SAPIENZA
UNIVERSITÀ EDITRICE

E-ISSN 2724-2943
ISSN 2723-973X

Psychology Hub (2022)
XXXIX, 3, 7-16

Article info

Submitted: 07 June 2022
Accepted: 04 August 2022
DOI: 10.13133/2724-2943/17728

Do text messages impact adolescents' sleep? A Narrative Review

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Abstract

New technologies, such as cell phones, are now a fundamental part of daily life and have become an essential tool in the social lives of all individuals. Adolescent sleep has been explored through various conceptual and empirical models and the most recent research shows that electronic media use has a significant role in sleep, especially during adolescence. This paper reviews the current knowledge of the impact of adolescents' text messaging habits and their sleep health. A narrative review of the literature on the impact of texting habits on adolescents' sleep was performed. Empirical evidence concerning adolescents' sleep confirms the relevance of texting habits in developing and maintaining sleep disturbances. In particular, increased time spent texting after getting into bed is associated with insufficient sleep, insomnia, and irregular sleep patterns, such as social jetlag, tiredness in school, difficulties in both waking up and falling asleep and differences between weeknights and weekends.

Keywords: sleep; adolescence; texting; text messages

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Introduction

Sleep is a fundamental indicator of overall health and concurrently an important component of individual wellness since it affects physical, emotional, and mental health as well as daily functioning. (Langer & Filer, 2020). Sleep needs vary across ages and are impacted by lifestyle and health (Barber & Cucalon, 2017; Kloss et al., 2016): sleep is essential for adolescent physical growth and development, just as for socio-emotional development and wellbeing (Dewald et al., 2010; Perkinson-Gloor, Lemola, & Grob, 2013; Sivertsen et al., 2015). Guidelines for sleep times are broken down by age group: 8 to 10 hours of nightly sleep is recommended for teenagers (Chaput, Dutil, & Sampasa-Kanyinga, 2018). However, despite these recommendations, the average duration of nighttime sleep among adolescents has declined by one hour in the last century (Matricciani, Olds, & Petkov, 2012): compared to adolescents in 2009, adolescents in 2015 were more likely to report getting less than 7 hours of sleep per night (Twenge, Krizan, & Hisler, 2017).

Several studies have shown that poor-quality sleep and inadequate amounts of sleep during adolescence predict worse academic performance, worse mental health, depression, anxiety, suicidal ideation, risk-taking behaviors, and poorer quality of life (Chelminski et al., 1999; Fredriksen et al., 2004; Gau et al., 2007; Lee et al., 2017; Roberts, Roberts, & Duong, 2009; Short & Louca, 2015; Short et al., 2013; Tarokh, Saletin, & Carskadon, 2016; Titova et al., 2015). Sleep deficiency among adolescents is considered a public health problem in the U.S. (Wernett & Emory, 2017) and in European and Asian countries (Huang, Wang, & Guilleminault, 2010; Sivertsen et al., 2014).

Puberty is a time of changing sleep patterns now characterized by a pronounced shift of bedtimes to later in the evening. For many students, this results in sleep deprivation during the school week and sleeping in on weekends (Crowley, Acebo, & Carskadon, 2007; Lemola, Schwarz, & Siffert, 2012; Perkinson-Gloor et al., 2013). The delay of bedtime during adolescence is a consequence of both biological maturation and environmental factors (Crowley et al., 2007). Among the environmental factors, electronic media use in the evening seems to have a relevant role: research on children's and adolescents' evening use of electronic media and its effect on sleep consistently shows that such use is associated with a reduction in total sleep time and delayed bedtime (Cain & Gradisar, 2010).

Exposure to electronic media is pervasive, especially during adolescence: teenagers in the United States can pass an average of eight hours per day using them (Rideout, Foehr, & Roberts, 2010). As media becomes lighter, smaller, and more accessible, adolescents are bringing media into their beds. According to the *2014 Sleep in America Poll*, 75% of children aged 6-17 had at least one media device in their room, including televisions (45%), music players (40%), tablets or smartphones (30%), video game consoles (25%) and computers (21%) (National Sleep Foundation, 2015). 85% of both male and female adolescents reported using their computer within the last hour before bed; over 90% of adolescent females and around 80% of adolescent males reported using their cell phone within the last hour before bed: approximately 50% of adolescents called or texted after lights out at least once a month when they would otherwise be sleeping (Hysing et al., 2015).

