REVIEW ARTICLE

Review on Physiology of Sleep and Factors Affecting Good Sleep Hygiene in Children

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Abstract

Sleep is a dynamic process in the human body that plays an important influence on various functions. Recent researches are exploring the field of sleep to understand the development, the process of the sleep/wake cycle, in an attempt to understand sleep-related disorders. In addition to understanding the sciences behind sleep disorders, understanding how sleep is integral to development and functioning helps in optimizing sleep to its fullest to aid in better functional outcomes. This is of particular importance in children due to their inability to communicate the decline in their functioning capacity and attribute it to their disturbed sleep patterns as like adults. Significant changes have been noted between various countries and hence the influence of various societal and cultural norms were identified. The impact of poor sleep on physical functioning, mental and psycho-social health is very well emphasized. Since children are more vulnerable to electronic devices and other habits that disrupt the good quality of sleep, it becomes the responsibility of the parents and pediatricians to understand the benefits of regular sleep habits and sleep hygiene.

Keywords: Sleep hygiene, Sleep patterns, Sleep latency.

Annals of SBV (2021): 10.5005/jp-journals-10085-8135

Introduction

Sleep is an important and dynamic part of human growth and development. During sleep multiple functions of the human body like the growth of the cells, consolidation of memory, and other restorative processes of cell function take place.[1] Thus, sleep is important for physiological, behavioral adaptation, and various neurocognitive processes. Hence, the disruption in the quality of sleep produces symptoms related to these domains.[2]

Children do not identify their disturbances in sleep and are less likely to report the decline in optimal function. This might have a negative impact on the children's growth, development, functional activity, and performance.[3] It can also cause mood-related changes, attention deficit, irritability, and impulsivity. In this review, we highlight the physiology of sleep, its effect on the growth and functions of the body, and the factors affecting it in children so that suitable measures can be taken to improve the same.

Materials and Methods

An electronic search strategy was used to select the studies from different databases like PubMed, Google scholar, SciELO. A combination of keywords like sleep hygiene and sleep patterns was used. A total of 44 articles were found relevant. The selected studies were further assessed for the quality of the research and included in the review.

Sleep Evolution

In the neonatal period, sleep is divided into three main phases which are quiet sleep, active sleep, and indeterminate sleep. The differentiation into rapid eye movement (REM) and non-REM sleep occurs by 2 months post-gestation, evidenced by the appearance of sleep spindles on the electroencephalography (EEG). By 5–6 months of age, sleep can be classified into N1, N2, and N3 and REM as like in older children and adults.[4] N1 and N2 are light sleep and N3 is slow wave or deep sleep.[5] As children grow, sleep cycles lengthen, percent of REM and N3 sleep decreases, total sleep hours decrease with increased fragmentation and decreased REM as seen in adult life. The dyssynchrony between sleep phase and societal demands, results in insufficient sleep in children causing day time sleepiness, reduced academic performance, problems with mood and promotes risk taking behaviors.[6]

Physiology of Sleep

Sleep is regulated by two distinct systems—the circadian system and the sleep/wake homeostasis. The suprachiasmatic nucleus of the hypothalamus controls the circadian rhythm between wakefulness and sleep.[7] The sleep/wake homeostasis is the body's internal neurophysiological drive toward either sleeping or waking.[8] With increasing wake hours, sleep debt increases, leading to accumulation of sleep promoting substances, which are called somnogens. Adenosine is one such somnogen and it promotes sleep by inhibiting arousal. Caffeine acts by blocking these adenosine receptors and hence helps in arousal.[9]

Sleep alternates between REM and NREM sleep. This balance between arousal and sleep is regulated through a network of activation and suppression of neurological pathways. The following are the four major pathways that are involved in the sleep–wake

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How to cite this article: Maniraj P, Jegadeesan P, AnanthaKrishnan S. Review on Physiology of Sleep and Factors Affecting Good Sleep Hygiene in Children. Ann SBV 2021;XX(X):1–5.

