SLEEP—ITS INDISPENSABILITY FOR LIFE AND THE NEED FOR INCLUSION IN THE CURRICULUM

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Sleep is a multifaceted process fundamental to human well-being. The quality of sleep to a large extent determines the quality of life. The impacts of inadequate or poor quality of sleep is manifested in every aspect of our lives—physiological processes, mental health, our performances related to brain function such as academic performance, problem solving ability, our social life, etc. Yet, we compromise sleep without giving much thought. Adolescents compromise the 8–10 hours of sleep per night recommended for their age and this impacts their well-being. With the advent of technology, the quality of sleep is also being compromised due to extended exposure to screen time. In spite of the adverse impacts of sleep deprivation on the well-being increasingly seen especially amongst young people, sleep or sleep hygiene has been left out from the curriculum. This paper attempts to reiterate the importance of sleep by exploring the science of sleep in a simple yet scientifically appropriate manner that will be understandable to a student at the secondary stage. It will further discuss on the consequences of sleep deprivation, its impacts on health and academic performance, all based on research evidence. The paper concludes with a recommendation to consider inclusion of sleep and sleep hygiene concepts in the curriculum appropriately at different stages.

Keywords: Sleep, Sleep hygiene, Curriculum, Adolescents, Mental health.

Introduction

We stay alive because we eat and sleep. However nutritious food we may eat, however healthy we may be, without adequate sleep we cannot survive after a certain point of time. Even one night without sleep is enough to make us realise its significance. When sleep deprived, most of us may feel drained, groggy and physically not our best. This indicates that the period of inactivity during sleep has clear importance for our body to function efficiently. The quality of life that sleep determines in terms of our physiological processes, our performances related to brain function, our social life and all other aspects of our life is unfathomable. Yet, when we have a target to be met, an assignment to be completed and many other similar situations, we sacrifice sleep, invariably. To make matters worse, with the intrusion of technology in our daily life—including in the education system, the amount of time we spend on electronic devices have also gone to such an extent that it has become one of the major reasons for disruptions in our sleep, both in terms of quality and duration.

So, the obvious question is—how long should we sleep? According to the American Academy of Sleep Medicine and Sleep

Research Society, the recommended sleep hours for children of 6 to 12 years of age is 9 to 12 hours, and teenagers of 13 to 18 years of age is 8 to 10 hours per 24 hours on a regular basis to promote optimal health while for adults it is 7 or more hours per night on a regular basis to promote optimal health (Watson et al., 2015; Paruthi et al., 2016). There is a general consensus that adolescents and children at large are not sleeping for an adequate number of hours (Andrade et al., 1993; Blunden & Rigney, 2015). Several Indian (Mathew et al., 2022; Maurya et al., 2022) and international studies (National Sleep Foundation, 2006) indicate that a large percentage of school-aged children and adolescents are not getting the recommended hours of sleep on weekdays. Since sleep has become an easily compromised part of daily routine, insufficient sleep, poor sleep quality and sleepiness are now common problems in children and adolescents. The reasons for these can be attributed to a number of causes. The pressure of performing well in academic and other curricular activities, unhealthy lifestyle choices and low priority given to sleep over other activities are some of the reasons why sleep is being displaced.

Considering the repercussions sleep can have on all aspects of our life, it is essential for students to learn and be informed about it. Yet, surprisingly sleep has almost never found space in the school curriculum not just in India but in many other countries as well, based on the curriculum frameworks available on the websites of Singapore[1], Sri Lanka[2], Bangladesh[3] and United Kingdom[4].

Keeping in view the above discussions, this paper attempts to reiterate the importance of sleep by exploring the science of sleep in a simple, yet scientifically appropriate manner that will be understandable to a student at the secondary stage who have learned the basics of the nervous system such as brain, neurons and nerve impulse. It will further discuss the consequences of sleep deprivation, its impacts on health and academic performance based on a thorough review of available literature. The paper concludes with a recommendation to consider sleep and sleep hygiene in the curriculum appropriately at different stages.

Exploring the Science of Sleep

Sleep is a multifaceted process fundamental to well-being. It is a physiological as well as a behavioural process that can be defined as a state of unconsciousness from which a person can be awakened with the help of a stimulus. Just like any other process in the body, sleep is also regulated by the brain. The transition from being awake to falling asleep, as well as the depth and quantity of sleep are under the control of specialised regions in the brain (Moore, 2007). However, sleep is also strongly influenced by external factors such as light (Tortora & Derrickson, 2021). In the following sections, we will discuss what makes us sleep or wake, what controls them and the stages of sleep. We will also discuss what happens to our sleep pattern when our biological clock is disrupted due to the introduction of modern lighting technology, etc.

