Sleep Medicine 15 (2014) 240–247

Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

Associations between specific technologies and adolescent sleep quantity, sleep quality, and parasomnias

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ARTICLE INFO

Article history:
Received 7 May 2013
Received in revised form 6 August 2013
Accepted 12 August 2013
Available online 15 December 2013

Keywords:
Sleep duration
Sleep quality
Adolescence
Technology
Insomnia
Parasomnias

ABSTRACT

Objective: We tested the hypothesis that weekday bedtime use of six technologies would be significantly associated with eight sleep parameters studied relating to sleep quantity, sleep quality, and parasomnias.
Methods: In our cross-sectional study, we previously administered validated age-appropriate questionnaires (School Sleep Habits Survey, Technology Use Questionnaire). Participating adolescents ($n = 738$; 54.5% boys) were aged 11–13 years and were from the Midlands region of the United Kingdom in 2010.
Results: Frequent use of all technology types was significantly inversely associated with weekday sleep duration (hours). Frequent music listeners and video gamers had significantly prolonged sleep onset ($\beta = 7.03$ [standard error {SE}, 2.66]; $P < .01$ and $\beta = 6.17$ [SE, 2.42]; $P < .05$, respectively). Frequent early awakening was significantly associated with frequent use of all technology types. The greatest effect was observed in frequent television viewers (odds ratio [OR], 4.05 [95% confidence interval {CI}, 2.06–7.98]). Difficulty falling asleep was significantly associated with frequent mobile telephone use, video gaming, and social networking, with music listeners demonstrating the greatest effect (OR, 2.85 [95%CI, 1.58–5.13]). Music listeners were at increased risk for frequent nightmares (OR, 2.02 [95%CI, 1.22–3.45]). Frequent use of all technologies except for music and mobile telephones was significantly associated with greater cognitive difficulty in shutting off. Frequent television viewers were almost four times more likely to report higher sleepwalking frequency (OR, 3.70 [95% CI, 1.89–7.27]).
Conclusions: Frequent weekday technology use at bedtime was associated with significant adverse effects on multiple sleep parameters. If confirmed in other samples and longitudinally, improving sleep hygiene through better management of technology could enhance the health and well-being of adolescent populations.

1. Introduction

The impact of sleep duration and sleep difficulties on health and performance is increasingly recognized [1,2]. Adolescence is associated with circadian phase alterations, which conflicts with social demands; thus this important developmental period is commonly accompanied by sleep deprivation [3]. Sleep problems also are frequently reported in adolescence and can be categorized into insomnia (difficulties initiating and maintaining sleep) [4], daytime sleepiness [5], parasomnias (sleep terrors, sleepwalking, bruxism, and nightmares) [6], and movement disorders (e.g., restless legs syndrome) [7].

Ownership and use of multiple technology devices is increasing and is prevalent in the adolescent population [8]. Calamaro et al. [9] showed that children ages 6–10 years with three technology types in their bedroom achieved 45 min less sleep than those without. Although there are multiple benefits from modern technology, its use may promote and exacerbate adolescent sleep deprivation. Television viewing [10], video gaming [11], computer use [11], and mobile telephone use [12] have been associated with reduced sleep duration or sleep disturbance. However, little is known about the effects of social networking on sleep, especially in young adolescents who commonly engage in this form of electronic communication with peers. Shorter sleep duration, also associated with daytime sleepiness, has been linked with negative consequences for health and performance such as obesity [13] and lower school grades [2,14].

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http://dx.doi.org/10.1016/j.sleep.2013.08.799

The impact of technology use on sleep parameters aside from sleep duration, including sleep-onset latency (SOL), sleep difficulties, nighttime awakenings, and parasomnias also may be important. Munezawa et al. [6] demonstrated that mobile telephone use after lights out was significantly associated with sleep disturbances, including short sleep duration, reduced sleep quality, excessive daytime sleepiness, as well as symptoms of insomnia in a large sample of Japanese adolescents aged 13–18 years. King et al. [15] experimentally showed a decrease in objective sleep efficiency, total sleep time, and rapid eye movement sleep along with an increased subjective SOL in adolescents (mean age, 16 years). To date, no studies have examined the impact of specific technologies on multiple sleep parameters in a young adolescent sample. Therefore, we sought to examine these relationships in a large early adolescent cohort.

