni et al., 2015), sleep patterns (Gamble et al., 2014), and daytime function (Johansson et al., 2016). In this paper, the aforementioned literature and its implications will be discussed and extrapolated, compared to existing research, and assessed for its importance in the domain of sleep research. In addition, a discussion will be included with summarizes and concludes the research provided. A reflection of the issue and current research limitations as well as suggestions for future research and its implications will be articulated.

Literature Review

In a literature review conducted by Hale and Guan, the association between screen time and sleep outcomes among school-aged children and adolescents was examined. 67 studies published from 1999 to 2014 were reviewed (Hale & Guan, 2015). Television, computers, video

games, and mobile devices were among some of the devices referenced in the research. It was found that screen time is negatively associated with sleep outcomes, where sleep duration was shortened and onset was delayed in 90% of the studies. Some results varied by type of screen exposure, age of participant, gender, and day of the week. It was found that 32 out of 42 studies regarding television watching found an association between television watching and negative sleep outcomes. These outcomes include lesser sleep duration, sleep onset latency, and delayed bedtime. In addition, for computer use, twenty-nine out of 31 studies found an association between computer use and at least one of the aforementioned sleep outcomes. Lastly, in regard to mobile devices, 15 out of 18 studies found an association between mobile device use and at least one negative sleep outcome. Though causality is unable to be established between technology use and sleep, it can be inferred that it is in our best interest to limit exposure to screens during the day and night. This may potentially reduce the harms associated with screen time on sleep, and subsequently physical and mental health. The implications of this research show that there is a demonstrable linkage between sleep and technology use -- one that isn't positive, and should be considered in understandings of adolescent daytime functioning in different contexts, such as school, work, and bedtime. This may hold implications for achievement, mental and physical health, education, and more. Since all of the studies examined found significant associations between the two variables, it can be postulated that other studies are in agreement with these findings.

Research conducted by Christensen indicated cultural differences and age differences that were observed in the participants, with older-teen participants and self-reporting Black and "Other" people reporting more smartphone screen time and less sleep (Christensen, et al., 2016). Screen time was found to be associated with poor sleep. This discrepancy is theorized to be the

result of socioeconomic differences by the researchers--racial minorities tend to have fewer computers at home and are more reliant on smartphones as a result. Thus, these findings are consistent with others while elucidating another (racial/ethnic) element of research on the connection between device-use and sleep patterns -- a different methodological approach than the one explored in previous research. A cross-sectional study was performed in 653 participants enrolled in an internet-based longitudinal cohort study. Mobile device screen-time was measured via mobile application. Total and average screen-time were computed over 30 days for participants, as well as average screen-time during bedtime hours and sleeping time. Participants were then surveyed for demographics, medical information, and sleep habits. Screen-time was found to vary across age, race and socio-economic status. Smartphone use may be influenced by these cultural factors. This study highlighted important distinctions between groups of people, some of which bear implications for the future of sleep research and technology use. It is important to understand the intersectionality behind this phenomenon, so as to better target social efforts aimed at bettering sleep. Adolescent reliance on technology and its impact on sleep is a widespread issue, but it cannot be considered properly without understanding the mediating factors at play. These findings are more or less consistent with that of previous research.

Research published by Bruni indicated that adolescents reported more sleep problems, a preference toward eveningness, and an increase of Internet and phone activities, while preadolescents were more involved in console-gaming and television viewing. Results showed that adolescents' bad sleep quality was associated with mobile device use and other devices in the bedroom, while in preadolescents, it was associated with Internet use and late turn-off time. (Bruni et al., 2015). A sample of 850 preadolescents and adolescents was collected and self-report questionnaires about sleep schedule, sleep wake behavior problems, circadian

