Changing Adolescent Sleep Patterns: Factors Affecting them and the Related Problems

Harpreet Kaur1, Harpreet Singh Bhoday2

Abstract
Sleep affects physical growth, behavior and emotional development besides determining cognitive functioning, learning and attention especially of a growing child. Adolescence represents one of the critical transitions in the life span and is characterized by a tremendous pace in growth and change that is second only to that of infancy. Adolescent sleep patterns deserve particular attention because of the potential impact on school performance. Average sleep period in adolescents is reduced during school days to around seven hours. The reasons may be biological mainly the sleep phase delay or psychosocial and environmental. These include academic demands, social activities, sports, internet, television viewing, part-time employment, and use of mobile phone at night, peer and parental influence and socioeconomic status. These changing patterns of sleep in adolescents lead to many behavioral sleep problems like Delayed Sleep-phase Syndrome; Difficulties in falling asleep (insomnia); excessive daytime sleepiness, poor academic performance. Decreased sleep in adolescents also causes obesity and other cardio-metabolic abnormalities. This needs an integrated approach involving adolescents themselves, their parents, teachers and specialized physicians to help improve the sleep quantity and quality and lead to a better quality of life and daytime functioning in adolescents.

Sleep
Sleep is a naturally recurring state characterized by reduced or absent consciousness, relatively suspended sensory activity, and inactivity of nearly all voluntary muscles.[1]

Sleep is divided into two broad types: Rapid eye movement (REM) and Non-rapid eye movement (NREM or non-REM) sleep. The American Academy of Sleep Medicine (AASM) describes the stages of sleep as follows (Table 1).[2]

An adult reaches REM approximately every 90 minutes, with the latter half of sleep being more dominated by this stage. The function of REM sleep is uncertain but a lack of it will impair the ability to learn complex tasks. One approach to understanding the role of sleep is to study the deprivation of it. A hypnogram is a graph that represents the stages of sleep as a function of time. It is an easy way to present the recordings of the brain wave activity from an electroencephalogram (EEG) during a period of sleep (figure 1).

Both these sleep states develop before birth. Infants cycle through many sleep periods throughout the day. As they develop, they sleep longer at night and have fewer sleep periods during the day. Newborns sleep almost all the time. By six months they sleep about 13 hours a day with the longest sustained period being about seven hours. By 24 months children sleep for 12 hours, including naps, and by four years children sleep 10–12 hours with one daytime nap at most. Throughout childhood children typically get about ten hours of sleep a night. This drops significantly at adolescence. National sleep Foundation (NSF) has given expert recommendations regarding the sleep durations according to the various age groups (Table 2).[3] Sleep timing is controlled by the circadian clock, sleep-wake homeostasis, and in humans, within certain bounds, willed behavior and genetics.[4]

Adolescents Sleep Patterns
World Health Organization identifies adolescence as the period in human growth and development that occurs after childhood and before adulthood, from ages 10-19. It is characterized by a tremendous pace in growth and change that is second only to that of infancy. Adolescent sleep patterns deserve particular attention because of the potential impact on academic performance, social behavior and cardiometabolic system. As per the NSF, the recommended sleep duration is 8 to 10 hours.[3] However, studies show that in

1Associate Consultant, Department of Internal Medicine, Fortis Hospital, Ludhiana, Punjab; 2Post Graduate Resident, Department of Pediatrics, Dayanand Medical College and Hospital, Ludhiana, Punjab

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adolescence, the average sleep duration timings tend to be lower than the recommended especially school going children. The reasons may be biological, psychosocial or environmental. These shall be discussed one by one below.