[1]https://www.moe.gov.sg/ accessed on August 1, 2024
[2]https://nec.gov.lk/ accessed on August 1, 2024
[3]https://nctb.gov.bd/ accessed on August 1, 2024
[4]https://www.gov.uk/government/publications/national-curriculum-in-england-framework-for-key-stages-1-to-4 accessed on August 1, 2024

The 24-hour Biological Clock and Sleep

The body maintains an internal 24-hour biological clock, also called the circadian rhythm. That is, the timing of various processes such as digestion, changes in body temperature, sleep, wake, etc., follow certain pattern in sync with the day-night cycle. The presence of light during day and darkness during night play important role in this. This circadian rhythm is controlled by a specialised cluster of nerves called the suprachiasmatic nucleus (SCN) in the hypothalamus. The human brain can be divided into three broad units called the forebrain, midbrain and hindbrain. The hypothalamus, which is an almond-sized region, lies deep within the forebrain. (Fig. 1).

The following explains how sleep-wake cycle occurs:

Several factors and processes are involved in this sleep-wake cycle which are complex and not necessary for a school student to understand. Hence, only the basic aspect of it is being explained here.

First, when light sensitive cells in the retina (of eyes) are exposed to light, a signal is transmitted through neurons to the SCN in the brain which activates the SCN. The SCN in turn, inhibits the release of a hormone called melatonin from the pineal gland. This hormone plays a role in regulating the sleep-wake cycle by promoting wakefulness. However, when it is dark, SCN is inactivated which results in the pineal gland releasing melatonin (Tortora & Derrickson, 2021). This promotes sleepiness. It may be noted that the secretion of melatonin varies with the time of day. It is naturally produced as light exposure decreases. Since more melatonin is released during darkness, it promotes sleepiness at

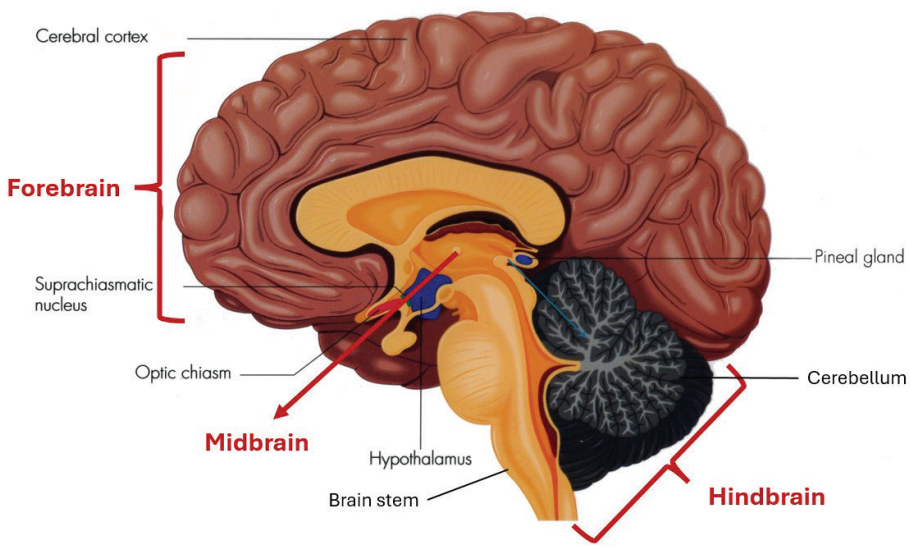


Fig. 1. Location of hypothalamus in the brain (Modified from https://commons.wikimedia.org/wiki/File:Suprachiasmatic_Nucleus.jpg)

night. Thus, melatonin helps synchronise the sleep-wake cycle with day and night. It is observed that during sleep, blood plasma levels of melatonin increase ten to twenty times and then decline to a low level again before awakening (Pandi-Perumal et al., 2006). The melatonin level at different time of the day is depicted in Fig. 2.

What Drives us to Sleep?

The SCN also regulates the sleep-wake state by coordinating with neurons of other regions of the brain. Certain neuronal regions called as the sleep-promoting region and wake-promoting regions play an active role in sleep regulation (Brown et al., 2012).

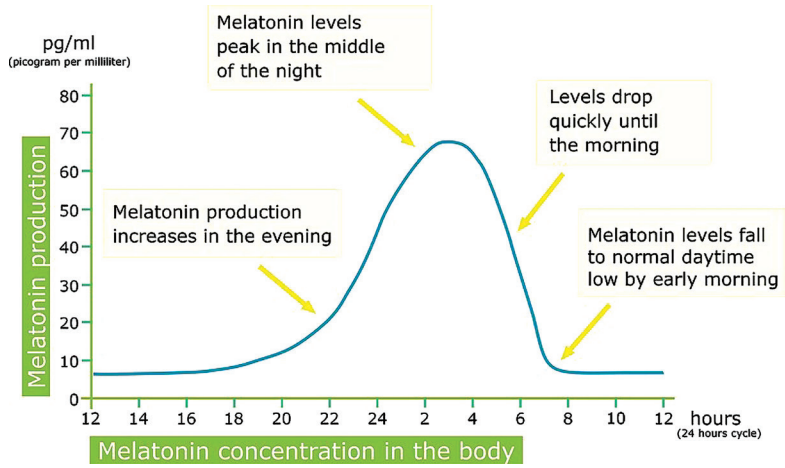


Fig. 2. Changes in melatonin level in blood throughout the day (*Source*: https://upload.wikimedia.org/wikipedia/commons/8/8e/Melatonin_production_in_24_hour_cycle.jpg)

