

**The Impact of Electronic Media Use and School Schedule on The Sleep of Adolescents –
A Mini Review.**

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Abstract

Background: During adolescence there are ongoing changes of sleep patterns, which tend to exhibit a phase delay. Among the various factors associated with this phenomenon, the use of electronic media and school starting time arise as highly significant, since they are modifiable.

Methods: Review of existing literature on adolescent sleep based on electronic literature searches using the best available evidence from PubMed, Medline, Google Scholar.

Results: Our study provides a review of findings on the impact of electronic media use and school starting time on a number of sleep characteristics in adolescence. Moreover, it highlights the significance of sleep problems and/or sleep deprivation on adolescent mental health and school performance. Finally, it reports data on the association between adolescents' sleep characteristics and overweight, obesity and physical health markers.

Conclusions: Strategies focusing on modifiable factors associated with sleep deprivation in adolescence are expected to contribute to the management of a broader range of physical and mental health problems in this age group.

Key-words: Adolescents, Mental health, Obesity, School performance, School starting time, Sleep deprivation, Use of electronic devices.

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Introduction

Until a few decades ago, sleep was considered to be a totally passive state. Today we know that when we sleep our brain is very active. Many theories have been developed on why we sleep: energy conservation, restoration of the body (muscle growth, tissue repair, protein synthesis) contribution to brain plasticity (structure and organization of the brain) and enhancing of learning and memory¹. Lack of sleep in children and adolescents, affects decision-making, mood, ability to learn and retain information, and increases the risk for accidents and injuries. Sleep deprivation leads to health related problems such as obesity, diabetes, cardiovascular diseases and even premature mortality².

During adolescence there are ongoing changes of sleep patterns and of the circadian timing systems. In addition, during this developmental phase, sleep needs and patterns are not in accordance with psychosocial and behavioural factors modulating sleep habits, resulting in incongruence to sleep phase delay, insufficient sleep and somnolence during the day.

Sleep patterns tend to exhibit a phase delay, with bedtime more than two hours

later during adolescence compared to childhood. Various factors have been associated with this progressive time delay in adolescents, such as academic requirements, extracurricular activities, late-night entertainment, extended use of electronic devices and social media etc, while early school starting time is the main factor behind chronic sleep loss and sleepiness during the day³.

Recent literature mainly focuses on the use of electronic media and school starting time, since these two factors have a strong impact on adolescent sleep and are modifiable. Aim of this paper is to review recent literature on these parameters.

Electronic media and sleep

There is an increasing popularity of electronic media as a means of information and socialization and this trend coincides with short sleep duration and sleep disturbances of children and adolescents. Young people use electronic media (television, mobile phones, computer, video games, audio devices) at times and in ways that affects sleep quality and quantity³. Adolescents with one or more electronic devices in their rooms go to bed/ sleep significantly later

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on weekdays and weekend days, get up significantly later on weekend days and report higher levels of being tired and feeling sleepy⁴. Large population-based studies confirm this association: in a study by Alexandru et al, 2006, in a sample of 9199 first grade junior high school students (aged 12 years old), increase in the duration of watching TV, playing video games and use of internet is associated with an elevated risk of sleep onset latency more than 20 minutes⁵. In another study by Punamaki et al, 2007, in a sample of 7292 adolescents, the results showed that adolescents who played video games and used computer (for typing, e-mailing and internet surfing at bedtime) reported shorter sleep duration, disturbed sleep, daytime sleepiness and poor perceived health⁶. Similar data were found in a national cross-sectional survey of 94777 adolescents by Munezawa et al, 2011. The use of mobile phone after lights out was associated with short sleep duration, subjective poor sleep quality, excessive daytime sleepiness and symptoms of insomnia⁷. In one of the most recent studies by Hysing et al, 2015 on 9846 adolescents aged 16-19, it is shown that the association between electronic media use and sleep is robust

across all sleep parameters, while a dose-response relationship was found between sleep duration and use of electronic devices; the risk for sleep less than 5h per night was about three times higher for computer users compared to non-users (OR=2.70, 95% CI: 2.14 to 3.39)⁴.

Owens et al, 2014 confirmed that school aged children and adolescents are not getting enough sleep and that among factors which contribute to sleep deprivation, is the use of electronic media close to bedtime⁸.

Some adolescents may use electronic media initially to help them with sleep induction, but when their use exceeds limits it affects sleep quality and leads to delayed sleeping time⁹. Media use that involves excitement, positive or negative, can affect physiological changes causing increased stress and secretion of arousal hormones which contribute to the delay of sleep onset, poor sleep quality, nightmares and frequent awakenings^{3,10,11}. The exposure to screen light during media use is implicated in the suppression of melatonin secretion, which delays sleep onset¹².

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School starting time and sleep

The impact of school starting time on sleep of adolescents is being actively researched during the last decades. In one of the first studies by Carskadon et al (1998) a sample of 40 adolescents were examined through actigraphy, sleep diaries and a 22-hour laboratory evaluation (saliva samples, sleep diaries, sleep studies and MSLT) during transition from junior high school to senior high school when school starting time changed from 8:25 to 7:20 am, something which is in direct conflict with adolescent phase delay. In that study fewer than half of the students were found to sleep more than 7 hours on school nights, compared to 82% for the pre-transition period. A delay in secretion of melatonin was noticed, MSLT, REM latency was shorter and the number of REM episodes was higher¹³. In another study by Dexter et al, 2003, sleep and sleepiness were measured in a sample of 780 adolescents from 2 different schools with different school starting times; it was found that students whose school start earlier reported statistically significantly less sleep and were sleepier during the day than those who woke up at a later time¹⁴.

