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CME ARTICLE

The sleepy adolescent: causes and consequences of sleepiness in teens

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EDUCATIONAL AIMS

- To describe the causes of adolescent sleepiness.
- To identify the sleep disorders common to or emerging in adolescence.
- To describe the consequences of adolescent sleepiness.
- To describe how to assess for sleep problems and insufficient sleep in adolescents.

KEYWORDS

sleepiness;
delayed sleep phase;
insufficient sleep;
adolescent sleep

Summary The majority of adolescents do not obtain the recommended amount of sleep, resulting in significant daytime sleepiness. For most adolescents, insufficient sleep results from the interaction between intrinsic factors such as puberty and extrinsic factors such as school start times. Insufficient sleep and sleepiness impact all areas of adolescent functioning, including academic, psychological and behavioural, which underscores the importance of evaluating sleepy adolescents. While polysomnography is required for the diagnosis of certain sleep disorders, causes of sleepiness are generally best identified with a detailed sleep history and daily sleep diary. The management of sleep problems in adolescents involves treating any underlying sleep disorders, increasing total sleep time and improving other environmental factors that impact sleep. Recognition and management of insufficient sleep and sleepiness is important for the health and functioning of adolescents.

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INTRODUCTION

Due to the interaction of physiological and social factors, adolescence is a period of development characterized by insufficient sleep and sleepiness. One recent study found that 45.7% of adolescents report daytime sleepiness at least

once per week.¹ Additionally, studies have shown that when adolescents and children sleep for the same number of hours per night, adolescents report higher rates of sleepiness during the day.² While the majority of adolescent sleepiness is accounted for by insufficient sleep, a number of intrinsic factors also may lead to a complaint of daytime sleepiness. In order to shed light on 'the sleepy adolescent', this review will describe adolescent sleep needs, discuss the causes and consequences of insufficient sleep and

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sleepiness in adolescents, and describe how to assess for and differentiate between sleep problems.

ADOLESCENT SLEEP NEEDS

Longitudinal studies of sleep needs through puberty have demonstrated that adolescents require >9 h of sleep at night, with some adolescents also requiring additional sleep during the day.^{2,3} Using a laboratory-based protocol, adolescents were put on a fixed 10-h schedule and allowed to sleep as much as they wanted. Results were that sleep need did not change from ages 10 to 17; that when well-rested, adolescents needed 9.25 h of sleep per night; and that at mid-puberty there was an increased tendency to sleep during the day even in the presence of sufficient night-time sleep. Despite the amount of sleep adolescents need, many studies have demonstrated that on average they obtain between 7.5 and 8.5 h/night, with 26.6% of adolescents obtaining <6.5 h/night and only 15% obtaining 8.5 h or more.⁴⁻⁷

CAUSES OF SLEEPINESS IN ADOLESCENTS

Insufficient sleep

The most common cause of daytime sleepiness in adolescents is insufficient sleep. Clinically, an adolescent with insufficient sleep will typically report a late bedtime and early wake time on school days, with significant oversleep at the weekends (sleeping >2 h later on weekend mornings compared to weekday mornings). Insufficient sleep results from the interaction of extrinsic factors (e.g. homework, time with friends and early school start times) and biological factors (puberty).

Extrinsic factors

Activities, employment and academic demands

Participation in extracurricular activities, jobs and academic demands compete for time during an adolescent's day,^{7,8} with each one potentially resulting in later bedtimes. Extracurricular activities, including sports, music, drama and social clubs, can delay bedtime with evening meetings, practices or games. Carskadon *et al.*⁶ found that nearly 20% of a sample of high school students reported spending 20 h/week or more in extracurricular activities, and that those teens reported significantly less total sleep time and significantly later bedtimes. In addition to activities, many adolescents have after-school jobs. In one study, 58.7% of adolescents reported having a part-time job and 28.3% reported working ≥ 20 h/week.⁶ As with activities, adolescents who worked >20 h/week reported significantly less total sleep time and significantly later bedtimes when compared to teens who worked <20 h/week. Participation

in extracurricular activities or holding a job may also delay homework completion until the late evening, further delaying bedtimes. One study found that >75% of adolescents aged 13–18 years go to bed at 11:00 pm or later on school nights.⁵ When bedtimes are delayed, the adolescent's sleep opportunity is significantly limited.