Digital technologies can interfere with sleep in three different ways: (a) by replacing time spent sleeping, for example, frequent aural notifications from mobile phones signaling email, social media alerts, and text messages may affect adolescents' sleep, including sleep efficiency, by awakening them throughout the night (Fobian, Avis, & Schwebel, 2016), (b) by containing psychophysiologically arousing content (e.g., highly positive or negative peer interactions such as text messages and social media) that can interfere with the ability to fall asleep, and (c) through melatonin-suppressing light emissions from devices that increase alertness and delay sleep onset (Burnell et al., 2022; LeBourgeois et al., 2017). When the exposure occurs before bed, it significantly prolongs sleep onset, delays the circadian clock, suppresses melatonin, and decreases morning alertness (Chang et al., 2015; Wood et al., 2013).

Several studies have shown that cell phone usage at night is associated with poor subjective sleep quality, excessive daytime sleepiness, insomnia, and increased medical complaints, including self-reported headaches, difficulties with attention and focus (Arora et al., 2014; Gradisar et al., 2013; Honda et al., 2008; Munezawa et al., 2011; Van den Bulck, 2007).

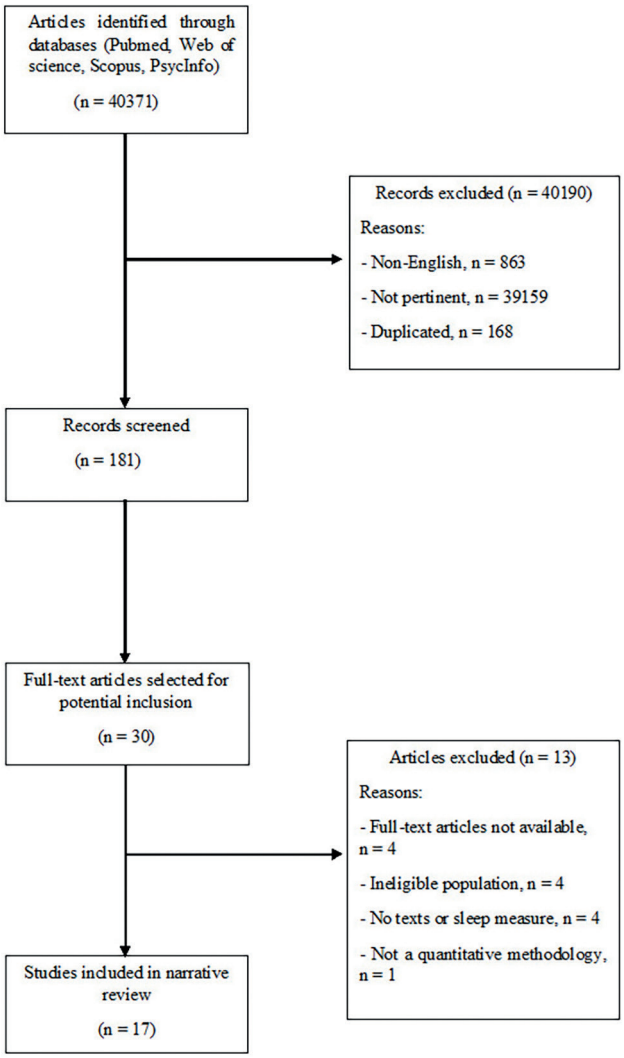
The "24/7", and "always-on" nature of society, compounded by easy access to cell phones, the Internet, television, and other media may have significantly contributed to the sleep deprivation and poor sleep experienced by young adults (Moulin & Chung, 2016). Texting is especially high in adolescents and young adults and many studies show that sending or receiving text messages not only contributes to later bedtimes and inadequate amounts of sleep but can also affect circadian rhythm (Carter et al., 2016; Crowley et al., 2015; Lemola et al., 2015; Malone et al., 2016; Touitou, 2013; Van den Bulck, 2007) and lead to social jetlag (Wittmann et al., 2006).