Source of support: Nil

Conflict of interest: None

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cycle, which are arousal promoting elements of the reticular activating system:

- Glutaminergic and cholinergic neurons originating in the upper brainstem projecting to thalamic relay centers and exciting widespread cortical regions.
- Noradrenergic and dopaminergic neurons from the upper brainstem and caudal hypothalamus directly ascending to broad regions of the cortex.
- Histaminergic projections from the posterior hypothalamus to the cortex.
- Relative deactivation of gamma-aminobutyric acid (GABA) projections from the ventrolateral preoptic nucleus of the anterior hypothalamus.[5]

Apart from this, environmental exposure to light helps to maintain the circadian rhythm for close to 24 hours.[6] The light stimulus is processed in the suprachiasmatic nucleus and then the pineal gland is stimulated to produce melatonin.[10] The serum levels of the melatonin hormone rise just before the sleep onset. The timing of release tends to shift to a later period during the adolescent age group, causing a "phase delay" leading to later sleep and wake times.[7] With the change in physiological mechanisms occurring in adolescents, the usage of various electronic devices which are blue light-emitting devices further delays the bedtime of the children and in the long run causes a disruption between the biological and social clock.

Sleep Ontogeny

Developmental aspects of sleep should be understood which will helps us in understanding the pathology behind various sleep-related disorders.[5] A preterm infant by 27–28 weeks can differentiate wakefulness from sleep, as evidenced by the EEG patterns. At this age, 80% of the total sleep time is REM sleep characterized by irregular respiratory pattern, intermittent electromyographic activity, and low-voltage mixed-frequency EEG activity. By term (40 weeks), time spent in quiet sleep increases, and the duration of REM sleep decreases to 50%. Sleep spindles and K complexes reflect the maturation of thalamocortical activity by 2–3 months of age in term infants. By 4–6 months in a term infant, non-REM sleep gets differentiated into N1, N2, and N3 sleep stages. During the N3 sleep stage, short-term memories stored in the hippocampus become consolidated into long-term memories.[11]

Sleep, Growth, and Development

The relationship between the hypothalamic–pituitary–adrenal axis is important for human growth and development. N3 phase of sleep suppresses cortisol release but is closely related to the secretion of growth hormone. As the amount of N3 sleep decreases with age so does the secretion of growth hormone. Sleep is also related to the normal development of puberty. Gonadotropin-releasing hormone is secreted at high levels during the neonatal period following which the secretion is suppressed. At the onset of puberty, there is again a sleep-entrained reactivation of GnRH, with the resulting sex steroids secreted at peak levels during the REM phase of sleep. Hence, any disturbances in the sleep phases will affect the normal development of the body.[12]

Optimal Duration of Sleep Recommended

The optimal duration recommendations by various organizations are mentioned below.

- According to the consensus statement from the American Academy of Sleep Medicine, the optimal duration is,[13]

4–12 months: 12–16 hours (total sleep duration including daytime naps).

1–2 years: 11–14 hours (total sleep duration including daytime naps).

3–5 years: 10–13 hours (total sleep duration including daytime naps).6–12 years: 9–12 hours.

13–18 years: 8–10 hours.

- The National Sleep Foundation Advisory Council based on its 2014 Sleep in America Poll, recommends 9–11 hours for school age children and 8–10 hours for teenagers as the optimal needed duration of sleep.[14]

Quality of Sleep

The sleep quality of children is predominantly opined by the parents based on the disturbance in their sleep. If a child does not disturb the parents' sleep, it is said to have a good sleep. Hence, an objective way for defining sleep quality was formed by National Sleep Foundation based on sleep latency, the number of prolonged awakenings, wake after sleep onset, and sleep efficiency.[15]

Sleep Latency

Sleep latency, the duration between lights out or bedtime to the time the child falls asleep. It is considered as an acceptable measure of sleep quality from 4 months of age onward. A sleep latency of $\leq$15 minutes is considered a good indicator of sleep latency. Prolonged sleep latency causes the child to have a late bedtime and thereby reduced sleep duration. Later bedtimes are particularly associated with overweight and obesity and lower cognitive performance among children.[16]

Night Awakening

Four or more night-time awakenings are considered not indicative of good sleep quality for all age groups, except for teenagers where three awakenings are used as cut-off values. Waking after sleep onset >41 minutes is not indicative of good sleep for school-aged children and young adults, but in teenagers 51 minutes is the cut-off value.[15]