School start times

After going to sleep late because of academic and extracurricular demands, adolescents then have to wake early for school start times, resulting in insufficient sleep. Studies have shown that when middle- and high-school start times are delayed by 1 h, bedtimes do not change.^{9,10} This results in students who attend later starting schools obtaining an additional 45–60 min of sleep per night. In turn, this additional 1 h of sleep that results from later school start times has been associated with higher attendance rates and better grades.⁹ Conversely, adolescents attending schools with early school start times have more irregular weekday sleep patterns and increased daytime sleepiness.¹⁰

Social interaction

Social demands during adolescence also contribute to insufficient sleep. Adolescents tend to have more freedom to spend time with peers and to stay out later, in addition to being able to socialize with peers electronically. With the rising use of mobile phones, text messaging, instant messaging, e-mail and other electronic communication, teens are in constant contact with their peers, even 'after hours'. Gender-specific effects have been found in electronic communication, with computer use for boys and mobile phone use for girls associated with less sleep time, irregular sleep schedules and daytime sleepiness.¹¹ Both genders report surfing the internet or instant messaging (44%) and talking on the phone (40%) in the hour before bed.¹²

Environment

Environmental factors (also called sleep hygiene; Table 1) often delay sleep onset, contributing to insufficient sleep. These factors include maintaining a consistent sleep schedule; avoiding caffeinated beverages in the late afternoon and evening, limiting use of electronics for at least 30 min before bedtime, and sleeping in a cool, dark, quiet room.

Adolescents typically have different sleep schedules on weekdays than on weekends. The insufficient sleep that adolescents experience as a result of late bedtimes and early school start times may lead to 'catch-up sleep' on non-school days.³ For example, an adolescent might sleep from 11 pm–6 am on weekdays and 2 am–1 pm at weekends. Recent poll data show that 88% of adolescents go to bed later on non-school days than on school days.¹² While the average school day wake time is 6:30 am, non-school day wake times range from 9:00 to 10:00 am, with older

Table 1 Tips for good sleep hygiene

- Maintain a consistent sleep schedule. Keep school day and non-school day bedtimes and wake times within 2 h of each other
- Avoid strenuous exercise in the late evening before bedtime
- Avoid caffeine in the late afternoon and evening
- Avoid eating large meals just before bedtime
- Remove the television from the bedroom. Minimize electronics (TV, computer, mobile phone) 30–60 min before bed
- Only use the bed for sleeping. Avoid doing homework or talking on the phone in bed
- Create a bedtime routine that is consistent and includes quiet activities
- Make sure the bedroom is cool, dark and quiet
- Set a consistent wake time. Instead of hitting the 'snooze' button, sleep until it is actually time to wake
- Obtain as much bright light as possible in the morning. Open the shades and avoid sunglasses
- Limit daytime naps to 45 min

adolescents sleeping later than younger adolescents.¹² These sleep schedules result in younger and older adolescents sleeping more (48 min for younger adolescents and 114 min for older adolescents), on non-school nights. Significant oversleep has been reported in 37% of adolescents,¹² and this inconsistent sleep schedule can perpetuate difficulties falling asleep on weekdays.

Caffeine use can also interfere with both sleep duration and sleep quantity.¹³ Survey data demonstrate that 75% of adolescents consume caffeinated beverages or 'energy drinks' to combat sleepiness.¹² Along with irregular sleep schedules and caffeine use, technology in the bedroom negatively affects sleep. In addition to being able to socialize with peers, the easy access to television, movies and the internet at any time of day or night contributes to increased arousal, thus making sleep onset more difficult.^{14,15} Survey data found that the majority of adolescents (76%) watch television in the hour before bedtime, and almost all adolescents (97%) have at least one electronic item, such as a television, computer, phone or music device, in their bedroom.¹² Additionally, adolescents with four or more electronic items in their bedrooms are almost twice as likely to fall asleep in school and while doing homework.¹²

Intrinsic factors

While extrinsic factors play a primary role in later bedtimes and insufficient sleep, there are also intrinsic factors, resulting from both normal development and sleep disorders that contribute to daytime sleepiness.