Based on the above considerations, this narrative review aimed to examine the current knowledge of the relationship between adolescents' sleep and their text messaging habits.

Method

The review of international literature was performed in the following electronic databases; a total of 40371 studies (PubMed, n = 397; PsychInfo, n = 148; Web of Science, n = 342; Scopus, n = 39484) were initially identified. The key terms used were: (adolescen* OR teen* OR "young adults" OR "high school students") AND (WhatsApp OR telegram OR chat* OR messag* OR text*) AND (sleep* OR insomnia OR circadian OR "morningness-eveningness" OR "delayed sleep" OR "social jet-lag" OR hypersomnia). The search strategy is detailed in Figure 1.

Fig. 1. Flow chart.



Eligibility Criteria

Since the primary focus of this review was the impact of text messaging on sleep habits in adolescents, articles that addressed other well-being constructs (e.g., school burnout and academic performance, depressive symptoms, headaches) were included only if they also made specific reference to the purpose of the review.

Studies were excluded based on the following criteria: (a) the article did not describe a quantitative methodology; (b) the article was not available in full text; (c) the article was written in languages other than English; (d) the article was not published between January 2012 and January 2022; (e) the article did not contain a measure of sleep habits and/or a measure of text messaging habits; (f) the study did not include a sample of adolescents aged between 13 and 19 years.

Results

Seventeen studies were included in the narrative review, published from 2013 to 2021. Eight (47.06%) of the studies were conducted in the United States of America, six (35.29%) studies were conducted in Europe, two (11.77%) in Oceania, and one (5.88%) in Asia. Study sample sizes ranged from 55 to 4511 participants and consisted of adolescents ranging in age from 12 to 19 years.

Among the 17 studies selected in this review, most showed that receiving or sending text messages has an influence on adolescents' sleep. A brief description of these studies is given in Table 1.

Tab. 1. Characteristics of included studies.

Reference	Age (years)	Sample (N)	Measurement of Text Messages	Measurement of Sleep
Burnell et al., 2022	M = 13.37 SD = 1.14	388	Number text x/day; Hours spent messaging	Wearable-recorded sleep, n = 254 Self-reported sleep, n = 134
Durusoy et al., 2017	M = 15.6 SD = 1.3	2150	Number text x/day (classified in categories)	Survey of sleep disturbances over the past month
Fobian, Avis, & Schwebel, 2016	M = 14.89 SD = 0.62	55	Total time spent texting daily; Number of times subjects were awakened in the night by their phone	Actigraphy (Phillips Respironics MiniMitter Actiwatch-2 devices); Sleep diaries
Garmy, 2014	M = 16	204	Frequency of texting at night rated on a Likert scale	Survey of sleep duration, bedtime, tiredness, difficulties falling asleep, and waking up.
Garmy and Ward, 2018	M = 16.23 SD = 0.63	278	Frequency of texting at night rated on a Likert scale	Sleep and Media Habits Questionnaire
Garmy et al., 2020	Range = 13-15	1518	Frequency of texting/other messaging at night rated on a Likert scale	Survey-based on the Sleep and Media Habits Questionnaire
Grover et al., 2016	Range = 13-18	1537	Survey about instant messaging before and after lights out	Survey of sleep duration and daytime sleepiness symptoms
Hena and Garmy, 2020	M = 13.9 SD = 0.4	1518	Frequency of texting/other messaging at night rated on a Likert scale	Survey-based on the Sleep and Media Habits Questionnaire
Lemola et al., 2015	M = 14.8 SD = 1.3	362	Frequency of texting/other messaging and time spent online in bed before sleep and in general rated on a Likert scale	Insomnia Severity Index; Survey about sleep duration
Nathan and Zeitzer, 2013	M = 16 SD = 1.2	211	Survey about the subjective impact of mobile phone use rated on a Likert scale	Epworth Sleepiness Scale (ESS) modified for use in adolescents rated on a Likert scale
Pecor et al., 2016	Range = 13-18	633	The survey instrument was a modified version of the one developed by Ming and colleagues (2011). Students were instructed to complete the survey based on a typical day	