Cross-cultural Differences

Sleep is determined by various factors including cultural and biological and it is the interaction of these factors that determine the establishment of developmental norms for the child's sleep.[17] Asian countries like India are found to have a late bedtime than the other countries. This could be because of the reason that in Asian countries like India, where co-sleeping is practiced, when both parents are working, they tend to have a later bedtime, thereby affecting the bedtime of the child.[18] Indian practices like nursing the child or rocking the child to sleep are found to have negative associations and were found to be associated with behavioral insomnia in the children. Also, the children from the Asian countries were found to have more daytime naps which ultimately equaled the total hours of sleep needed for a day.[19] It has been reported in the same study conducted by Mindell et al. that Asian parents were generally found to report more sleep problems in their children than the rest. It indicates that parental concerns regarding sleep vary significantly across the countries, hence in countries like India, while evaluating for sleep patterns and the associated problems, it must be kept in mind that, parents could actually perceive more sleep problems in their children than that actually is present.[20]

Factors Affecting Sleep

Nocturnal Enuresis

Nocturnal enuresis was associated with various sleep problems like frequent night awakenings and excessive daytime sleepiness.[21] The same was found in a study conducted by Anyanwu et al. in Nigerian children, where children with nocturnal enuresis were found to have more bedtime problems and frequent night awakenings.[22] In a study conducted by Cohen-Zrubavel et al., where the sleep disturbances were documented by actigraphy and it has been found that nocturnal enuresis affected the sleep pattern of the children by causing more frequent night awakenings and increased sleep latency.[23]

Caffeine Usage

Caffeine is the most widely used and abused psychoactive substance in the world. It is a stimulant and the sleep disruptive efforts are produced by the blockade of adenosine receptors. Plasma levels peak after 30 minutes of administration and the half-life is around 3–7 hours. The half-life is influenced by individual differences in their metabolism. Hence, intake of caffeine during later parts of the day is generally not advised since it disrupts the quality of sleep. Children who took caffeine daily were found to have reduced total sleep time compared to their peers.[24] Caffeine helped adolescents stay awake at night but because of the disruption in sleep, it causes excessive day time sleepiness.[9]

Sleep and Television Viewing

Sleeping late at night in the adolescent age group has been attributed to homework, spending time with friends, late-night television viewing, video games, and internet surfing.[25] Television viewing displaces sleep time and thereby decreasing the total sleep duration and also affecting the sleep efficacy and sleep latency.[26] Children who engage in television viewing tend to spend less time playing outside or engaging in other habits thereby affecting the quality of sleep.[27] The content of the television programs, like those simulating violence affects sleep by causing difficulty in falling asleep and causing anxiety and night awakenings. The content viewed causes bedtime resistance in the children causing a reluctance to fall asleep.

Television viewing as a bedtime sleeping aid has also been seen in many children and it was found to have significant sleep disturbances. Passive exposure to television affects the younger children because of their underdeveloped abstract thinking skills, because of which they do not differentiate between fantasy and reality. They become vulnerable to the influences of media. When children were allowed to wake up at their own time and where there were no regulations on the television watching, children were found to get up earlier than the wakeup time of their counterpart, to buy extra time to indulge in television watching.[24]

Co-sleeping

Co-sleeping, the practice of parent and child sleeping together alongside is a common practice in India, whereas, in industrialized western countries, that is often not encouraged. Because it is thought that co-sleeping affects their individualization. With respect to sleep problems, co-sleeping is thought to be both a problem and a solution to sleep-related disorders. In families where parents adopt a healthy sleeping habit, it is found to impact the child's sleep also by an increased sense of security and decreased incidence of nightmares in families practicing co-sleeping.[28] In families with poor sleep hygiene where the parents sleep late or often awake late at night watching television in the bedroom, it is found to affect the quality of the child's sleep also.[29]

It is not clear by literature as to whether there is any benefit or harm to children by co-sleeping, as supported by an 18-year-old longitudinal study conducted by Okami et al., where it was found that it was neither of any particular benefit nor of any harm. Hence suggested that co-sleeping can be practiced as a part of cultural practices.[30]

Sleep Hygiene

Sleep hygiene could be defined as modifiable parent and child practices that promote good sleep quality in the child, allows sufficient sleep duration, and prevents daytime sleepiness.[24] Hygiene practices cover large domains like the sleep environment of the child, the sleep routine, and the various daytime activities that could affect sleep.

