



Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study[☆]



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ABSTRACT

A growing body of literature is associating excessive and addictive use of digital media with physical, psychological, social and neurological adverse consequences. Research is focusing more on mobile devices use, and studies suggest that duration, content, after-dark-use, media type and the number of devices are key components determining screen time effects. Physical health effects: excessive screen time is associated with poor sleep and risk factors for cardiovascular diseases such as high blood pressure, obesity, low HDL cholesterol, poor stress regulation (high sympathetic arousal and cortisol dysregulation), and Insulin Resistance. Other physical health consequences include impaired vision and reduced bone density. Psychological effects: internalizing and externalizing behavior is related to poor sleep. Depressive symptoms and suicidal are associated to screen time induced poor sleep, digital device night use, and mobile phone dependency. ADHD-related behavior was linked to sleep problems, overall screen time, and violent and fast-paced content which activates dopamine and the reward pathways. Early and prolonged exposure to violent content is also linked to risk for antisocial behavior and decreased prosocial behavior. Psychoneurological effects: addictive screen time use decreases social coping and involves craving behavior which resembles substance dependence behavior. Brain structural changes related to cognitive control and emotional regulation are associated with digital media addictive behavior. A case study of a treatment of an ADHD diagnosed 9-year-old boy suggests screen time induced ADHD-related behavior could be inaccurately diagnosed as ADHD. Screen time reduction is effective in decreasing ADHD-related behavior. *Conclusions:* Components crucial for psychophysiological resilience are none-wandering mind (typical of ADHD-related behavior), good social coping and attachment, and good physical health. Excessive digital media use by children and adolescents appears as a major factor which may hamper the formation of sound psychophysiological resilience.

1. Introduction

Current young generation experiences electronic media as a central part of their lives. Children and adolescents use for leisure an increasingly growing variety of digital media devices. Rapid technological improvements allow condensing into the users' experience a growing variety and faster-paced stimuli which is accessible almost any time and place through mobile devices, consequently, drawing youth to an excessive screen time use over the recommended 2 h per day limit (Henderson et al., 2016). In many of western and some far-east countries appear a continuous rise in youth's digital media consumption. In 2011, 52% of 0 to 8-year-old children had access to a mobile device. This access had increased, by 2013, to 75% (Chassiakos et al., 2016). In 1999, the average screen time of 8–18 year-olds was 6.21 h per day and had increased by 2009 to 7:38 h, (Magee et al., 2014). Additionally, a

shift in the youth's device of choice appears to be occurring. With more than 75% of families owning some mobile device, use of smartphones and other Internet-enabled small devices is rising (Lauricella et al., 2015). Consequently, adolescents owning a smartphone are likely to have higher screen time compared to adolescents with a conventional mobile phone because they have higher online and calling/sending messages time (Lemola et al., 2015). Thus, the use of mobile devices which allows access to most types of content, and encourages multi-screening (Cain and Gradisar, 2010; Cajoche et al., 2011), is creating a growing concern (Falbe et al., 2015) and is drawing research attention.

Along with advantages associated with access to information and fast communication, in recent years many studies associated screen exposure to health and psychological problems among infants, children, and adolescents. This article reviews screen time effects on sleep, the cardiovascular system, orthopedics, and vision and screen time psycho-

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neurological and social outcomes. A case study of an ADHD diagnosed nine-year-old boy presents an example of screen time in-the-field-effects and will assist to conclude the role of screen time in the formation of the psychophysiological resilience of the young generation.

2. Screen time effects on sleep

Children in 2011 were estimated to sleep, on average, one hour less per night when compared with children of the early 20th century (Magee et al., 2014). In Britain, 20–30% of young children experience sleep problems (Cheung et al., 2017). Sleep is highly important for neurodevelopment of infants and toddlers. Accumulating evidence indicates that inadequate sleep, both in duration and quality may compromise youth's physical and mental health and psychosocial functioning. Additionally, risk-taking behavior and school performance are likely to be negatively affected by inadequate sleep (Falbe et al., 2015). Sleep may also critically affect the regulation of circadian rhythms by affecting the pineal hormone melatonin, which is involved in enhancement of immune function and inhibition of development of cancer (Figueiro and Overington, 2015; Blask, 2009).

The association between digital media and sleep duration and quality relates to infancy through adolescence (Parent et al., 2016). Novel findings suggest an inverse association between sleep duration and subsequent screen time. A longitudinal study of 4–8-year-olds found that short sleep time can promote a following-day fatigue, thus leading to more screen viewing sedentary behavior. Researchers, therefore, suggested a bidirectional association between children's length of sleep and screen time (Magee et al., 2014). An examination of all developmental stages found that sleep disturbances, when they are a result of excessive screen time, are linked to internalizing, externalizing, and peer problems (Parent et al.). Another study related to the effects of sleep on executive functioning and theory of mind (ToM) (i.e., the capacity to understand mental states, motives, and feelings of others). This study examined preschoolers and found that extensive exposure to background TV or nighttime TV viewing was associated with decreased sleep duration, consequently resulting with decreased ToM (Nathanson and Fries, 2014).