### Biological Factors

In adolescents, the circadian rhythm that also controls sleep and wakefulness tends to undergo biological changes. This natural shift is called “sleep phase delay.” On weekdays, the adolescents tend to be sleep for a lesser duration, so they have a longer sleep duration on weekends because of the rebound effect. The irregularity that results from adolescents’ typical sleep patterns (i.e. sleep phase delay, decreased nocturnal sleep, irregular sleep-wake schedule, late bedtime and rise time, poor perceived sleep quality) is associated with many sleep related problems like Delayed sleep phase Syndrome (DSPS), insomnia, excess daytime sleepiness, reduction in concentration levels, alterations in mood and temperament, and risk taking behavior.

### Psychosocial Factors

A primary psycho-developmental task of adolescents is to achieve independence in many areas of their lives. One area where this striving for autonomy is displayed is the decision of when to go to sleep. Different psychosocial and environmental factors influence these changes in adolescents sleep patterns. These include academic demands, social activities, sports, media usage and part-time employment. In addition, decreasing parental involvement due to modernization may play a role as well.

### Academic Pressures

Studies have shown the influences of academic pressures on these sleep patterns. It has been seen that the combination of delayed circadian sleep phase and early start times at high schools causes adolescents to lose sleep during the school week. This causes day time sleepiness, inattentive behavior and poor academic performance. It also leads to negative effects on neurocognitive performance, mood and health and even put adolescents at risk for accidents or injury. A study by Hansen et al showed that there was a delay of about two hours in the sleep onset of adolescents on weekdays but not on weekends. It was associated

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**Table 1: Stages of sleep**

<table>
<thead>
<tr>
<th>Stage W</th>
<th>Waking</th>
<th>NREM Sleep</th>
<th>REM Sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes open, responsive to external stimuli</td>
<td>Transition between waking and sleep.</td>
<td>Main body of light sleep. It becomes harder to awaken the sleeper</td>
<td>Also called the Slow waves Sleep (SWS)</td>
</tr>
<tr>
<td>Can hold intelligible conversation</td>
<td>If awakened, person will claim was never asleep.</td>
<td>Memory consolidation.</td>
<td>Sleeper is less responsive to external environment</td>
</tr>
<tr>
<td></td>
<td>The muscles are active</td>
<td>Synaptic pruning</td>
<td>Initiated in preoptic area</td>
</tr>
<tr>
<td></td>
<td>Eyes roll slowly, opening and closing moderately</td>
<td>Interruption of alpha waves by abrupt sleep spindles and K-complexes.</td>
<td>High amplitude slow delta waves on EEG. Earlier divided into stages 3 and 4</td>
</tr>
<tr>
<td></td>
<td>Alpha waves</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Expert panel recommended sleep durations according to age**