A commonly recommended sleep hygiene practice is to maintain a consistent timing for bedtime, wake-up time, and nap time.[5] Several factors have been mentioned by Gregory Stores which includes providing a familiar sleeping environment with a comfortable bed in a darkened, quiet room with the correct temperature and encouraging consistent bedtime and waking up time, and avoiding caffeine-containing drinks during the latter part of the day.[31]

Screening Tools

There are various screening tools used to assess sleep habits,

- BEARS screening tool.
- Brief Infant Sleep Questionnaire.
- Children's Sleep Habits Questionnaire.
- Pediatric Sleep Questionnaire.
- Sleep Disturbance Scale for Children.

The BEARS screening tool stands for bedtime issues, excessive daytime sleepiness, night awakenings, regularity and duration of sleep, and sleep-disordered breathing. It was formed as a user-friendly scale, to enable physicians to obtain more information pertaining to each of the acronyms. It was developed by the investigators of Brown University School of Medicine, Rhode Island Hospital, USA.[32]

In a study conducted by Ravikiran et al., the BEARS screening tool was used to analyze children from rural India who reported any illness to the hospital. It was found that 51% of the study population enrolled were found to have at least problems in one of these domains, emphasizing the existence of sleep-related disorders in our country.[33] Similarly in a study conducted in Tehran, the BEARS screening tool was used to screen children and a high prevalence of sleep problems was identified in both pre-school and school-aged children.[34]

Sleep and BMI

The relationship between sleep and BMI remains unclear. Recent studies from the literature suggest that sleep deprivation might disrupt hormones that are involved in appetite and metabolism, causing reduced levels of leptin, increased levels of ghrelin that is often associated with a hunger for carbohydrate-rich foods.[35] The association between lesser sleep duration and increased risk of diabetes has been found with blood investigations like blood glucose levels, HbA1c, leptin, and insulin levels which were elevated in children with less sleep duration.[36] Similar findings

Table 1: Studies showing an association between various factors affecting sleep hygiene

Study author	*Study group*	*Study population*	*Type of the study*	*Key result*
Dayal et al.[45]	School going healthy children between 4 years and 12 years of age	572 children	Observational	Prevalence of sleep disorders 51%. Co-sleeping was found in 81%. Poor academic performance was found in 47.5% of children
Li et al.[29]	Children aged 5–11.92 years old from eight cities in China	20,505 children	Cross-sectional	Prevalence of frequent nocturnal awakening was 9.8%
O'Dea et al.[46]	Students from 10 primary schools in grades 2–6	939 students	Prospective	BMI increased with reduced duration of sleep
Ravikiran et al.[33]	Children aged 2–12 years who attended pediatric outpatient of a rural medical college hospital	513 children	Cross-sectional	Prevalence of sleep disorders was 51.1%. BEARS screening tool was used to identify the problems in the various domains
Barathy et al.[11]	In children aged 5–12 years, every 5th child who attended OPD was included in the study	650 children	Cross-sectional	Prevalence of the sleep problem was 51.1%. Co-sleeping was seen in 97.5%. Reduced physical activity/exercise was significantly associated with sleep problems
Ebarhim et al.[34]	Children aged 2–12 years were selected based on their clustered randomization of families in Tehran based on their zip codes	746 children	Cross-sectional	BEARS screening tool used to assess the sleep problems in various domains. The most common problem identified was excessive daytime sleepiness

were emphasized in the study conducted by O'Dea et al. where an inverse relationship between sleep duration and levels of BMI was established.[37] Though the relationship between sleep and obesity has been documented and is still a choice of research in various studies, it is not clear whether the disruption of the hormonal balance has a direct impact on metabolism or whether they affect food selection or activity choices.[38]

Sleep and Academic Performance

Studies have hypothesized that declarative memory is consolidated during NREM sleep and procedural memory is consolidated during the REM phase of the sleep cycle.[39] Poor sleep habits have been linked to poor academic performance as evidenced by various studies.[40] The hypothesized mechanisms include decreased sympathetic system activity causing a decreased alertness, lack of voluntary control, decreased decision making with changes in mood and emotions.[38] Studies conducted by Meijer and Wittenboer have found that chronic sleep deprivation has an impact on the cognition of the children thereby affecting the academic performance of the children.[41]

In countries like India, children face increasing academic challenges with advancing grades, hence leading to more time spent on homework and mental stress leading to sleep deprivation, as demonstrated in the study conducted by Geethu Mathew et al. in Kerala, India.