Digital media time is considered to affect sleep through the following means:

- (a) Displacing other activities: screen time can displace physical activity time known to be beneficiary for sleep. Additionally, screen time can come at the expense of sleep time (Cheung et al., 2017; Chahal et al., 2013), thus shortening sleep duration and quality (Cheung et al., 2017; Cain and Gradisar, 2010; Magee et al., 2014). Children of lower-income families are reported to have increased TV viewing and reduced sleep quality. However, a large number of digital devices in higher socioeconomic status families could be assigned for contributing to increased screen exposure and shorter sleep time (Magee et al., 2014)
- (b) Time of use: Evening and nighttime exposure to bright light and blue light emitted by self-luminous devices may suppress melatonin production, affect the timing of melatonin production and, consequently, cause circadian disruption (Cheung et al., 2017; Figueiro and Overington, 2015; Falbe et al., 2015; Cajochen et al., 2011). Bedtime access to media devices is associated with compromised sleep components of various age ranges (Carter et al., 2016). Sleep problems correspond to toddlers' evening media exposure (Garrison et al., 2011) and to night-time access to digital devices, which according to another study seemed to have caused to fifth graders a decrease in sleep length (Chahal et al., 2013). Falbe et al. reported that use of mobile phones after bedtime by seven graders was associated with a year later report of feeling significantly more tired. Pre-adolescents and adolescents are reported to experience sleep problems particularly if they use digital media after 9:00 p.m. Additionally, extended messaging post-bedtime is likely to decrease

sleep duration of high school students and to cause them daytime sleepiness and poorer academic achievements (Grover et al., 2016). Other findings on cohorts aged 16–19 reported that over four hours of digital media use is associated with extended sleep onset latency (Hysing et al., 2017).

- (c) Media type – television vs. small touch-screens: the number of TV viewing hours of infants and toddlers was found related to irregularities in day naptime and bedtime onset (Thompson and Christakis, 2005). Passive TV viewing by five and six-year-olds, in particular, who were viewing adult-targeted TV programs, was found to be associated with sleep disturbances. Both active and passive viewings were found associated with sleep-wake transition disorder among 5–6-year-old children (Paavonen et al., 2006). A more recent study added that increased passive exposure to TV was independently related with reduced daytime sleep (Cheung et al., 2017).

In contrast to TVs, small touch-screens can emit audible notifications (e.g., text messages) during sleep time, thus delaying falling asleep or causing an inadequate sleep. Thus, it was found that 18% of adolescents were reported to be awakened by mobile phones at least a few times a night (Falbe et al., 2015). Touch-screen devices were also found to affect toddlers aged 6–36 months as reported in a study which found a significant association between frequency of touch-screen device use (mostly tablets) which increased daytime sleepiness (average of 10.8 min) and decreased night sleep (15.6 min in average). Also, overall night and day sleep duration increased and night sleep onset (falling-asleep time) became longer for this population (Cheung et al., 2017).

- (d) Media content: exposure, primarily to video games, may increase children's psychophysiological arousal, therefore affecting sympathetic regulation (Cheung et al., 2017; Falbe et al., 2015; King et al., 2014). Consequently, arousal may disturb pre-bedtime relaxation and is likely to cause delayed sleep onset and shortened sleep time (Cheung et al.; Magee et al., 2014). Garrison et al. (2013) further elaborated on the effect of violent media content on 3–5 year-olds and reported that 12 min of violent daytime content or 15 min of evening media increases the risk of inadequate sleep. Use of social media is another type of content found to affect sleep. Wood and Scott (2016) reported that adolescents' use of social media at night time predicts inadequate sleep, especially when emotional investment is involved. Moreover, the combined effect of looking at a bright mobile phone display while involved in an excitement provoking task (e.g., fast paced/violent game or worrying messaging) may increase psychophysiological arousal, thus disrupting sleep (Oshima et al., 2012).
- (e) Location: media devices located in children's bedroom are likely to increase overall screen exposure especially at evenings. Small sized touch-screen devices enable them to flexibly be used in children's rooms, both by the children and by parents who increasingly use such devices for interacting with their children (Northwestern University - School of Communication - Center on Media and Human Development, 2014). Findings by Brambilla et al. (2017) suggested that children's use of electronic media devices in the bedroom is related to decrease in sleep duration. The number of media devices owned by adolescents, particularly when located in the bedroom, was related to delayed bedtimes, shorter sleep duration, increased bedtime resistance, and a higher level of sleep disturbance (Bruni et al., 2015; Hysing et al., 2017).
- (f) Electromagnetic radiation is sensed as light: The pineal gland, producing melatonin, may sense electromagnetic radiation as light. Therefore exposure to electromagnetic radiation from wireless devices may delay melatonin production, thus affecting sleep (Halgamuge, 2013).

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