preferences, and technology use were administered. Thus, it was determined that the use of electronics (internet and mobile phone use in particular) are positively associated with sleep problems, as well as preference for eveningness also plays a big role. This study helped to provide context for technological use by comparing preadolescents and adolescents. This bears implications in regard to the transition from preadolescence to adolescence, as the former is at risk for the development of sleep problems during adolescence which are related to technology use before bedtime. Prevention strategies should be tailored to preadolescents, so as to prevent overuse of technology and the onset of sleep problems at a young age. A cohort effect may potentially be observed, as younger, less-developed minds may be more at risk for development of sleep problems than their older teenage-counterparts -- a problem which has the potential to get worse with age. This study highlights differences between both groups, which is an important facet of sleep research, since there is a difference in the physiology and psychology of young children and teens which may be affected by both factors. Moreover, results (that technology affects sleep quality) are consistent with that of previous sleep research.

Research conducted by Johansson indicated that adolescents who had used technology before bed (nearly all of those sampled) and were awoken in the night by a cell phone were significantly more likely to wake too early, wake up feeling unrefreshed, and more prone to experiencing daytime sleepiness. Adolescents who reported inadequate sleep had shorter sleep duration, greater frequency of technology use before bedtime, felt unrefreshed upon waking, and experienced greater daytime sleepiness than those who received adequate sleep. (Johansson et al., 2016). The study explored the National Sleep Foundation's Sleep in America Poll with participants aged 13 to 21 years. The survey included questions on demographics, sleep habits, and use of technology before bedtime. Typically, adolescents require about 8-10 hours of sleep,

yet in this study and in others, they received less -- 7.3 ± 1.3 hours. In addition, it was found that there were no significant differences between those reporting “adequate” or “inadequate” sleep in terms of age or race -- a finding that contradicts the findings of Christensen (2016) and Bruni (2015). However, participants who reported having worse sleep were significantly more likely to be female, both work and go to school, and complete the survey on a computer-- pointing to gender and socioeconomic disparities potentially associated with mood. Because adequate sleep is crucial for the areas of health, growth, learning, memory, and academic performance, it can be inferred that technology use before sleep by adolescents has negative consequences on nighttime sleep and on daytime function -- an implication that cannot be emphasized enough. This study illuminates the issue of daytime function, which is presumably worsened when not enough quality sleep is attained. Thus, this bears implications for the next generation of individuals and their health, achievement, and emotional outcomes -- an issue that is of utmost importance in the context of adolescent development.

According to research conducted by Gamble, device use before bed had associations with later sleep onset on weekdays and weekends and later waking on weekdays and weekends (Gamble, et al., 2014). Participants who reported using the computer almost every night tended to have short weekday sleep duration, and only almost every night cellphone use was associated with waking later on weekends. Adolescent participants had taken part in the The Big Sleep Survey -- a web-based survey of Australian sleep habits. The survey assessed demographics, medical and psychiatric history, factors affecting sleep such as exercise, smoking, caffeine intake, alcohol use, medication use, shift work, and sleep disorders and treatments. Average sleep duration on weekdays was significantly shorter than weekend sleep duration, pointing to the possibility of a “catch up” of sleep resulting from sleep deprivation during the weekdays. Sleep

onset was significantly later on weekends than on weekdays. In addition, adolescents woke significantly later on weekends compared with weekdays. Excessive use of computers, cell-phones and televisions was linked to delayed sleep and wake schedules and delayed waking. This has implications for adolescent sleep cycles, as they are worth exploring in the context of sleep research. Addressing the sleep catch-up phenomenon is crucial because of its frequency amongst teenagers, thereby pointing to a larger and existing problem of sleep deprivation taking place during the weekday. During the weekday, various activities take place, such as schooling, work, and other physically and psychologically-intensive duties. Thus, being sleep-deprived can have a substantial effect on the adolescent's wellbeing and stamina. Naturally, this poses implications within all areas of life and functioning, as well as future development. This study puts into perspective the problem of sleep deprivation resulting from technology use before bedtime and its consequences. Nevertheless, the findings in this study reflect that of previous research, in that greater technology use before bedtime is associated with less sleep, and less restful sleep.