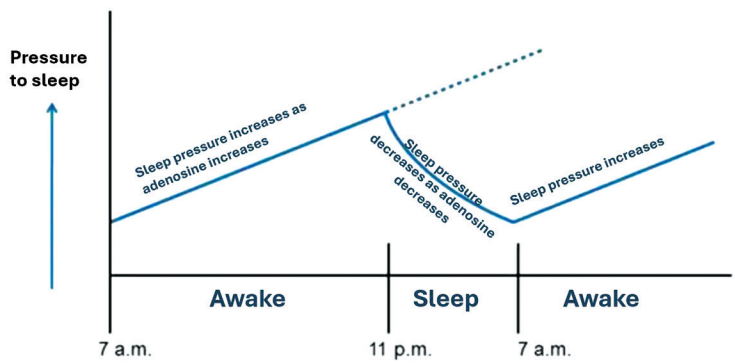


Fig. 3. Sleep pressure rises the longer one stays awake and drops on falling asleep (Modified from https://www.cdc.gov/niosh/work-hour-training-for-nurses/longhours/mod2/11.html)

Other than the circadian rhythm, a different mechanism exists to regulate the sleep-wake cycle, called the sleep drive. Homeostatic sleep drive is basically the body's need for sleep or pressure to sleep. It is low after a good night's sleep and then starts to build up as we awaken (Fig. 3) (Centers for Disease Control and Prevention, n.d.). During waking hours, the brainstem and hypothalamus release chemical messengers that stimulate the cerebral cortex to remain alert and maintain a state of consciousness (Saper, Scammell & Lu, 2005). But throughout the day as neurons break down ATP for energy, the byproduct adenosine builds up, stimulates the sleep-promoting region and drives the pressure to sleep (Tortora & Derrickson, 2021; Halassa et al., 2009).

The depiction of how sleep and wake state are regulated by different regions in the brain is shown in Fig. 4.

Different Phases of Sleep

When we sleep, the state of our brain goes through different phases which can be categorised—Rapid eye movement (REM) and non-REM. Rapid eye movement (REM) sleep is characterised by movement of eyes even though the person is asleep while the absence of random eye movement is a feature of non-REM sleep (Hall & Hall, 2016). This can be monitored by the means of Electroencephalogram (EEG) which measures the electrical activity of the brain (See Box 1 for details) (Hall & Hall, 2016). The non-REM phase is further categorised into three stages. Therefore, sleep is categorised into four phases. The four phases progress in successive, tightly regulated order in a cyclic manner (Fig. 5). On average, a person cycles through these phases four or five times a night.

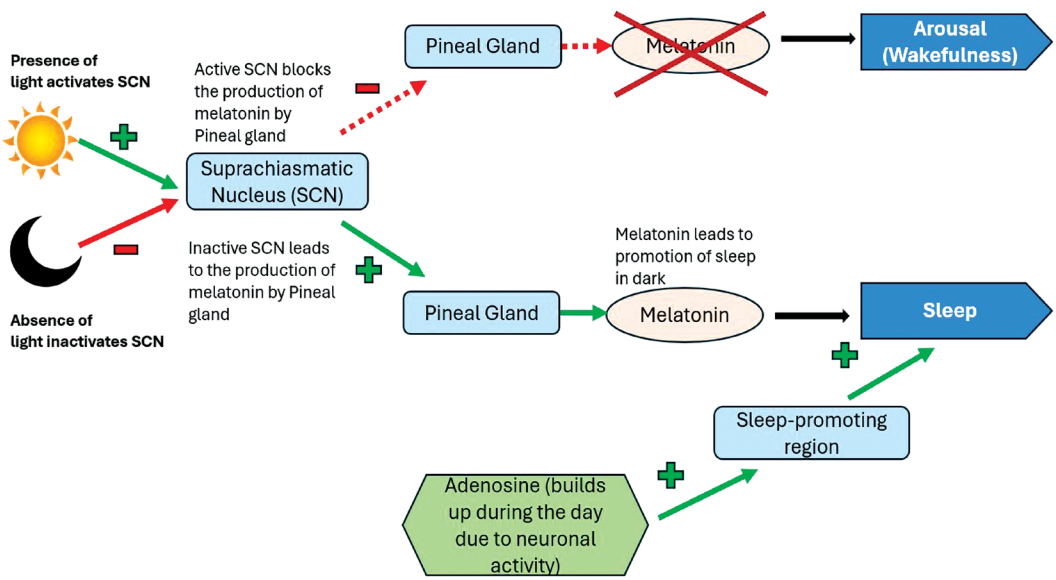
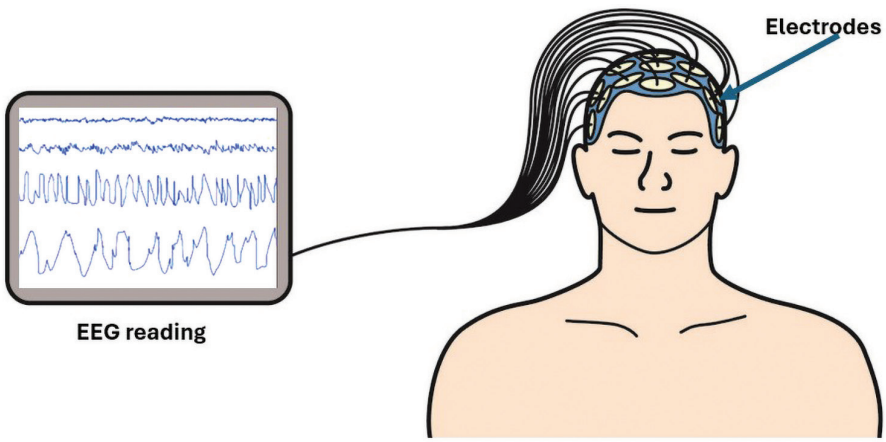