Recent studies have focused on the results of delayed school starting time on sleep characteristics (sleep duration, sleepiness, sleep patterns), attention performance, academic achievement, motor vehicle accidents, mood, and health related outcomes¹⁵. It was shown that total sleep time in weeknights is longer for students attending schools with later starting times and students whose schools start later in the morning are less sleep deprived than their peers. Feeling tired, absenteeism, falling asleep during class and arriving late to class due to oversleeping were less often among students with a later school starting time¹⁶. The majority of studies have shown that bedtime remains the same, regardless of at what time school starts, as well as that daytime sleepiness and need for assistance to wake up in the morning were more common and sleep satisfaction was lower among students who attended schools with an earlier starting time^{15,17}. Furthermore, school start time is associated with teen motor vehicle crashes¹⁸. According to an observational study car crashes for four consecutive years, related to student drowsy driving, were higher by 41% in a district with earlier starting school systems¹⁹.

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Consequences of poor or inadequate sleep in adolescence

1. Mental health

Research data show that sleep problems and/or sleep deprivation increase the risk for subsequent mental or emotional dysfunction in adolescents^{20,21}. Short sleep duration is associated with higher risk for depressive symptoms, anxiety, attention problems, tiredness, aggression and low self-esteem, as well as it leads to poor perceived mental health and to low life satisfaction²²⁻²⁴. Insomnia specifically increases the risk for depression and is correlated with disturbed mood, fatigue and suicide ideation^{25,26}.

2. School performance

Sleep plays an important role in memory, learning and attention, functions that are associated with academic achievement. Wolfson et al in 1998 showed that among adolescents those with lower average grades went to bed significantly later and received on average 3h less sleep per week than those reporting higher grades²⁷. Similar results linking poor academic performance to sleep insufficiency, later bedtimes, and weekend oversleep were replicated later across South America²⁸, Europe²⁹, and Asia³⁰, demonstrating that

this is a worldwide phenomenon. Daytime sleepiness is also a common sleep disorder among adolescents, which is related with poor school-related daytime functioning, feelings of being tired and reduced academic performance^{28,31}.

3. Overweight and obesity

Various sleep variables, such as short sleep duration, late bedtime and waking times, have been associated with a risk for being overweight and an increase in the risk of obesity³²⁻³⁵.

On the contrary, in one epidemiologic study in over 13000 adolescents aged 12-18, reduced sleep duration was not associated with higher BMI and short sleep duration (<6 hours) failed to predict obesity³⁶.

As far as gender differences are concerned, in a European survey by Garaulet et al, 2011 the association between short sleep duration and obesity is more pronounced in females³⁴. The same relationship between sleep duration and body fat percentage in females is also found in Lytle et al (2013) study³⁷. Short sleep duration, insufficient quality and quantity of sleep is also associated with increased markers of cardiovascular risk^{38,39} and impaired insulin

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resistance^{40,41}. It seems that sleep deprivation resulted in decreased leptin levels, increased ghrelin levels, markedly elevated hunger and appetite ratings and compromised insulin sensitivity⁴². In contrast, adequate sleep (defined as 6-8h regularly) is positively associated with healthy promoting behaviors such as physical activity, healthy diet, stress management and life appreciation⁴³.

Shochat et al (2014) in a recent systematic review about functional consequences of inadequate sleep in adolescents have reached the conclusion that inadequate sleep is associated with negative outcomes in several areas of health and functioning, including somatic and psychosocial health⁴⁴.

Suggestions for management

The assessment of delayed sleep phase syndrome, sleep deprivation or other sleep disorders of adolescents is based initially on clinical history, so it is very important for parents, teachers or the adolescents themselves to recognise the symptoms and for clinicians to be aware of the condition. Proposed non pharmacological treatments for the delayed sleep phase syndrome are sleep hygiene measures, such as the implementation of rigid sleep/wake

schedules⁴⁵ and light therapy (30 minute exposure to bright light box in the morning to “reset the clock”), with studies reporting mixed findings concerning the effectiveness of these interventions⁴⁶.

The administration of melatonin is also discussed. Melatonin is an endogenous hormone that plays a role in the circadian system control and in the initiation of sleep. Exogenous melatonin is expected to successfully re-entrain sleep-wake rhythms. However, the safety of melatonin administration in adolescents has not yet been established⁴⁷.

The most commonly used, sleep hygiene interventions are critical in the treatment plan for sleep deprivation and refer to behaviours that lead to good sleep. Adolescents are advised to establish a regular bedtime routine even on weekends, tone down loud music or flashing computer screens as they prepare for bed and shut down devices, like laptops and cell phones before falling asleep, so that the sleep won't be interrupted by text messages and alerts during the night. Another practice that may ensure natural sleepiness and may help the quicker induction of sleep is to wear yellow tinted sunglasses at night, to

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avoid the blue wavelengths coming out from the electronics devices⁴⁸.

Conclusion

Sleep deprivation in adolescence is a common phenomenon that is usually being caused by the increased demands of social and educational activities. The use of electronic media and the school schedule contribute to later bedtime, shorter sleep duration and daytime sleepiness, which may have serious consequences for psychosocial and physical health, as well as for school performance.

The American Academy of Pediatrics (AAP) has taken into consideration the role of school starting time as a potentially modifiable factor on adolescent sleep patterns and recommends that middle and

high schools start no earlier than 8:30 a.m.⁴⁵.

Parents', teachers' and health personnel's awareness of the meaning of sleep deprivation and its treatment possibility by modifying school starting time and by advising on the correct use of electronic media is essential and is expected to contribute to the total management of the problems of this age group.

Conflict of Interest Statement

The authors have no conflict of interest to report in relation to this paper.

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