Normative changes

Normal adolescent development causes adolescents to feel sleepy later in the evening than school age children. During puberty, the timing of melatonin release has been shown to change, shifting the adolescent's circadian rhythm. Melatonin is a hormone that is excreted by the pineal gland when exposed to darkness, and usually precipitates sleepiness. The delayed release of melatonin found in adolescents causes a later onset of sleepiness, as well as a later natural wake time.¹⁶ This change to the circadian rhythm is in contrast to the extrinsic demands of an early school start

time, resulting in an overall decrease in total sleep duration.¹⁷ In essence, adolescents must be awake and learning at a time of day when their bodies should be sleeping.

It has also been suggested that the nature and quality of sleep may be different in adolescents compared with school age children. Slow wave, restorative sleep (N3) generally takes place during the first 1–3 h of sleep. During early adolescence, the total time in slow wave sleep declines by approximately 40% compared to school age children,² and this may lead to increased daytime sleepiness. This decrease continues throughout the lifespan, yet at a much more gradual rate. The onset of rapid eye movement (REM) sleep occurs following N3 sleep, and teenagers show changes in time to first REM onset, which also suggests a decrease in slow wave sleep time. In school age children, time from sleep onset to REM is approximately 3 h, while in early adolescents it is 90–110 min.¹⁸ These normative developmental changes in the amount of slow wave sleep and timing of REM sleep may contribute to increased daytime sleepiness, as adolescents ultimately have less restorative sleep than school age children.

Sleep disorders

In addition to normative developmental changes in sleep, a number of sleep disorders are seen in adolescents. Although insufficient sleep and inadequate sleep hygiene are the most common, the following sleep disorders can also contribute to daytime sleepiness.

Circadian rhythm sleep disorder – delayed sleep phase type (also known as delayed sleep phase syndrome or DSPS), is estimated to occur in 5–10% of adolescents.^{18–20} DSPS is characterized by a persistent delay of at least 2 h beyond the desired bedtime, resulting in disruptions to the adolescent's activities of daily living (e.g. school, extracurricular activities).²¹ When adolescents with DSPS attempt sleep at the time they typically fall asleep (e.g. 3:00 am), they report no difficulty falling asleep or staying asleep for an adequate duration. While there are likely to be a number of factors contributing to DSPS, a preference for staying up until 12 am or later during adolescence has been shown to be a strong risk factor for the development of DSPS.^{19,22}

In addition to daytime sleepiness, adolescents with DSPS present with difficulty initiating sleep and difficulty waking for school. Treatment of DSPS requires a substantial commitment on the part of the adolescent, as a consistent sleep schedule on both weekdays and weekends is necessary.¹⁹ This is critical beyond the initial treatment, as even one night of a delayed bedtime may cause DSPS to return. When the discrepancy between the ideal bedtime and the actual bedtime is <3 h, treatment starts with the adolescent going to bed at their actual time and gradually moving their bedtime earlier in 15 min increments. Increasing natural light exposure in the morning and limiting daytime napping are also recommended.²³ When the discrepancy is >3 h, chronotherapy (phase delay) may be effective.²⁴ Using this method, the bedtime and wake times are moved forward 2–3 h every day until the desired sleep schedule is achieved (e.g. day 1: 3 am–11 am; day 2: 6 am–2 pm, day 3: 9 am–5 pm, etc).

Melatonin has also been used as a treatment for DSPS.²³ However, there have been no clinical trials demonstrating the effectiveness or side effects of melatonin for DSPS in adolescents. In addition, melatonin is not regulated by the Food and Drug Administration (FDA) and thus the amount of melatonin in each dose is questionable. Finally, there is no clear consensus on the timing of melatonin administration in the treatment of DSPS.