Fig. 4. Regulation of sleep and wake state by different regions in the brain

Box 1

Electroencephalogram (EEG)

Brain comprises billions of neurons that generate nerve impulses. Nerve impulses when taken together at any instant generate electrical signals called brain waves. When sensors called electrodes are placed on the scalp and forehead, these brain waves, especially those generated by neurons present near the brain surface (cerebral cortex) are detected. A record of these brain waves is known as electroencephalogram.



(Image modified from https://www.flickr.com/photos/easy-pics/9408344706)

Phase I: It is the first stage of non-REM sleep which is the transitory phase from being awake to falling asleep (represented by N1 in Fig. 5). This stage of initial light sleep that lasts for several minutes with the heart rate, breathing and eye movement slowing down. Brain waves also begin to slow (National Sleep Foundation, 2021).

Phase II: It is the second stage of non-REM sleep which is also a period of light sleep (represented by N2 in Fig. 5). Heartbeat and breathing slow down and muscles relax. There is also a drop in body temperature and eye movements stop completely (National Sleep Foundation, 2021).

Phase III: It is the third stage of non-REM sleep which we experience as deep sleep (represented by N3 in Fig. 5). It is during this stage that growth hormone is released by cells in the body and the body goes through a phase of repair (National Sleep Foundation, 2021).

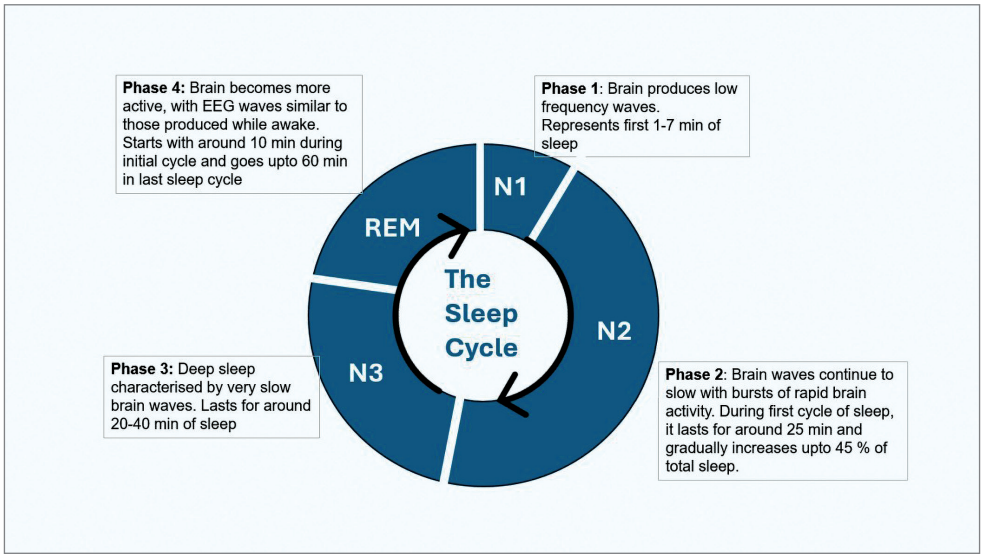


Fig. 5. The sleep cycle

Phase IV: Next stage, known as the REM sleep, is characterised by random movements of eyes behind closed eyelids. It occurs around 90 minutes after falling asleep (Hall & Hall, 2016). The overall brain metabolism may be increased to as much as 20 per cent since the brain is highly active during this stage (Hall & Hall, 2016). Brain wave activity during this stage is identical to that during wakefulness, therefore it is also known as paradoxical sleep (Hall & Hall, 2016). Heart rate and breathing increase but muscles remain paralysed. A pattern of brain waves similar to those that occur during wakefulness are seen in the EEG during this stage (Hall & Hall, 2016).

