EDITORIAL

# Problems Associated With Use of Mobile Devices in the Sleep Environment—Streaming Instead of Dreaming

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Related article

**Children today have unprecedented access** to technology and media, the use of which is no longer limited to waking hours now that mobile devices have invaded the bedroom. According to a recent National Sleep Foundation poll, half of school-age children in America have active, light-emitting electronic devices in their bedrooms.[1] Parents estimate that more than two-thirds of older teens (15-17 years old) leave an electronic device on while sleeping at night, with 43% reading or sending electronic text messages after initially falling asleep. The parents of children who sometimes sleep with electronic devices switched on at night estimate that their children sleep almost 1 hour less than children who never do so. The systematic review and meta-analysis by Carter and colleagues[2] in this issue of *JAMA Pediatrics* reveals that the mere presence of a mobile device in the sleeping environment at bedtime, and certainly its use, increases the risk of inadequate sleep quantity, poor sleep quality, and—most important—excessive daytime sleepiness the next day in children 6 to 19 years old.

After reviewing more than 450 references identified by search terms, 11 studies involving more than 26 000 children met the inclusion criteria for this first meta-analysis on the effect of access to and use of media devices on children's sleep and wakefulness. The authors found that the daily sleep durations of children and adolescents who use mobile media devices in their sleeping environment at bedtime are more than twice as likely to be less than 10 hours and 9 hours, respectively, than those who do not use such devices. They found that access to media devices near bedtime at least 3 times per week has a similar effect, almost doubling the odds of inadequate sleep among children and adolescents. The authors report that, when media devices are present in the sleep environment, the odds of poor-quality sleep are approximately 50% greater, and the odds of excessive daytime sleepiness are more than doubled in children and adolescents.

The use of mobile media devices at bedtime provides socially and physiologically stimulating material at a time when the transition to sleep requires the brain to wind down. Interesting content is often difficult to resist, and children frequently have a fear of missing out if they disconnect. Coupled with the demands of homework, media devices can keep children and adolescents awake well past the bedtime needed to obtain an adequate amount of sleep.[3] Delays in sleep initiation can set off a reinforcing physiological cascade to further delay sleep onset and restrict sleep duration on subsequent nights.[4] This situation is exacerbated during the school year, when weekday school start times and weekend athletic competitions and other extracurricular activities often require an early start to the day. Delayed bedtimes are usually coupled with increased exposure to biologically potent wavelengths of light emitted from both mobile devices and the energy-efficient LED lamps that are replacing incandescent lamps. Such light exposure near bedtime suppresses the release of the pineal hormone melatonin, an important indicator to the brain that it is time to sleep, and signals to the brain's circadian clocks that dusk has moved to a later hour, thereby shifting those clocks to a later hour.[5] Awakenings due to receipt of text messages and the like after sleep onset further disturb sleep. These collective effects contribute to short- and long-term sleep deprivation, along with disruption of circadian rhythms, which can lead to enhanced appetite, obesity, reduced insulin sensitivity, greater type 2 diabetes risk, hyperactivity, diminished ability to focus attention, mood lability, poorer academic performance, impaired immunity, attentional failures, slower reaction times, degraded memory consolidation, anxiety, and depressed mood.[6] Sleep and circadian disruption may also adversely affect the sleep-induced hormonal signals that occur during adolescent development.[7] Finally, the use of mobile media devices in the bedroom at night enables children to explore the virtual world well into the evening, free from oversight by sleeping parents and other family members, which may leave the child exhausted on school days or asleep during daytime hours on free days. The adverse effect of sleep deficiency on learning and memory,[8] together with the recognition that many symptoms of sleep loss mimic those of attention-deficit/hyperactivity disorder,[9] raises serious ethical concerns about advertising campaigns targeting school-age children that tout the use of mobile media devices in the bedroom at the expense of sleep.

The systematic review and meta-analysis by Carter and colleagues[2] notably highlights limitations of the data available to guide parents, educators, health care professionals, and policy makers. Of 463 references identified through database searching, only 17 studies were of sufficient quality to be included in the report, and only 11 of those met criteria for inclusion in the meta-analysis. Overlapping age groups, varying event definitions, weekday vs weekend information, parental vs self-reported sleep details, and the variety of types of media devices evaluated add challenges to the data interpretation. Consequently, cohorts of children who had access to media devices less than 3 times a week were grouped with those who had no access to devices. None of the studies were randomly controlled, although the feasibility of ethics of such a design is complicated. Finally, the strength of a meta-analysis is limited by the quality of the included studies. In this case, only 2 of the 17 included

studies were judged to be of good quality, and the rest were judged to be of low or unclear quality.

These findings make it clear that the rapid development of technology and media use has outpaced the ability of medical researchers to assess the positive and negative effects of ubiquitous exposure to media during the critical years of brain development in children and teenagers. Nonetheless, as Carter and colleagues[2] highlight in their article, parents—who are called on to guide their children's exposure to mobile devices—look to educators, health care professionals, and policy makers to assist in this effort. Parents need guidance on how to reestablish the bedtime routines for children at different stages of development. The National Sleep Foundation has provided age-specific guidance on the duration of sleep recommended for children and adolescents at different stages of development.[10] Much focus is devoted to the very early years, but parents often declare "get to bed" as children get older, without teaching or modeling tools and strategies that facilitate the transition from wakefulness to sleep. For those concerned about the effect of media use on sleep time, technology is now available to restrict service between designated hours or allow a maximum daily duration of media use each day, while allowing for parental overrides in exceptional circumstances. Such programs can be used to reinforce consistent bedtimes and wake times, which are vital for sleep health,[6] especially in children and adolescents.

Software programs can reduce the amount of the most biologically active wavelengths of light emitted from the screens of media devices in the evening before bedtime (ie, from sunset to bedtime). The first of these programs (f.lux; https://justgetflux.com) was introduced 7 years ago. Several apps with a similar goal are now available. Recently, 2 operating systems have been modified to add blue light–blocking features (Apple; Night Shift and Amazon; Blue Shade). A screen protector that reportedly filters blue light transmittance is also available (OcuShield; http://www.ocushield.com). Further research is needed to evaluate the efficacy of such blue light blocking. Technology that automatically reduces light intensity of screens between dusk and dawn is just as important because the biological effects of light are directly related to retinal illuminance,[11] which is greatly increased when portable light-emitting screens are held close to the eyes.

The study by Carter and colleagues[2] draws critical attention to the effect of access to mobile media on reduced sleep in children and calls for additional and routine surveillance and research on the health and development of children. Current technology should allow objective studies on actual device use times and frequency in children of all ages. Increasing awareness of guidance and technology that assist parents, educators, health care professionals, and policy makers in balancing the benefits and reducing the risks of mobile media in children is important for this and future generations.

## ARTICLE INFORMATION

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