Estimates of *insomnia* symptoms (difficulty with sleep onset, staying asleep or early morning waking) in adolescents range from 25% to 34%,^{25,26} with one study reporting that 10.7% of 13–16 year olds met full criteria for insomnia.²⁷ Insomnia likely results from a combination of predisposing factors (genetic vulnerability or temperament, underlying medical conditions, psychiatric disorders or sleep disorders), precipitating factors (e.g. stress, illness) and perpetuating factors (poor sleep habits, caffeine use, learned associations that interfere with sleep and worries about sleeping). Sleep diaries may be used to identify potential maladaptive bedtime activities, behaviours or schedules. Management includes a thorough evaluation of causes and contributing factors, maintenance of healthy sleep habits and screening for psychiatric disorders. One of the most effective treatments for adults is cognitive behavioural therapy for insomnia (CBTI),^{28,29} yet this treatment has not yet been adapted or evaluated for use with adolescents.

Although *obstructive sleep apnoea (OSA)* is more common in young children, there is also an increased likelihood of OSA in middle adolescence that is associated with obesity.¹⁸ During sleep the airway may be slightly obstructed or blocked, causing airflow to decrease or to stop, thus leading to repeated hypoxia and frequent arousals during sleep. An apnoea + hypopnoea index (AHI) derived from polysomnography (PSG) is required for the diagnosis of OSA. A recent study demonstrated significant differences in AHI scores between overweight adolescents and controls (2.17 vs 0.59).³⁰ Management includes surgical

approaches (such as adenotonsillectomy), weight loss and continuous positive airway pressure (CPAP).

For both *restless legs syndrome (RLS)* and *periodic limb movement disorder (PLMD)* the most common presenting complaint is daytime sleepiness. RLS is a common condition in adults that is likely also to be present in many adolescents, given that 38% of adults with RLS reported onset of symptoms prior to age 20.³¹ RLS is a clinical diagnosis and in adolescents (13 years or older) the criteria are the same as for adults.³² These include: (1) an urge to move the legs due to an uncomfortable sensation (e.g. creepy-crawly or tingling); (2) the urge to move begins or worsens with sitting or lying down; (3) the urge to move is partially or totally relieved by movement; and (4) the urge to move is worse in the evening or night than during the day. Unlike RLS, a diagnosis of PLMD is based on PSG. The diagnostic criteria include: (1) elevated number of periodic limb movements per hour exceed norms for age; (2) clinical sleep disturbance; and (3) the absence of another primary sleep disorder or underlying cause (including RLS).²¹ In addition to a thorough history and PSG, serum ferritin levels may also be drawn, as adolescents may benefit from iron therapy when values are <3.5 µg/dl.^{32–34} Medications may also be used; however, large, well-controlled studies of medications for the treatment of RLS and PLMD in adolescents are lacking.

Narcolepsy is a neurological disorder characterized by excessive daytime sleepiness (EDS) that typically emerges during adolescence. Along with EDS, diagnostic symptoms include loss of muscle tone following strong emotional experiences (cataplexy), spontaneous 'naps' during the day, hallucinations during the transition from sleep to wakefulness (hypnagogic hallucinations) and sleep paralysis.²¹ The prevalence of this disorder in Americans is 1 in 2000,³⁵ while the prevalence in adolescents is unclear. More than half of adults with narcolepsy describe symptoms occurring before age 20 and one-third describe symptoms before age 15.³⁶ Yet, only 4% of patients with narcolepsy are diagnosed before age 15.³⁶ Assessment for narcolepsy includes PSG with multiple sleep latency testing (MSLT). Of note, a diagnosis of narcolepsy cannot be made in the presence of insufficient sleep, as changes on the multiple sleep latency test (MSLT) suggestive of narcolepsy are also present in the face of chronic partial sleep deprivation.²¹ Treatment of narcolepsy generally involves medications as well as non-pharmacological strategies such as improving sleep hygiene and implementing scheduled daytime naps. Stimulant medications and modafinil are indicated for daytime sleepiness^{37,38} and anticholinergic medications (clomipramine, imipramine) may be indicated for cataplexy.³⁹

CONSEQUENCES OF INSUFFICIENT SLEEP AND SLEEPINESS

Regardless of the cause of insufficient sleep, sleepy adolescents experience a number of negative consequences,

including academic difficulties, mood disturbances, increases in risk-taking behaviours and drowsy driving.^{6,8,40–42}