<table>
<thead>
<tr>
<th>Age</th>
<th>Recommended (hours)</th>
<th>May be appropriate (hours)</th>
<th>Not recommended (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborns</td>
<td>14 to 17</td>
<td>11 to 13</td>
<td>Less than 11</td>
</tr>
<tr>
<td>0-3 months</td>
<td>12 to 15</td>
<td>10 to 11</td>
<td>Less than 10</td>
</tr>
<tr>
<td>Infants</td>
<td>12 to 15</td>
<td>16 to 18</td>
<td>More than 18</td>
</tr>
<tr>
<td>4 – 11 months</td>
<td>11 to 14</td>
<td>9 to 10</td>
<td>Less than 9</td>
</tr>
<tr>
<td>Toddlers</td>
<td>10 to 16</td>
<td>15 to 16</td>
<td>More than 16</td>
</tr>
<tr>
<td>1 – 2 years</td>
<td>10 to 13</td>
<td>8 to 9</td>
<td>Less than 8</td>
</tr>
<tr>
<td>Preschoolers</td>
<td>9 to 11</td>
<td>7 to 8</td>
<td>Less than 7</td>
</tr>
<tr>
<td>3 – 5 years</td>
<td>8 to 10</td>
<td>12</td>
<td>More than 12</td>
</tr>
<tr>
<td>School aged children</td>
<td>7 to 9</td>
<td>11</td>
<td>More than 11</td>
</tr>
<tr>
<td>6 – 13 years</td>
<td>7 to 9</td>
<td>6</td>
<td>Less than 6</td>
</tr>
<tr>
<td>Teenagers</td>
<td>7 to 9</td>
<td>10 to 11</td>
<td>More than 11</td>
</tr>
<tr>
<td>14 – 17 years</td>
<td>7 to 9</td>
<td>6</td>
<td>Less than 6</td>
</tr>
<tr>
<td>Young adults</td>
<td>7 to 9</td>
<td>10</td>
<td>More than 10</td>
</tr>
<tr>
<td>Adults</td>
<td>7 to 9</td>
<td>5 to 6</td>
<td>Less than 5</td>
</tr>
<tr>
<td>26 – 64 years</td>
<td>7 to 8</td>
<td>9</td>
<td>More than 9</td>
</tr>
<tr>
<td>&gt;65 years</td>
<td>7 to 8</td>
<td>9</td>
<td>More than 9</td>
</tr>
</tbody>
</table>
with the same pattern of poor morning performance, compared with afternoon performance ($P < .001$), and all students felt less vigorous in the morning ($P < .0001$) than in the afternoon.\textsuperscript{10} Fulgini and Hardway in 2006 conducted a study using the Daily Diary system to assess the effects of activities of daily living on the variations in the adolescent sleep and their psychological wellbeing and found out variability among individual adolescents’ sleep time in addition to the phase delay and also in the daily activities, and psychological well-being among adolescents. Studying and stressful demands were among the most important factors that caused sleep deprivation. Daily feelings of anxiety, depression, and fatigue were the most consistent psychological outcomes of obtaining less sleep at night.\textsuperscript{11}

**Media Usage**

Increased modernization and exposure to newer high tech media has in one way increased our awareness, but on the other hand is also a risk factor for irregular sleep habits, shorter sleep duration, and sleep disorders especially in adolescence.\textsuperscript{12,13} A recent review by Cain and Gradisar\textsuperscript{14} noted shorter, late, and/or more disrupted sleep in adolescents who have greater television watching, computer/Internet/electronic games use, or mobile phone use in the evening before bed time. These adolescents also tend to have more day time sleepiness or disruptive behavior.

**Addictions**

Adolescent age is marked by acquaintance of various new things in life but comes with addictions to alcohol, cigarette smoking and various drugs. All these behaviors have an effect the sleep onset timings and other consequences. A large survey of 12- to 15-year-old subjects showed correlations between sleep problems, rebelliousness, depressive symptoms and cigarette smoking.\textsuperscript{15} It is also shown that there is an increase use of caffeine in adolescents nowadays. High school students who have high intake of caffeine have nearly 2 times more difficulty in sleeping and more day time sleepiness as compared to those with low intake.\textsuperscript{16} Caffeine especially reduces the percentage of time spent in deep sleep and alters the temporal relation of REM/ non-RM sleep. Since both deep and REM sleep are essential for learning and memory consolidation, caffeine interrupts that and can cause serious concentration deficits in growing adolescents.\textsuperscript{17}

**Modern life style and its influence on adolescent sleep**

An important consequence of our modern-day society is that it is difficult for children and caregivers both to get adequate sleep. Sleep involves reciprocal interactions between all members of a household as well as with the environment of the home and outside. Changing work schedules and increasing night shifts of parents do influence a child’s bed time and sleep duration. As children grow, they want to be more independent and want to sleep alone. Studies have shown that children generally have better age-appropriate sleep in the presence of household rules and regular sleep-wake routines. Neighbourhood noise from vehicular traffic, commercial, or industrial activity and neighbour’s night parties also create disturbances in sleep.\textsuperscript{18} Gangwisch and colleagues examined from a large epidemiologic data set gathered from adolescents (grades 7 to 12) in the US during the mid-1990s. The analysis showed that young people whose parents set their bedtime at midnight or after relative to those with bedtimes set earlier, were significantly more likely to suffer from depression or suicidal ideation.\textsuperscript{19}