As mentioned earlier, on an average, a person cycles through these phases four or five times a night. Therefore, in order for a person to have quality sleep it is important that the sleep cycle should not be disrupted. For example, if a person wakes up or is woken up, say when their sleep is in phase 2, then when the person goes back to sleep their sleep cycle will start all over again. Thus the person is not able to reach that much-needed deep sleep stage, i.e., phase 3. Disruption of sleep also impacts the duration and quality of deep sleep stage. However, sleep requirement of a person is also decided by various factors such as the physiological condition of the person, age, profession, etc.

Not just sleep deprivation, disrupted sleep cycle can also lead to detrimental effects on health of a person. The inability to proceed through each sleep stage on a long-term basis has been linked with increased risk of weight gain, cardiovascular disease and metabolic issues such type 2 diabetes (Duffy, Scheuermaier & Loughlin, 2016; Medic, Wille & Hemels, 2017).

Getting a sufficient amount of deep sleep is responsible for feeling revitalised and well-rested the next day. It is also essential for consolidating memories, which is critical to

learning (helps restore connections between neurons that can become overwhelmed during waking hours). The production of growth hormone is increased during deep sleep which helps in muscle repair, bone mineralisation, tissue regeneration as well as enhances the immune function. If a person is awakened during deep sleep, they are likely to experience sleep inertia which is a period of fogginess and disorientation after waking up that can negatively affect thinking and mood. While sleep inertia can be disruptive it normally resolves within an hour of waking up.

However, it may be noted that excess sleep also has its negative impacts.

Disruption in Circadian Rhythm

Just like any other species on this planet, human beings too have evolved to thrive on a 24-hour night and day cycle. Night-time sleep is hypothesised to have been of advantage for early humans as it allowed them to simultaneously avoid predators, conserve energy and meet their need for rest (Freiberg, 2020). However, with the advent of electricity and artificial lighting, sleeping patterns of humans began to alter. In the present time, artificial light illumination has made it possible for us to stay awake at night, beyond what would be considered apt by our biological clock.

This brings us to the question, what happens when we are in the presence of artificial light even during night-time? How does it affect our circadian rhythm and melatonin secretion? In the earlier section we have discussed how the SCN acts as the master clock, syncing the internal body clock with the day-night cycle and the absence of light during night-time acts as a stimulator for melatonin release which plays a vital role in sleep.

Various studies on melatonin levels in people (night-time workers) exposed to artificial light at night showed reduced levels, particularly in people who regularly stay up in the light at night for work or other reasons (Figueiro et al., 2017). Low melatonin levels, in turn, lead to the disruption or misalignment of the sleep-wake rhythm. Besides its role in sleep, melatonin also acts as an antioxidant and affects cardiovascular function and other metabolic processes (Lee et al., 2019).

Results from a number of studies (Filipski et al., 2002; Fu et al., 2002; Filipski et al., 2002; Fu & Lee, 2003) indicate that shifts from the normal circadian rhythm of the secretion of melatonin interfere with metabolism and cardiovascular functions. There is also speculation that low level of melatonin might be a predictor of the future development of hypertension.

What Happens if We are Sleep-deprived?

Inadequate sleep is often perceived to not have any long-term negative consequences. Despite the limited importance given to sleep, decades of research shows that deficient as well as disrupted sleep results in poor physical as well as mental health. There now is unequivocal evidence that sleep plays a critical role in the body's overall normal functioning. It is essential to restore the function of the body at cellular level and adequate sleep is vital for optimal functioning of the body (Tortora & Derrickson, 2021).

Lower metabolic rate and temperature that occur during sleep seem to provide an opportunity for the brain to clear off the metabolites that accumulate when awake

and metabolically active (Sharma & Kavuru, 2010). Over the years, numerous studies have associated inadequate sleep with increases in blood pressure and the incidence, progression, and severity of cardiovascular disease, impaired glucose tolerance (diabetes), reduces leptin and increased ghrelin (obesity), higher cortisol levels (stress), cancer, other metabolic disorders and neuroendocrine abnormalities (Grandner et al., 2016).

The following section discusses the impacts of sleep deprivation on some specific dimensions.

Impacts on Metabolism

Physiological studies reveal that even a week of sleep deprivation can result in a significant alteration in metabolic and endocrine function. The mechanism of sleep deprivation causing metabolic dysregulation may be multifactorial. Sleep deprivation can affect metabolism through changes in regulation of metabolic hormones, fat storing cells and insulin producing cells (Van Cauter et al., 2008; Buxton et al., 2010).

Several studies have documented a relationship between insufficient sleep and diabetes risk. A recent meta-analysis showed that insufficient sleep is associated with a 33 per cent increased risk of incident diabetes (Shan et al., 2015). These studies are supported by laboratory findings that show that physiologic sleep loss is associated with diabetes risk factors, including insulin resistance and other diabetes risk factors, such as increased consumption of unhealthy foods (Tasali et al., 2008). Restricting sleep alters the insulin sensitivity in the body. It changes the way insulin secreted from pancreatic cells signals peripheral tissues to take up sugar.