Academic performance

Academic performance is clearly affected by insufficient sleep and sleepiness. In a recent survey of adolescents in the US, 28% of high school students reported that they fall asleep at school at least once per week, and 14% reported being late or missing school because of oversleeping.¹² While 80% of adolescents who reported obtaining an optimal amount of sleep also reported achieving As and Bs in school, adolescents who obtained insufficient sleep reported lower grades.¹² Moreover, a weekend bedtime delay of >2 h has been associated with daytime sleepiness and poor academic performance (e.g. lower grades).⁵

Mood disorders

The association between sleep problems and depression in adolescents has been well-documented. However, it is likely a bidirectional relationship with depressive symptoms disrupting sleep and sleep problems increasing depressive symptoms. In fact, sleep problems are considered to be both a symptom and consequence of major depressive disorder.⁴³ In studies of sleep problems among adolescents, elevated rates of depressive symptoms have been identified.^{44,45} One study found that the strongest correlates of insomnia in adolescents were unhappiness, mood disturbance, substance use and suicidal ideation.⁴⁵ Another study showed that teenagers who obtained <6 h of sleep per night, or reported a discrepancy between school night and weekend bedtimes of >2 h, reported significantly more depressive symptoms.⁵ Similarly, self-reported sleep time has been positively associated with self-reported depressive symptoms.⁷

While less well documented, sleep disturbances have also been associated with anxiety disorders.^{42,46} However, the causal direction of the association is not known, with sleep problems again being both a symptom and a consequence of anxiety disorders.⁴³ Consistent with the clinical literature, at least one study has found that adolescents who reported symptoms of insomnia also reported symptoms of anxiety.⁴⁴

Risk taking and drowsy driving

Increases in risky behaviours are also related to insufficient sleep in adolescents. In addition, drowsy driving is a serious concern given that motor vehicle accidents cause the greatest number of American adolescent deaths.⁴⁷ More than half of 10–12th grade drivers report drowsy driving in the past year, and 15% of 10–12th grade drivers report drowsy driving at least once per week.¹²

Insufficient sleep and sleepiness also have been associated with increased substance use. One study found that

less total sleep time was associated with more alcohol use on weekdays, and that increased daytime sleepiness and later weekend bedtimes related to greater tobacco, alcohol and marijuana use, and sexual behaviours.⁴⁸ At least one other study has found a significant association between increased sleep problems and greater cigarette, alcohol and illicit drug use.⁴⁹

Clearly the potential consequences of insufficient sleep and sleepiness are serious, impacting all areas of adolescent functioning. Given the number of adolescents who do not obtain sufficient sleep, a thorough investigation of any adolescent presenting with daytime sleepiness is warranted.

ASSESSING SLEEP IN ADOLESCENTS

History and sleep diary

A detailed clinical sleep history is the first step required in differentiating between insufficient sleep, inadequate sleep hygiene and other sleep disorders. Along with a basic sleep schedule (bedtime, wake time and total sleep time), clinicians should enquire about all aspects of the adolescent's sleep and daytime functioning. Questions about sleep scheduling should focus on the consistency of a bedtime routine, typical bedtime and wake time (for both weekdays and weekends), and time spent falling asleep. A family member should be asked about symptoms and behaviours while the adolescent is asleep, including snoring and pauses in breathing, sleepwalking and leg movements. Questions about daytime functioning should focus on difficulty with morning waking, daytime sleepiness, fatigue, napping (either scheduled or unscheduled), mood, behaviour and academic performance. Current, past and family history of sleep disorders should also be queried. Because of their interaction with sleep, psychiatric conditions, medical conditions and medications should also be part of the assessment. Finally, significant life events (parental divorce, death of a family member or friend, move, social problems, etc) should also be explored, as each may impact adolescent sleep.

Along with the clinical history, additional information about sleep patterns can be collected with daily sleep diaries. For compliant adolescents, a daily sleep diary kept over a period of 1–2 weeks can provide a wealth of information about the consistency of bedtimes and wake times, weekend oversleep, prolonged sleep onset and naps.