**Socioeconomic Status**

In developing countries, where people from all kinds of socioeconomic strata reside, differences in the socioeconomic status and availabilities of sources of distraction also influence the sleep patterns. Only a single study could be found in Indian literature, where sleep patterns were studied only in urban school going adolescents.\textsuperscript{20}

**Sleep Related Disorders**

Studies indicate that these changing patterns of sleep in adolescents lead to many behavioral sleep related disorders. Sleep disorders in adolescents are highly prevalent, with prevalence rates ranging from 25% to 40%, and they are often persistent.\textsuperscript{21} Behaviorally-based sleep disorders typically present with at least 1 of the following complaints:

1. **Delayed Sleep-phase Syndrome**
2. Difficulties in falling asleep (insomnia);
3. **Disturbed daytime performance**.
4. Obesity and its effects

**Delayed sleep phase syndrome (DSPS)**

Delayed sleep phase Syndrome (DSPS) is a circadian rhythm disorder that usually appears during adolescence. First described by Weitzman and colleagues,\textsuperscript{21} it is characterized by a cluster of features including a chronic inability to fall asleep and wake at a desired clock time, consistency in reported sleep times at later hours than other individuals, and otherwise normal sleep when measured by all-night polysomnography if the delayed schedule is allowed. It is associated with a wide range of problems, including inability to work or attend school, which can lead to school failure, daytime sleepiness, social difficulties, and depressed mood.\textsuperscript{22} Etiological mechanisms of DSPS include abnormalities of the circadian timing system with delayed timing of melatonin secretory patterns, the sleep homeostatic system, systems coordinating circadian and sleep processes, behavior, psychological traits and features,
genetic processes, and combined effects. Treatment is usually by chronotherapy, phototherapy and/or pharmacotherapy like exogenous melatonin administration. Insomnia

Insomnia Disorder is characterized by difficulties in initiating or maintaining sleep or by non-restorative sleep with these symptoms lasting at least one month and causing clinically significant distress or impairment in daytime functioning. Insomnia can be primary where there is no antecedent medical or psychiatric cause or it may be secondary. Insomnia is most likely caused by a combination of physiological/genetic factors and psychosocial factors. Only a few studies assessed the prevalence and development of insomnia among adolescents. A possible contributing factor during adolescence is the change in circadian rhythm, causing a delay in sleep onset and therefore sometimes misdiagnosed in them with DSPS. Chronic insomnia increases subsequent risk for somatic health problems, interpersonal problems, psychological and emotional problems, high incidence of anxiety and risk taking behavior. [5,6,26]

Daytime sleepiness and poor daytime performance

As discussed earlier, since most of the adolescents get insufficient sleep because of the tendency to delay sleep, they experience what is called excessive day time sleepiness (e.g. an increased tendency to fall asleep during wakefulness). It has many negative effects on their academic performance, cognitive and neurobehavioral functioning, emotional regulation and risk taking behavior. Obesity and its effects

Adolescents gain greater autonomy and independence in their eating and sleeping habits and are therefore more vulnerable to over-nutrition and sleep disorders. For this reason, reduced sleep duration may lead to metabolic and hormonal deregulation, thus favoring food intake, obesity and cardiometabolic risk. A systematic review and a meta-analysis of studies conducted on adolescents indicated a reverse association between sleep duration and obesity. [29] Ruiz et al analyzed the possible association among nocturnal sleep duration, the presence of overweight and metabolic alterations in a group of adolescents. It was found that among ninety adolescents, adolescents with excessive weight had, in average, fewer sleep hours \( p < 0.05 \) and a higher rate of sleep deficit and sleep debt \( p < 0.05 \). Low HDL cholesterol and insulin resistance was significantly associated with sleep debt \( p < 0.05 \). Among adolescents with sleep debt, the risk of having excess weight was 2.70 times higher (95% CI= 1.09-6.72; \( p = 0.032 \)) regardless of age, gender, sexual maturity, sleep deficit and history of cardiovascular disease and diabetes in first-degree relatives. [30]