2. Methods

2.1. Study population

Seven schools were randomly selected and recruited into the Midlands Adolescents Schools Sleep Education Study. Parents of registered students were mailed a letter regarding study participation. Student participants were included if they (1) provided parental consent, (2) provided personal written consent, (3) were not previously diagnosed with a sleep disorder, (4) were not taking sleep medication, or (5) had not traveled to a different time zone 4 weeks prior to data collection. A total of 1495 parents of year 7 and year 8 students were contacted across participating schools. The overall parental response rate was 79% ($n = 1181$). A total of 1075 (91%) participants' parents provided parental consents. Of those eligible, a sample of 959 (89%) provided data used for subsequent analyses. There were no statistically significant differences between participating and nonparticipating students for age, gender, or ethnicity ($P > .05$). All participants were aged between 11 and 13 years and were registered in education in the United Kingdom. The type of school (secondary [57.8% of sample], grammar [37.5% of sample], and independent [4.7% of sample]) was used as a potential proxy for socioeconomic status [16]. Self-reported data included ethnicity (42.9% white, 41.8% Asian, 5.1% black, 4.2% mixed race, and 6.0% other); gender (54% boys); bedroom sharing (69.5% nonsharing); napping (54%); extracurricular sporting activity (55%); paid employment (4%); self-reported ownership of a mobile telephone (88.7%) and portable game console (82.7%); and the presence of television (54.7%), video game console (44.7%), computer or laptop (58.5%), or music player (74.5%) in the participants' bedrooms.

2.2. Exposure and outcome measures

Participants completed an online survey including the previously validated School Sleep Habits Survey (SSHS) [17] and the Technology Use Questionnaire [18]. All measures were self-reported; information was obtained on weekday sleep duration (h) and SOL (min). The number of nighttime awakenings was categorized (never/once per night/two or more times per night/do not know). We also asked about difficulty falling sleep in previous 2 weeks (never/once/twice/several times every day or night). Additionally, we included questions about sleepwalking (never/once/twice/several times every day or night) and bad dreams or nightmares (never/once/twice/several times every day or night). The SSHS provided information on waking early with the inability to fall back to sleep termed *early awakening* (never/once/twice/several times every day or night). Difficulty falling asleep at bedtime (Likert scale 0–10; 0 = no difficulty and 10 = great difficulty) provided an indication of how difficult participants reported switching off their minds for sleep initiation. A median split was calculated for difficulty switching off at bedtime and was dichotomized into no ($\leqslant 3$ points) or yes (>3 points) to perform the logistic regression analysis.

We specifically assessed weekday sleep duration as sleep reduction is more likely to occur due to school attendance, and sleep loss throughout the week may exhibit stronger effects compared to weekends when sleep debt may be partially repaid. Technology use (television viewing/video games/computer or laptop for studying/Internet for social networking/mobile telephone for calling or texting/music) before going to bed on weekdays was obtained (never, sometimes, usually, or always). We also calculated the amount of technology within the bedroom (0–6 technologies). Ethical approval was obtained from the University of Birmingham Research Ethics Committee (ERN_08-437).

2.3. Other measures

We obtained objective measures of height (to nearest 0.5 cm) and weight (to nearest 0.1 kg) for calculation of body mass index (BMI) converted into BMI z scores. Information was obtained from the SSHS on circadian preference (definitely morning/more morning than evening; or more evening than morning/definitely evening); bedroom sharing (yes/no); sleeping with lights on (yes/no), bedtime caffeine consumption (never/sometimes/usually/always), napping (yes/no) and extracurricular sporting activities (yes/no). Participants also reported age, gender, school, and ethnicity. Information on these additional factors was obtained to rule out potential confounders and to better isolate the impact of technology use on adolescent sleep.

2.4. Statistical analysis

Data analyses were performed using the Statistical Package for the Social Sciences (SPSS, version 20.0 Chicago, IL, USA). We assessed if the quantity of bedroom technology (0–6) was related to each of the sleep parameters using Pearson bivariate correlation, independent t tests, or analysis of variance as appropriate. We conducted an independent t test to assess if SOL was related to circadian preference. We then assessed if early weekday wake time (06:30 AM or earlier) was related to circadian preference using χ^2 testing.

To assess the relationships between all types of technology and sleep duration and SOL, we first conducted analysis of variance. Linear regression was then conducted to assess the relationships between all technology types and sleep duration (h) in addition to SOL (min) while considering a range of potential confounders. Relationships between each type of technology and categorical sleep parameters also were explored using multinomial regression techniques or multiple logistic regression analyses as appropriate. All models were adjusted for gender, school, ethnicity, caffeine consumption, circadian preference, BMI z score, sleeping with lights on, and bedroom sharing. Models that reached statistical significance after adjustment are presented according to technology type and sleep parameter.

3. Results

Of the 959 student volunteers who provided data, 738 (77%) had complete information on all variables of interest. There was a negative correlation between the quantity of bedroom technology and sleep duration ($r = 0.15$; $P < .001$). No relationships were observed for quantity of bedroom technology with any other sleep parameters. Although those with an evening circadian preference ($n = 459$) had a slightly longer mean SOL (28 min) compared to