Actigraphy

In conjunction with daily sleep diaries, actigraphy provides an objective assessment of sleep patterns over an extended period of time (e.g. 1–2 weeks). An actigraph is the size of a wrist watch, but contains an accelerometer that provides information about when the adolescent is asleep or awake. Actigraphy has been used in several studies with adolescents,^{30,50,51} and has demonstrated validity for total sleep

time when compared with PSG.⁵¹ Actigraphy may be most useful in adolescents without OSA, as sleep time may be underestimated in adolescents with sleep disordered breathing.⁵¹ One notable benefit of actigraphy is that it allows information on sleep patterns to be collected over multiple nights (both weekdays and weekends) in the adolescent's typical sleeping environment.

Polysomnography/multiple sleep latency test

Overnight PSG is considered to be the gold standard for identifying sleep architecture (the time spent in each of the sleep stages) and sleep disorders such as OSA and PLMD. PSG yields data from multiple sources, including EEG, EKG, oxyhaemoglobin saturation, electromyography and electro-oculogram. Unlike actigraphy, PSG is typically conducted in a sleep laboratory on one night.

PSG is also used in conjunction with the MSLT to identify narcolepsy and has successfully been used in studies of adolescents.² MSLT is conducted following one night of PSG and involves a series of four or five daytime naps administered at 2-h intervals using rigorously standardized procedures. A diagnosis of narcolepsy is determined by the time it takes a subject to fall asleep (with a shorter sleep onset latency indicating more sleepiness) and the number of naps in which REM sleep occurs. In adults, two or more REM periods in a series of five naps are diagnostic of narcolepsy. Interpretation of MSLT findings in adolescents can be challenging,⁵² as results are affected by pubertal status, age, insufficient sleep and drugs (both prescription and illicit).⁵³

CONCLUSION

Adolescence is a time marked by physiological, social and psychological changes. While some adolescents may be considered moody or lazy, in fact they simply may be sleepy. Insufficient sleep, the most common cause of adolescent sleepiness, is typically the result of the interaction between puberty and academic, social and extracurricular demands. The interaction between these two arenas results in adolescents who do not get enough sleep at night and are sleepy during the day. Insufficient sleep and sleepiness significantly impact daytime functioning, including academic performance, mood and risk-taking behaviours, all of which are critical for healthy adolescent development. The scope and impact of insufficient sleep and sleepiness require that clinicians evaluate sleep problems in these youth. While PSG and MSLT are required for the diagnosis of OSA, narcolepsy and PLMD, insufficient sleep is best identified with a thorough clinical sleep history and daily sleep diary. The management of sleep problems in adolescents involves addressing any underlying physiological sleep disruptors, improving sleep hygiene, maintaining a consistent sleep schedule and, in turn, increasing total sleep

PRACTICE POINTS

- The interaction of intrinsic and extrinsic factors predisposes adolescents to obtain insufficient sleep and to be sleepy.
- Insufficient sleep is the most common cause of sleepiness in adolescents.
- Sleepiness can affect academic, behavioural and psychological functioning.

time. Increased recognition of insufficient sleep and sleepiness as barriers to optimal adolescent health and well-being may reduce at least some of the struggle associated with this critical period of development.

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Educational questions

Answer true or false to the following questions:

1. The most common causes of adolescent sleepiness are:
 - a. Obstructive sleep apnoea.
 - b. Narcolepsy.
 - c. Insufficient sleep.
 - d. The interaction of intrinsic and extrinsic factors characteristic of adolescence.
2. The recommended amount of sleep for adolescents is:
 - a. 9.25 h.

- b. This varies by individual adolescent.
 - c. Less than recommended for school age children.
 - d. 6 h at night plus 45 min of naps.
3. Consequences of insufficient sleep in adolescents include:
- a. Drowsy driving.
 - b. Depressive symptoms.
 - c. Poor academic performance.
 - d. Difficulty concentrating.
4. Which sleep disorders are commonly identified first during adolescence?
- a. Obstructive sleep apnoea.
- b. Insomnia.
 - c. Narcolepsy.
 - d. Sleep disordered breathing.
5. In delayed sleep phase syndrome (DSPS), sleep duration is typically:
- a. Shortened, even if given the opportunity for longer periods of sleep.
 - b. Normal if given the opportunity for longer periods of sleep.
 - c. Shorter on school days and much longer at week-ends.
 - d. Biphasic.

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