Obese children tend to have interrupted sleep with snoring, sleep disordered breathing called obstructive sleep apnea and therefore they have excessive daytime sleepiness. This causes poor academic performance and bad social impact. Sleep Hygiene and Management of Sleep Related Disorders

Adolescents around the world are experiencing a decreased amount of sleep time, which is in clear contrast to their sleep needs. This has many physical, neurobehavioural, academic and social implications on their mental and physical growth. Therefore, adolescents should be made aware of their growing sleep needs, the developmental shift in the circadian clock and such implications of chronic sleep insufficiency. This can be done by proper sleep hygiene and management of sleep related disorders.

a. Sleep Hygiene: Adolescents should be encouraged to:

1. Keep consistent regular bedtimes and rise times, also on weekends.
2. Avoid sleeping late into the noon hours on weekends. Also napping in the early afternoon hours should be avoided or limited to 30 minutes
3. Use the bed only for sleeping.
4. Create a routine before bedtime that will include calming and relaxing activities to break the connection between the stimulating activities of the day and sleep.
5. Reduce or avoid exposure to bright light in the evening
6. Avoid using any drugs, alcohol, caffeine, or stimulating substances.
7. Maintain regular food habits.
8. Keep regular exercise in the beginning of the day and avoid exercise in late evening hours.
9. Avoid using sleeping pills

Besides the steps adolescents can take by themselves, parents, teachers and health care practitioners should be aware of the high prevalence of problematic sleep patterns and sleep difficulties in adolescents.

b. Clinical approach to sleep disorders: Chronically sleepy adolescents, who are late for school and perform poorly at school without any clear reason, should be carefully examined for sleep disorders. If the adolescent shows excessive sleepiness even though he/she gets sufficient time to sleep, the presence of possible underlying physiological sleep disorders with potentially obstructive effects on daytime functioning, such as breathing related sleep disorders, should be examined. Such children are usually obese and should be counselled for weight reduction by increasing physical activity of at least 30 to 45 minutes per day along with limiting sedentary lifestyle to less than two hours in a day. These children should also
be screened for large adenoids, nasal polyps or any other causes of upper airway obstruction (retrognathia, macroglossia, neuromuscular weakness) and should be managed accordingly. These recommendations may help to improve sleep quantity and quality and lead to a better quality of life and daytime functioning in adolescence.

Conclusions

To summarize, adolescence is a dynamic phase and needs special attention. It is marked by a phase to be independent and try out new things. Most common problem in adolescents is delayed sleep onset and duration. Many biological, psychosocial and environmental factors contribute. These include academic pressures, changing lifestyles with increased modernization leading to progressively decreasing parental influences, presence of media and its late night use and neighbourhood noise. All these factors cause increasing sleep deficits and therefore many sleep related problems ensue. These sleep related problems include the physiological delayed sleep phase syndrome or the pathological insomnia, excessive daytime sleepiness, poor academic performance, obesity and other cardiometabolic derangements. Management includes proper parental guidance and set sleep times, a good sleep hygiene, avoidance of stimulating drugs and foods and a healthy lifestyle. A coordinated effort by parents and children can lead to healthy and stress free living.

Abbreviations

REM: Rapid eye movement; NREM: Non-rapid eye movement; AASM: The American Academy of Sleep Medicine; SWS: Slow-wave sleep; EEG: Electroencephalogram; DSPS: Delayed sleep phase Syndrome; ICSD: International Classification of Sleep Disorders; CBT-I: Cognitive-Behavioral therapy for Insomnia; HDL: High Density Lipoprotein; NSF: National sleep Foundation

References