Discussion

The research discussed above explores the relationship between sleep duration, quality and wake times with technology use before bedtime. All studies pointed to the existence of a significant relationship between the variables, with greater technology use being inversely related to sleep duration, and positively related to worse sleep outcomes, such as delayed onset, and the incidence of sleep-related problems. Nevertheless, different studies explored the various intersections of adolescence and personhood, such as gender, race, socioeconomic status, age, and employment status. The research summarized that the prevalence of sleep problems was associated with sleepiness during the day, alluding to the looming problem of worsened daytime

function. Because adolescence is an extremely formative period in the life of the developing human, and because the brain is undergoing constant development in both physiological and psychological respects, the overuse of technology has implications which render the issue at hand of utmost importance. The risks associated with this phenomenon are material and important in the consideration of campaigns which seek to minimize screen time before bed. Technology has undoubtedly played an important role in the context of society, however, the effect it has on young minds should not be disregarded. Because of sleep's effect on cognition, abilities such as learning, memory, academic performance, emotions and emotional regulation may be altered as a result. In order to ensure that these capabilities are not affected, it is imperative that we evaluate the ways in which they could be -- specifically, through the use of technology before bedtime.

One possible limitation that arises is the inability to derive a causal effect from the examination of the linkage of sleep and technology use. Therefore, one is not able to conclude with certainty that increased screen time affects sleep duration -- there is merely an observed relationship between those two variables. An extraneous variable (such as lack of physical activity) may be affecting sleep duration. In addition, other variables apart from screen-time play into sleep-wake cycles as well, such as Circadian rhythms, mood, energy level, and other factors. Thus, we cannot ensure that screen time has an impact on sleep duration. Another limitation of the study includes the fact that one cannot conflate hours of sleep with sleep quality. The two variables are not synonymous, as people have varying sleep durations and experience varying qualities of sleep -- an individual who gets very little sleep might still experience restedness. This idea has both personal and scientific implications, as sleeplessness, sleepiness and restedness might affect individuals differently. In future research, it would help to explore the variable of

sleep quality to a greater extent. Lastly, some of the current research examines time spent on devices, but does not take into account the number of devices used, which could potentially make a difference in how it relates to sleep duration. Perhaps there is a compounded effect that is not being considered with the use of multiple devices (smartphones, tablets, computers, TV) in the relationship between screen time and sleep duration. We cannot properly gauge just how much devices affect sleep, or if they affect sleep at all -- let alone multiple devices.

Future research possibilities include the deeper exploration of age and gender differences. Running statistical analyses on both genders would help to see if there is a meaningful difference between screen time and sleep duration between the groups. Because one group might exhibit longer device use and/or shorter sleep duration, it would be interesting to see if there is a distinction between males and females in these areas. The same could be done for the variable of age, where meaningful differences between age groups can be gleaned depending on elements like sleep duration and screen time in adults versus children, with children likely displaying greater screen time than adults. In addition, further research could explore the distinction between screen time in general and screen time that occurs at night, given that blue light may have the most effect on people during bedtime hours. One other thing that would be important to explore would be the facet of sleep quality, rather than duration. Administering a questionnaire like the Pittsburgh Sleep Quality Index (PSQI) to assess sleep quality could determine whether screen time is related to sleep quality, because sleep duration does not necessarily suggest anything about quality. Quality is an important facet to assess in experimental research, because it has psychological and physical implications for the human being. In addition, a longitudinal design could also be helpful in understanding how screen time and resulting sleep patterns change over time, to determine if greater screen time over a period of time results in less sleep.

This is especially important in the context of maturity and growth, for the formative periods of preadolescence, adolescence and, eventually, adulthood. Further research could explore the element of socioeconomic status much more closely, in order to determine whether it plays a significant role in technology use and availability. Exploring the idea of what, when and how long different kinds of devices are used by adolescents in different classes could be helpful in targeting prevention efforts.

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