Sleep and Overall Health

The established consequences of sleep deficit on health include metabolic dysregulation and cardiovascular morbidity, using an increase in body weight which when associated with poor physical activity will contribute to a higher risk of obesity. In the adolescent population, it is often associated with an increase in blood pressure and other somatic outcomes like fatigue and headache.[42] It has been well documented that sleep deprivation results in depressive symptoms and recently associations with suicidal ideation and suicidal attempts have been found in sleep-deprived adolescents.[6]

A study was conducted by Sadeh et al. by restriction of sleep experimentally in children, to assess the neurobehavioral functioning. It was found that delay in going to bed by even an hour makes significant differences in various aspects of functioning.[2] These findings are further emphasized by the systematic review of various studies regarding sleep conducted by Shochat et al. It was found that sleep restriction had a negative impact on various aspects of functioning like behavior, emotion, and attention, representing a cognitive impairment.[43] These findings were further emphasized and supported by the systematic review done by Galland et al.[44] (Table 1).

Conclusion

Sleep is an active and dynamic state which has a great influence on the daytime functioning of humans. Understanding the need for good sleep hygiene, the pathophysiology behind the sleep disorders could help in developing appropriate interventions for various sleep disorders and also ascertain the impact of sleep hygiene on adolescence and emotional disorders. Sleep research is continuously expanding, drawing more and more attention for sleep-related studies. It is well known that each individual's body does not react in the same way to sleep loss. Hence pediatricians should discuss sleep habits and adoption of a regular bedtime routine during routine visits to prevent sleep-related problems.

References

1. Curcio G, Ferrara M, De Gennaro L. Sleep loss, learning capacity and academic performance. Sleep Med Rev 2006;10(5):323–337.
2. Sadeh A, Gruber R, Raviv A. The effects of sleep restriction and extension on school-age children: what a difference an hour makes. Child Development 2003;74(2):444–455.
3. Perkinson-Gloor N, Lemola S, Grob A. Sleep duration, positive attitude toward life, and academic achievement: the role of daytime tiredness, behavioral persistence, and school start times. J Adolesc 2013;36(2):311–318.
4. Sukumaran TU. Pediatric sleep project. Indian Pediatr 2011;48(11):843–844.