Reference	Age (years)	Sample (N)	Measurement of Text Messages	Measurement of Sleep
Polos et al., 2015	M = 13.3 SD = 2	3139	Time spent texting and on social media; Number of texts sent/received while in bed after lights-out; Number of times per night they were awakened in bed due to incoming texts	Minimal Insomnia Severity Scale; Pediatric Daytime Sleepiness Scale; Children's Morningness-Eveningness Preferences Scale; Survey about sleep duration and bedtimes
Reynolds et al., 2019	M = 13.3 SD = 2	189	A survey to determine the frequency of instant messaging use during the hour before bedtime, assessed on a Likert scale	Children's Report of Sleep Patterns
Smith et al., 2020	Range = 13-17	4811	Prebedtime Behavior Questionnaire (adapted)	Pittsburgh Sleep Quality Index
Tamura et al., 2017	M = 16.2 SD = 0.9	295	A survey about mobile phone use: time x/day	Athens Insomnia Scale
Tavernier et al., 2017	M = 14.5 SD = 1.84	71	Number text x/day; Time spent messaging	Actiwatch Score (Phillips Respironics)
Whipps et al., 2018	M = 18.7 SD = 0.4	114	Nighttime media usage was assessed using 7 questions adapted from those used by Adachi-Mejia et al (2014) rate on a Likert scale	Pittsburgh Sleep Quality Index

Sleep efficiency

Fobian and colleagues (2016) evidence that sleep efficiency was negatively related to daily time spent text messaging ($r(52) = -0.29$, $p < .05$), consistent with findings of Tavernier and colleagues (2017): at the daily level, adolescents slept less on days when they reported spending more time than usual texting ($B = -0.236$, $P = .011$); another study (Burnell et al., 2022) found associations between sleep duration and hours spent messaging (respected, self-report sleep: $b = -.64$, $p = .008$, $\beta = -.17$; wearable-recorded sleep: $b = -.83$, $p = .010$, $\beta = -.20$) and also noted association with later bedtime and hours spent messaging ($b = 61.88$, $p < .001$, $\beta = .23$).

One study (Polos et al., 2015) observed that STRICT (Sleep Time-Related Information and Communication Technology) use correlated positively with insomnia and negatively with sleep duration on school nights, and positively with later bedtimes; the effect sizes were modest in general, with most of the correlation coefficients between 0.2 and 0.4.

Adolescents' sleep habits are particularly influenced by texting in bed or during the night: in one study (Grover et al., 2016), no difference in sleep duration was observed among groups of students with different messaging durations before lights out ($F = 1.35$, $p = .25$); there was, however, a significant difference among categories of messaging duration after lights out ($F = 3.69$, $p = .005$). Two of the seventeen studies show that sending and/or receiving text messages at night was significantly associated with having shorter sleep on weeknights ($p = .001$), being tired more often at school ($p = .028$), having greater difficulties both sleeping ($p = .010$) and waking up ($p = .019$), going to bed later in the week ($p = .034$) and weekends ($p = .001$), and waking up later on weekends ($p = .031$) (Garmy, 2014; Garmy & Ward, 2018).

However, Reynolds and colleagues (2019) noted that there was no significant association between the high frequency of instant messaging in the hour before bed and time in bed; further, they observed that controlling for age, the odds of reporting insufficient sleep on most nights was an OR = 2.68 (95%, CI = 1.39 - 5.17) times higher for those reporting a high frequency of instant messaging. Consistently, one study (Smith et al., 2020) demonstrated that limited texting was associated ($p = .012$) with longer sleep duration for boys aged 13-14 years and that limiting texting ($p = .012$), and Internet access ($p = .013$) were associated with longer sleep duration for boys aged 15-17 years. In this regard, Garmy and colleagues (2020) found that short sleep duration (<8 hours) is correlated with nighttime texting x/week: OR = 2.50 (95% CI = 1.90–3.28, $p<.0001$).