Poor Mental Health

Sleep deprivation is also linked to poor mental health as observed in certain studies with sleep disruptions being a common diagnostic feature of many mental health disorders (American Psychiatric Association, 2005, pp. 591–643). Short sleep duration is commonly experienced by patients with anxiety and mood disorder (Grandner et al., 2015). It also has been identified as a risk factor for suicide (Chakravorty et al., 2015). Generally, overall mental health of a person has been identified as the primary predictor of self-reported insufficient sleep (Grandner et al., 2015).

Increased Mortality

Early sleep studies on rodents (Rechtschaffen et al., 1989) and dogs (de Manacéïne, 1897) have shown that prolonged sleep deprivation resulted in their death in 2–3 weeks. Though clinical studies of prolonged sleep deprivation cannot be conducted in humans, there is increasing evidence from research in the last few decades that habitually short sleep duration is linked with greater mortality (Grandner et al., 2010; Cappuccio et al., 2010, 2011). But, the mechanisms underlying the process are still not fully understood. Studies have also found that since sleep deprivation contributes to adverse health impacts such as diabetes, cardiovascular disease and obesity, it increases mortality risk in humans (Cappuccio et al., 2010).

Impacts on Cognitive Function

The relationship between sleep loss and neurocognitive function has been an area of interest in sleep research for a long time. Several studies show that with decrease in duration of sleep, attention lapse becomes more common (Banks & Dinges, 2007; Goel,

Durmer & Dinges, 2009). These impairments build up over time and continue to worsen even weeks after, in a controlled setting (Van Dongen et al., 2003). Restricted sleep has also been shown to cause impairments in higher level cognitive functions such as working memory, executive function, processing speed and perception (Killgore, 2010). The association of sleep disturbances and multiple cognitive impairments of dementia has also been pointed out (American Psychiatric Association, 2005, p. 136).

Sleep and Academic Performance

Multiple studies in recent years have shown an association between poor sleep quality and decreased academic performance among almost all subsets of students (children, adolescents, college level) (Gruber, 2016). Poor sleep, increased sleep fragmentation, late bedtimes and early awakenings seriously affect learning capacity, school performance and neurobehavioural functioning (Dewald et al., 2010). Empirical evidence demonstrates an association between sleep and the consolidation of cognitive performance, which is required for executive functioning including abstract reasoning, goal-directed behaviour and creative processing. Sleep-related overnight brain processes are thought to influence cognitive, physical and emotional performance throughout the day (De Valck, Groot & Cluydts, 2003). This is because neural areas that govern emotional regulation and executive functions are sensitive to sleep deficiency (Zohar et al., 2005)

A study utilising wearable wrist devices to monitor sleep found that greater consistency of sleep, sleep quality, and longer duration correlated with better grades and sleep inconsistency correlated with lower academic performance (Okano et al., 2019). These studies highlight that the consistency of sleep and wake patterns have an impact on academic performance.

Another study from India shows a connection between report card grades and sleep. The findings suggest that poor school performance is statistically correlated with poor or inadequate sleep quality rather than academic abilities of the child (Sivakumar et al., 2022). Furthermore, altered sleep habits are strongly correlated with poor academic performance. Cognitive and learning deficits were seen in healthy children after reduced sleep time of even 1 week (Fallone et al., 2005).

In typically developing adolescents, a moderate sleep extension was associated with improvements in daytime sleepiness, anger, vigour, fatigue, confusion and impulsivity (Baron et al., 2021). The findings highlight that even moderate alterations in sleep durations can have resulting observable effects on the academic performance as well as behaviour of students. Hence, extending and improving sleep could be an effective means to maximise the ability of our youth to fulfill their academic potential while also improving their emotional health.

Furthermore, research showed a stronger association between sleep quality and neurobehavioural functioning in younger children than in older children (Sadeh, Gruber & Raviv, 2002). The influence of sleep on prefrontal cortex functions and therefore also on cognitive functioning and school performance is larger during early rather than later adolescence.

We now have enough evidence to show us that sleep is critical for optimal execution of learning, memory, executive functions,

sustained attention, emotional regulation and mood regulation (Sadeh, Gruber & Raviv, 2003; Kopasz et al., 2010; Gruber et al., 2010; Rasch & Born, 2013) all of which are essential for academic success, adjustment and mental health. Collectively, these studies provide unequivocal evidence that sleep plays critical roles in achieving the key goals of education.

Screen Time and Sleep Deprivation in School-aged Children

While different factors play a role in determining the quality and duration of sleep, one major cause that has emerged in recent times as the reason behind delay in bedtime of children is the excessive time spent on electronic devices (Hale & Guan, 2015). A meta-analysis of scientific literature on the association between screen time and sleep outcomes among school-aged children and adolescents found that screen time is adversely associated with sleep outcomes in 90 per cent of studies (Hale & Guan, 2015). A more recent meta-review by Lund et al. (2021) shows that for children aged 6–12 years there is evidence for associations of electronic media usage and delay in bedtime as well as poor sleep quality. While for adolescents (13–15 years), there is evidence for association between screen time and problems falling asleep, and between use of social media and poor sleep quality.

