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CLINICAL REVIEW

Protective and risk factors for adolescent sleep: A meta-analytic review

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SUMMARY

Teenagers need sufficient sleep to function well daily, yet consolidated evidence advising which factors protect, or harm, adolescents' sleep is lacking. Forty-one studies, published between 2003 and February, 2014, were meta-analysed. Mean weighted r values were calculated to better understand the strength of protective and risk factors for 85,561 adolescents' (age range = 12-18 y) bedtime, sleep onset latency (SOL) and total sleep time (TST). Results showed good sleep hygiene and physical activity were associated with earlier bedtimes. Video gaming, phone, computer and internet use, and evening light related to delayed bedtimes. Good sleep hygiene negatively correlated with sleep latency. Alternatively, sleep latency lengthened as a negative family environment increased. Tobacco, computer use, evening light, a negative family environment and caffeine were associated with decreased total sleep, whereas good sleep hygiene and parent-set bedtimes related to longer sleep length. Good sleep hygiene appears to be protective, whereas a negative home environment and evening light appear to be risk factors. Cautious use of technology (other than television), caffeine, tobacco and alcohol should be considered. These factors, along with pre-sleep worry, are likely to have some negative impact on sleep. Parent-set bedtimes and physical activity may be beneficial. Future research directions are discussed.

Introduction

The importance of sleep and sleep habits for adolescents

Sleep is an essential part of everyday functioning, therefore restricting it can have multiple, negative consequences [1]. Longitudinal and survey data indicate that adolescents with unrestricted sleep opportunities obtain over 9 h of sleep [2,3]. However, systematic reviews and meta-analyses show millions of adolescents worldwide achieve insufficient sleep (e.g., less than 8 h), especially on school nights [4,5].

Considering only 14% [6] to 27% [1] of adolescents obtain over 9 h of sleep on school nights, and worse still, up to 25% [1] acquire *less than* 6 h, it is hardly surprising that most teenagers wake feeling unrefreshed at least a few times per week [6]. Additionally, the consequences of insufficient sleep extend far beyond morning tiredness [7]. Less than 8 h sleep increases sleepiness throughout the day, and decreases mood, motivation and scores on intelligence tasks [8] and impairs daytime functioning [3]. Conversely, longer sleep duration, better sleep quality and lower daytime sleepiness have been associated with better school performance [9]. Severe restriction of sleep during the week (i.e., less than 6 h/night) is associated with increased interpersonal problems at school, psychological problems, such as lower life satisfaction, lower self-esteem, higher incidence of drug use [1] and a higher rate of motor vehicle accidents [10].

A lack of sleep on school nights is a transcontinental phenomenon, with adolescents' bedtimes delaying during development. Despite later bedtimes, school start times remain constant, resulting in insufficient sleep duration during the school week [11], and catch up sleep when given extended opportunities (i.e., weekends; [5,12]). Given that a lack of sleep is detrimental to healthy functioning and performance [1], it is crucial to identify factors which affect sleep in order to minimise subsequent negative consequences.

Bedtimes and sleep onset latency (i.e., the time it takes to fall asleep; SOL) have been found to negatively correlate with total sleep time (i.e., night time sleep duration; TST) and are also

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Abbreviations

AUDIT	alcohol use disorders identification test
BT	bedtime
CI	confidence interval
EEG	electroencephalography
PSQI	Pittsburgh sleep quality index
SAAQ	sleep anticipatory anxiety questionnaire
SOL	sleep onset latency
SSHS	school sleep habits survey
TST	total sleep time
TV	television
VG	video gaming

associated with fatigue, anxiety and depressed mood [13]. It therefore appears important to investigate not only sleep duration, but also bedtime and sleep latency.

Possible reasons why adolescents do not get enough sleep

"Risk" factors

Many internal and external factors have been identified as detrimental to teens' sleep (e.g., [14]). Although this paper will primarily focus on factors under behavioural control, internal, biological mechanisms also contribute to adolescents' sleep (e.g., [2,14,15]). Physiological sleep pressure takes longer to rise in adolescents than in children, thus it takes longer for adolescents to feel sleepy and prolongs sleep onset [16,17]. Additionally, sleep/wake rhythms naturally drift later in adolescents than in children, meaning their natural inclination is to go to bed later and sleep later [15].