One study (Pecor et al., 2016) evinced no difference in hypersomnolence scores between students who messaged after lights out and those who did not ($H = 0.31$, $df = 1$, $p = 0.58$), and, finally, one study (Nathan & Zeitzer, 2013) showed that even if there wasn't a Spearman correlation between the number of texts and sleepiness ($r = 0.13$, $p = 0.07$), in examining the final model it appears that adolescents who felt that they needed to be accessible "around the clock" (ESS = 9.2 ± 2.9) were sleepier than all others (ESS = 6.7 ± 3.4) ($p < 0.01$, post hoc t-test); this study also shows that those who had attempted to reduce their mobile phone use had a higher texting rate (60 vs. 20 per day; $p < 0.01$, Mann–Whitney U test) and stayed awake later than desired more often (53% vs. 11%, weekly or daily; $p < 0.01$, $\chi 2$ test).

A 2015 study (Lemola et al., 2015) differs slightly from previous findings: sleep duration on weekdays and sleep difficulties were negatively correlated with all types of electronic media use at night, however, regression models revealed that being online on social media or chatting in bed, but not watching TV, video games, and calling/text in bed, were related with sleep duration on weekdays ($\beta = -.21$, $t = -4.13$, $p < 0.001$).

Finally, time spent using the mobile phone may also be important: Tamura and colleagues (2017) noted that using a cell phone for 120 min or more for online chatting was associated with insomnia (OR: 2.81; 95% CI: 1.28–6.15), compared with mobile phone use of 30 min or less for online chat.

Sleep disturbances

One of the studies included (Whipps et al., 2018) observed that higher scores on the Pittsburgh Sleep Quality Index, indicative of poorer sleep quality, were related to reports of texting after bed ($r = .199$, $p = .04$) and, also, that texting was related to sleep interruptions ($r = .293$, $p = .002$).

Durusoy and colleagues (2017) evidenced that sleep disturbances were more frequent in mobile phone users (OR =

1.53, CI = 1.05–2.21) and that number of text x/day (> 200) and sleep disturbances were significantly associated: OR = 1.84 (95% CI = 1.23 – 2.74, p < .001).

A 2013 study (Nathan & Zeitzer, 2013) observed that adolescents who felt that they needed to be accessible "around the clock" (ESS = 9.2 ± 2.9) were sleepier than all others (ESS = 6.7 ± 3.4) (p < 0.01, post hoc t-test). In this regard, a 2015 study (Lemola et al., 2015) showed that being online on social media or chatting in bed before sleep, but not watching TV, video games, calling/texting in bed, and having the mobile switched on at night, was related with sleep difficulties (β = .22, t = 4.10, p < 0.001). Polos and colleagues (2015) observed that STRICT use correlated positively with daytime sleepiness, and negatively with children's morningness-eveningness preferences scores, suggesting evening chronotype. The effect sizes were modest in general, with most correlation coefficients between 0.2 and 0.4.

Sending and/or receiving text messages at night was significantly associated with being tired more often at school (p = .028; Garmy, 2014) and poorer overall health (p<.0001; Garmy et al., 2020).

One study (Grover et al., 2016), noted that for daytime sleepiness symptoms scores, there was no difference among categories of messaging before lights out (H = 3.39, df = 4, p > .05) but there was a significant difference among categories of messaging duration after lights out (H = 25.25, df = 4, p < .001).

Finally, one study focused on social jetlag: Hena and Garmy (2020) found a significant association with texting at night (p = 0.002); nighttime texting showed a significant OR (OR = 1.487) with social jetlag.