Spending too much time on electronic devices can have adverse consequences for important developmental processes such as sleep. The Indian Academy of Pediatrics recommends that screen time for children aged between 5–10 years should not exceed 2 hours and for adolescents screen time must not replace other activities such as physical activities, sleep, family interaction, etc., that are crucial for overall health and development of the children and adolescents (Indian Academy of Pediatrics, 2021). A recent survey revealed that Indian children on average spend 6.5 hours on their phone and 85 per cent of the students used electronic devices one hour before bedtime (Mathew et al., 2022).

The light emitted from screens of electronic devices, such as smartphones, tablets, and laptops, primarily falls within the blue light spectrum and typically has wavelengths between 400 and 490 nanometres (nm). This shortwave radiation affects the circadian rhythm as well as alertness. Blue light from electronic screens disrupts circadian rhythm through suppression of melatonin onset (Maurya et al., 2022). The intensity of light emitted decreases or decays with the square of the distance from its source. Since portable devices like cell phones and tablets are held closer to the face, they are more likely to emit light intense enough to suppress melatonin release and thereby delay sleep onset as well as reduce sleep duration (Twenge, Hisler & Krizan, 2019). The suppression of melatonin further leads to difficulty in sleep initiation and non-restorative sleep.

Light emitted from electronic screens has also been shown to inhibit melatonin release more in children than in adolescents. A study found that self-luminous tablets (set to full brightness) caused statistically significant melatonin suppression after two hours of use, but not from only one hour (Figueiro and Overington, 2015). Additional research has shown that light has an acute alerting effect in which the dose, exposure duration, timing and wavelength of light evokes an alerting response among humans (Cajochen, 2007).

Screen time spent on social media was also associated with increased likelihood of short sleep duration.

Other than affecting circadian rhythm, screen time adversely affects sleep in two other ways — the first is time displacement with more time spent in front of screens, children have less time available to sleep. Second, psychological and physiological arousal due to the content of the media and social interaction may also interfere with the ability to fall and stay asleep (Cain & Gradiser, 2010).

Current findings show that children with shortened sleep time due to screen time use often experience excessive daytime sleepiness, irritability and higher odds of sleep disorders (Dewald et al., 2010). In some studies it was also found that excessive exposure to screen time is associated with poor psychosocial and physical health of students, with sleep playing a mediating role (Zhao et al., 2018). Further research is needed to establish the health effect of sleep deprivation on children.

Recovery Sleep and Sleep Deprivation

The impact of persistent sleep deprivation is so serious that catch-up or recovery sleep (which is usually done on the weekend) is not an effective way to prevent metabolic dysregulation linked with recurrent or persistent sleep deprivation as was found in a study by Depner et al. (2019). Another study by Ochab et al. (2021) also revealed that cognitive functions of sleep deprived people had not returned to normal even after getting recovery sleep in which the participants were subjected to 4 days of normal sleep, followed by 10 days of chronic partial sleep restriction and subsequently given 7 days of recovery. These studies further consolidates the need to sleep well, and at the same time, the studies also trigger more warnings about the ill-effects of sleep deprivation.

Sleep-related Interventions in Schools

As we have discussed in the earlier section, sleep deprivation adversely affects memory and other cognitive functions of school-aged children. Short sleep duration, poor sleep, sleep disruption and late bedtimes have in multiple studies been shown to negatively impact learning capacity, academic performance and neurobehavioural functioning in school-aged children.

Interventions are needed to make students aware about the significance of sound sleep and the impact of sleep deprivation on health. Because adequate sleep is a core foundation of good health and is reportedly decreasing, sleep education should be an important consideration for school-aged children and adolescents, not only with an intention to rectify sleep hygiene and habits but also to prevent further sleep deprivation from taking place in the first place. Integrating sleep education into school curriculum can be seen as a way to improve sleep health among school-aged children. Such interventions are expected to enhance knowledge regarding the significance of sleep, at the same time help in improving sleep behaviour, habits and related outcomes, including mental health and academic performance (Gruber et al., 2016).

There have been a number of attempts in integrating sleep education into curriculum in Canada and Australia. A recent study from Australia found that sleep knowledge and healthy sleep practices significantly improved post the introduction of a sleep education programme delivered by teachers. Time in bed on both school days and weekends increased slightly and sleepiness decreased slightly, though the changes were not statistically significant (Davis et al., 2022).