Melatonin, a hormone released by the body in the evening in preparation for sleep, is released later in the evening for older adolescents than younger adolescents, which prolongs the onset of evening sleepiness [14]. Together, these biological mechanisms drive adolescents' tendency to stay up later.

Although not a biological mechanism, teenagers are unable to control their school start time, which remains the same or becomes earlier with increased age. This works against teenagers' inclination to sleep later and results in sleep restriction [14]. Conversely, when adolescents are given the opportunity to start school later in the morning they obtain more sleep and feel less tired throughout the day [11].

Looking to external contributors, much hype surrounds the use of electronic media and its detrimental impact on sleep [18]. However, results from studies concerning the effect of television (e.g., [19]), computer use (e.g., [19,20]), video gaming (e.g., [20]), mobile phone use (e.g., [21]) and internet use (e.g., [22]) have not exclusively nor consistently stated that all these media have a negative impact on adolescent bedtime, sleep latency or duration - nor that the impact is large. Similarly, the effects of substance use, such as caffeine, alcohol and tobacco have shown a variety of effects on sleep, ranging from no relationship of cigarette use [23] and caffeine [24] on weekday sleep, to medium negative effects from alcohol and smoking [25].

Other factors hypothesized to affect adolescent sleep include; time spent with their peers [26]; whether they are worried close to bedtime (e.g., [27]), and; involvement in extracurricular activities, such as sport and work (e.g., [12]). All these factors have been surveyed in relation to sleep habits, and have presented mixed results in terms of the presence and size of the effect. Another external factor proposed to lead to less sleep and later bedtimes is longer day length, which is affected by longitude, latitude and season (e.g., [28,29]). Although day length is not under behavioural control, using room lighting in the evening is. For example, Brazilian adolescents in homes with electric lighting have later bedtimes than those without electric lighting [30].

Despite many factors theorised to negatively impact adolescent sleep, it is difficult to reach conclusions between studies regarding the consequences and severity of these risk factors. Thus, this review aims to consolidate and quantify these research findings using a meta-analytic approach.

Protective factors

A neglected 'half' of the adolescent sleep research field is the investigation of factors benefiting adolescent sleep. Several variables consistently show a protective relationship to adolescents' sleep, bedtime and sleep latency. For instance, adolescents in Australia [31], the United States [12] and Germany [32] all had longer sleep durations when their bedtimes were set by their parents. Better sleep hygiene, such as rarely using one's bed for things other than sleep and relaxing before bed, are positively correlated with sleep duration and negatively correlated with sleep latency [33,34]. A positive family environment, with low conflict [35] or chaos [33], has also been shown to benefit adolescents' sleep patterns.

Although it appears that some factors are harmful, or at least not beneficial, there also seems to be protective factors present. Furthermore, most external factors can be modified through changes in people's behaviour (e.g., restricting caffeine intake, avoiding television before bed, etc.). Understanding these relationships simultaneously will be helpful in shaping teenagers' activities in order to improve their sleep.

Current research and the need for consolidation

Although many studies have looked at the impact of individual risk and protective factors on adolescent sleep, no meta-analysis exists to consolidate or quantify these data. Reliance on individual studies may lead to assumptions and misunderstandings concerning the relationship between sleep and risk or protective factors [36], among both the scientific community and the general population. As the magnitude and consistency of these relationships are currently unknown, synthesis of data could provide assurance that risk factors are actually harmful, and to what extent. Moreover, the importance of actively promoting protective factors, rather than simply decreasing unfavourable behaviour, will be a useful addition to therapy, education programs and developments within the field. A research field often needs collaboration of existing data, rather than more studies, to find consistency, minimise variance, and provide new direction for future research [36]. As such, a meta-analytic approach to consolidate existing data will be used to gain information on protective and risk factors for adolescent sleep.

Method

Literature search

Databases (e.g., Proquest Central, Flinders University search engine, Sage, PubMed, Google Scholar) were searched for articles relating to adolescent sleep. Combinations of keywords, such as 'adolescent,' 'teenage,' 'sleep,' 'parent monitoring,' 'bedtimes,' 'electric light,' 'media use,' 'technology use,' 'sunrise,' 'sunset,' 'longitude,' 'latitude,' 'anxiety,' 'worries,' 'stress,' 'delayed,' 'late,' 'sleep hygiene,' 'substance use,' 'caffeine,' 'adequate sleep' and 'consequences' were used to search for articles which relate to relevant factors on sleep duration, sleep onset latency and bedtime.