Discussion

This narrative review aims to examine the relationship between adolescents' sleep and their text messaging habits. Research in the last decade has documented that greater overall electronic media use, especially nighttime-specific, was associated with worse sleep quality and shorter sleep duration (e.g., Cain & Gradisar, 2010; Carter et al., 2016; LeBourgeois et al., 2017; National Sleep Foundation, 2015; Schoeni, Roser, & Röösli, 2015; Woods & Scott, 2016). Specifically, media use is associated with three aspects of adolescent sleep health: sleep efficiency, sleep onset, and sleep offset (Oka, Suzuki, & Inoue, 2008; Van den Bulck, 2004). STRICT use during adolescence is significantly associated with insomnia, daytime, and eveningness sleepiness and also correlates with poor academic performance, later bedtimes, and fewer hours of sleep on school nights; age and gender moderate some of these relationships (Polos et al., 2015). Mobile phone overuse was linked to disturbances in sleep habits, which is known to be a risk factor for insomnia (Gellis et al., 2014). Sending and receiving text messages, in-bed in particular, is rampant: it's more common in high school students and girls and appears to be more widespread than previously reported (Adachi-Mejia et al., 2014; Munezawa et al., 2011). In fact, while boys reported playing video games more compared to girls (Galland et al., 2017; Hysing et al., 2015; Mullan, 2018; Pieters et al., 2014; Rideout, 2016), girls, in contrast, were more engaged with activities involving communication, including social media and text messages (Rideout, 2016; Viner, Davie, & Firth, 2019). Evidence report that girls had significantly shorter sleep duration than boys (Garmy, 2014; Garmy et al., 2020; John, 2014; Polos et al., 2015).

Increased time spent on media use or/and texting after getting into bed is associated with delayed sleep onset; compared to adolescents, those who reported sending more online messages had shorter sleep duration: this review shows that sending or receiving text messages was associated with increased odds of sleep disturbances, social jetlag, insufficient sleep, and insomnia (Durusoy et al., 2017; Garmy et al., 2020; Hena & Garmy, 2020; Reynolds et al., 2019; Tamura et al., 2017).

Texting at night is a sleep-disturbing activity: in fact, it's associated with shorter sleep, sleep problems, and irregular sleep patterns, such as tiredness in school, difficulties in both waking up and falling asleep, and differences between weeknights and weekends, as some of the studies selected in this review showed (Burnell et al., 2022; Fobian et al., 2016; Garmy, 2014; Garmy & Ward, 2018; Garmy et al., 2020; Grover et al., 2016; Hena & Garmy, 2020; Polos et al., 2015; Tavernier et al., 2017; Whipps et al., 2018).

Receiving text messages at night can particularly affect sleep, as teens who text each other right before bed may find it difficult to disengage from these conversations to sleep (Burnell et al., 2022). Research indicated that increased phone awakenings at night were associated with earlier sleep onset. This could be because sleep disruption due to awakenings caused by incoming texts after bedtime may cause insomnia but this is unlikely to be the sole explanation. One potential explanation is that habitually engaging in texting in bed and being awoken by such texts primes the adolescent for a state of psychological and physiological hyperarousal due to excessive emotional and mental stimulation around and after bedtime (Polos et al., 2015). One study selected in this review (Nathan & Zeitzer, 2013) shows that even if there wasn't a Spearman correlation between the number of texts and sleepiness, in examining the final model it appears that adolescents who felt that they needed to be accessible "around the clock" were sleepier than all others; this study also shows that those who had attempted to reduce their mobile phone use had a higher texting rate and stayed awake later than desired more often.

Prior research suggests that the combination of teen social pressures, circadian biology, and the immediacy of texting as a means of communication may become mutually reinforcing factors (Troxel, Hunter, & Scharf, 2015). This combination of factors, in turn, makes it exceedingly difficult for teens to "disconnect" at bedtime or provide sufficient time to unwind before bedtime, potentially setting the stage for inadequate quality or insufficient sleep. Moreover, exposure to backlit displays that are common to mobile devices may affect sleep by disrupting circadian function and melatonin expression (Arora et al., 2014). Sleep integrity may be compromised even with just a few text messages: indeed, it has been shown that even brief pulses of light lasting seconds through closed eyelids can delay melatonin release (Figueiro, Bierman, & Rea, 2013). Time spent messaging is important because it could be extending time spent on completing other tasks that consequently could limit adolescents' sleep: those who do not send or receive

messages may be more efficient without constant distractions and sleep disruptions (Grover et al., 2016).