Another intervention called "Sleep for Success", a 6-week sleep education programme was developed for integration in classroom curriculum for children of elementary stage in Canada by Gruber et al. (2016). Following participation in the programme, they found that the children's true sleep was extended by an average of 18.2 minutes per night and their sleep efficiency improved by 2.3 per cent, and their sleep latency (time taken to fall asleep) was shortened by 2.3 minutes. Such findings indicate that a sleep education programme can successfully increase students' sleep duration and improve their sleep efficiency. The increase in sleep duration was previously associated with improved daytime functioning among children in studies (Sadeh, Gruber & Raviv, 2003; Gruber et al., 2012).

These studies indicate that sleep duration and quality can be improved by the help of interventions. Successful integration of sleep in curriculum holds the opportunity of having a positive influence not only on the physical and mental health but also on academic performance and overall functioning of students.

Conclusion

As explained earlier under the science of sleep, it is clear that the quality of sleep can be managed to a large extent by following a proper sleep hygiene which is defined as "a set of behavioural and environmental recommendations intended to promote healthy sleep" (Irish et al., 2015). However, as mentioned earlier, the concepts related to sleep and sleep hygiene have not been included in the curriculum in the past or in the existing curriculum. An analysis of Science textbooks developed by the National Council of Educational Research and Training (NCERT) since 1979 such as Class IX Science textbook (NCERT, 1979), Class X Science textbook (NCERT, 1980), Class XI Biology textbook (NCERT, 1988), Class VI Science textbook (NCERT, 2006a), Class VII Science textbook (NCERT, 2007a), Class VIII Science textbook (NCERT, 2008), Class IX Science textbook (NCERT, 2006b), Class X Science textbook (NCERT, 2007b), Class XI Biology textbook (NCERT, 2006), and Class XII Biology textbook (NCERT, 2007) reveal the same. The only times anything about sleep was mentioned prior to the National Curriculum Framework 2005 (NCF 2005) were in Class X Science textbook under the heading "Exercise, Relaxation and Habits" which mentioned "Regular exercise is also necessary to keep the body and mind fit, particularly for SEDANTARY workers (work done mostly sitting). So is regular sleep and relaxation." (NCERT, 1989, p. 82); in Class IX Science and Technology textbook where it was also mentioned in the context of "Exercise and Relaxation" which mentioned "...The duration of sleep also varies with age and nature of work of the individual" (NCERT, 2002, p. 183); and in Biology Class XII textbook under the head "Mental Health" wherein "insomnia (lack

of sleep) or excessive sleeping" is listed as one of the symptoms for mental illness (NCERT, 2003, p. 338). Similarly, textbooks developed by NCERT subsequent to those have also not included the concept of sleep in Science and Biology textbooks except for some stray mention of the word sleep in different contexts, which have little to do with the concept of sleep per se (NCERT, 2006b, pp. 181, 184; NCERT, 2007, p. 161; NCERT, 2007a, pp. 108, 111; NCERT, 2008, pp. 33, 73, 167). The treatment of the concept of sleep is no better in the National Curriculum Framework for School Education 2023 (NCF-SE, 2023) in spite of the fact that "Physical Education and Well-being" have been introduced as a curricular subject. While it would have been appropriate to introduce sleep as an overarching theme that not only influence the physical capacities but mental, emotional and social capacities as well, in this document, sleep has been mentioned only in the context of "Knowledge of physical self and capacities" (NCERT, 2023, p. 423). The only other time sleep was mentioned in NCF-SE 2023 was in the context of "Managing Classrooms or Student Behaviour" wherein "lack of sleep" was mentioned as one of the reasons for students' inappropriate behaviour (NCERT, 2023, p. 108). Such exclusion or lack of interest to include sleep as an overarching concept in the curriculum is surprising since with the increase in sleep-related health issues in the society, especially amongst adolescents, the least one would expect is the emphasis of sleep and the related concepts in the curriculum.

With students increasingly spending extended period of time on electronic devices such as computers, phones and other devices, and top it up with other stressors in their day-to-day life, it is likely that their quality of sleep will be compromised even more, which will have adverse impacts on their well-being. It is, therefore, inevitable for students to learn the basics of sleep and the importance of sleep hygiene. This can be best done by integrating it in the curriculum at different stages appropriately. For example, up to Grade 8, the curriculum may include sleep hygiene so that students are engaged in discussions, sharing personal experiences, projects, etc., which will enable them to develop good sleep habits. This may be included in the appropriate subject and grade. From Grade 9 onwards, in addition to sleep hygiene, the curriculum may also consider including sleep science, so that just like any other life processes such as respiration, digestion, circulation, etc., students understand the basics of sleep science. Through this, they may be engaged in critical thinking about the various factors that affect sleep.

With 44, 83, 14, 000 of its population under the age of 18 (NIPCCD, 2018), which is roughly 31.6 per cent, India is blessed with this valuable asset in the form of human resource. The contributions of these highly potential young people in nation-building will be crucial. However, their ability to contribute meaningfully will depend on their personal well-being, and thereby the well-being of the society, for which quality sleep will play an important role, as discussed earlier. Therefore, inclusion of sleep in the curriculum is the need of the hour, and not a choice that we have.

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