The content of messages may also interfere with sleep. Although texting communication tends to be neutral, some content can nonetheless be psychophysiologically stimulating, such as sexual exchanges or text-based conversations that are distressing, negative in content, or retread daytime concerns that may conceivably result in maladaptive autonomic responses, leading to sleep initiation and maintenance difficulties (Burnell et al., 2022; Ehrenreich et al., 2020; LeBourgeois et al., 2017; Polos et al., 2015).

Limitations and suggestions for future research

Inspired by previous work (Mei et al., 2018), this review aimed to focus attention on the relationship between adolescents and nighttime texting, going to outline a general overview of possible sleep issues that may result. It was found that the impact of text messaging on youth sleep is well known but poorly investigated: in fact, only 17 studies were included to meet eligibility criteria. Thus, the first limitation is the small number of studies, which may reduce the statistical power to determine heterogeneity and accuracy of effect sizes. Furthermore, the results of the selected studies should be viewed considering several methodological limitations: most of the selected studies did not use standardized questionnaires to measure the number of text messages or time spent sending/receiving texts. Sleep, instead, has been measured primarily by self-reported data that could be biased by social desirability; some studies have measured sleep with a wearable instrument, and although it is more objective than self-report assessments, it should not be considered the "gold standard" for obtaining sleep data as other methods are available, such as polysomnography, although more expensive and less environmentally valid. In future studies, sleep could be objectively assessed with actigraphy, while sleep hygiene and electronic media use could be measured by experience sampling methods in order to achieve higher validity of measurement.

In addition, in some studies (Fobian et al., 2016; Garmy & Ward, 2018; Nathan & Zeitzer, 2013; Reynolds et al., 2019; Tamura et al., 2017; Tavernier et al., 2017; Whipps et al., 2018) because of the small sample size (N < 300), some of the statistically significant results may have been due to chance alone; future studies should be conducted using a larger sample size to validate these findings.

Because of the cross-sectional design of the studies, it is not possible to conclude causality. It is impossible to determine which factors most influence sleep duration, and thus health, given that puberty itself is a factor. Future studies should have a longitudinal design to examine these associations in the context of experimental designs and specifically assess possible bidirectional effects between texting habits and sleep behaviors.

Conclusions

Modern technologies, intrusive and/or too engaging digital platforms and media-related behaviors are rapidly changing and exceed our understanding of their impact on sleep and health. Hand-held mobile screens, such as smartphones and tablets, complicate research on the relationships between media and sleep in developing individuals (LeBourgeois et al., 2017).

Excessive media use in the late evening and overnight may further exacerbate the negative consequences of inadequate sleep: in particular, this narrative review demonstrates that sending or receiving texts impacts adolescents' sleep and may be associated with sleep difficulties such as delayed awakening and/or falling asleep, insomnia, worse sleep quality, and daytime tiredness.

Lack of sleep, as well as inadequate sleep, are associated with daytime tiredness (Hale & Guan, 2015), which in turn is linked to a large number of negative consequences, including poor academic performance, worse physical health, and a host of psychological problems that impact healthy daytime functioning (Beebe, 2011; Davis, Avis, & Schwebel, 2013; Falbe et al., 2015; Stallones, Beseler, & Chen, 2006; Wolfson & Carskadon, 2003). In fact, due to the continuous development of infrastructures and technologies, electronic media have penetrated deeply into daily life and have become an essential tool in the social life of all individuals.

The results of this review show that future research must continue to focus on these issues.

Author Contributions
All authors contributed equally to this manuscript.

Conflict of interest
The authors declare that they have no competing interests.

Funding
The authors received no financial support for the research, authorship, and/or publication of this article.

Ethical approval
This article does not contain any studies with human participants or animals performed by any of the authors.

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