5. Beebe DW. A brief primer on sleep for pediatric and child clinical neuropsychologists. Child Neuropsychol 2012;18(4):313–338.
6. Alfonsi V, Scarpelli S, D'Atri A, Stella G, De Gennaro L. Later school start time: the impact of sleep on academic performance and health in the adolescent population. Int J Environ Res Public Health 2020;17(7):2574.
7. Kotagal S, Pianosi P. Sleep disorders in children and adolescents. BMJ. 2006;332(7545):828–832.
8. Bathory E, Tomopoulos S. Sleep regulation, physiology and development, sleep duration and patterns, and sleep hygiene in infants, toddlers, and preschool-age children. Curr Probl Pediatr Adolesc Health Care 2017;47(2):29–42.
9. Calamaro CJ, Mason TBA, Ratcliffe SJ. Adolescents living the 24/7 lifestyle: effects of caffeine and technology on sleep duration and daytime functioning. Pediatrics. 2009;123(6):e1005–e1010.
10. Touitou Y, Reinberg A, Touitou D. Association between light at night, melatonin secretion, sleep deprivation, and the internal clock: health impacts and mechanisms of circadian disruption. Life Sci 2017;173:94–106.
11. Kotagal S. Sleep-wake disorders of childhood. Continuum: Lifelong Learn Neurol 2017;23(4):1132.
12. Carter JC, Wrede JE. Overview of sleep and sleep disorders in infancy and childhood. Pediatr Ann 2017;46(4):e133–e138.
13. Pediatrics AA. Recommended amount of sleep for pediatric populations. Pediatrics [Internet] 2016;138(2): Available from: https://pediatrics.aappublications.org/content/138/2/e20161601.
14. 2014 Sleep in the Modern Family [Internet]. Sleep Foundation. [cited 2021 Feb 22]. Available from: https://www.sleepfoundation.org/professionals/sleep-americar-polls/2014-sleep-modern-family.
15. Pelayo R. Commentary on national sleep foundation sleep quality recommendations. Sleep Health 2017;3(1):20–21.
16. Nixon G, Thompson J, Han DY, Becroft D, Clark P, Robinson E, et al. Falling asleep: the determinants of sleep latency. Archives of disease in childhood 2009;94:686–689.
17. Jenni OG, O'Connor BB. Children's sleep: an interplay between culture and biology. Pediatrics. 2005;115(1 Suppl):204–216.
18. Social and Demographic Predictors of Preschoolers' Bedtime Routines | Request PDF [Internet]. [cited 2021 Feb 22]. Available from: https://www.researchgate.net/publication/247588135_Social_and_Demographic_Predictors_of_Preschoolers%27_Bedtime_Routines.
19. Mindell JA, Sadeh A, Kwon R, Goh DYT. Cross-cultural differences in the sleep of preschool children. Sleep Med 2013;14(12):1283–1289.
20. "My child has a sleep problem": A cross-cultural comparison of parental definitions | Request PDF [Internet]. [cited 2021 Feb 22]. Available from: https://www.researchgate.net/publication/51037080_My_child_has_a_sleep_problem_A_cross-cultural_comparison_of_parental_definitions.
21. Esposito M, Gallai B, Parisi L, Roccella M, Marotta R, Lavano SM, et al. Primary nocturnal enuresis as a risk factor for sleep disorders: an observational questionnaire-based multicenter study. Neuropsychiatr Dis Treat 2013;9:437–443.
22. Anyanwu O, Ibekwe R, Orji M. Nocturnal enuresis among Nigerian children and its association with sleep, behavior and school performance. Indian Pediatr 2015;52(7):587–589.
23. Cohen-Zrubavel V, Kushnir B, Kushnir J, Sadeh A. Sleep and sleepiness in children with nocturnal enuresis. Sleep. 2011;34(2):191–194.
24. Mindell JA, Meltzer LJ, Carskadon MA, Chervin RD. Developmental aspects of sleep hygiene: findings from the 2004 national sleep foundation sleep in America poll. Sleep Med. 2009;10(7):771–779.
25. Cespedes EM, Gillman MW, Kleinman K, Rifas-Shiman SL, Redline S, Taveras EM. Television viewing, bedroom television, and sleep duration from infancy to mid-childhood. Pediatrics 2014;133(5):e1163–e1171.
26. Fobian AD, Avis K, Schwebel DC. Impact of media use on adolescent sleep efficiency. J Dev Behav Pediatr 2016;37(1):9–14.
27. Owens J, Maxim R, McGuinn M, Nobile C, Msall M, Alario A. Television-viewing habits and sleep disturbance in school children. Pediatrics. 1999;104(3):e27.
28. Mishra A, Pandey R, Minz A, Arora V. Sleeping habits among school children and their effects on sleep pattern. J Cari Sci 2017;6(4):315–323.
29. Cortesi F, Giannotti F, Sebastiani T, Vagnoni C. Cosleeping and sleep behavior in Italian school-aged children. J Dev Behav Pediatr 2004;25(1):28–33.
30. Okami P, Weisner T, Olmstead R. Outcome correlates of parent-child bedsharing: an eighteen-year longitudinal study. J Dev Behav Pediatr 2002;23(4):244–253.
31. Stores G. Children's sleep disorders: modern approaches, developmental effects, and children at special risk. Dev Med Child Neurol 1999;41(8):568–573.
32. Owens J, Dalzell V. Use of the "BEARS" sleep screening tool in a pediatric residents' continuity clinic: a pilot study. Sleep medicine 2005;6:63–69.
33. Ravikiran SR, Kumar PMJ, Latha KS. Sleep problems in preschool and school aged rural Indian children. Indian Pediatr 2011;48(3):221–223.
34. Ebarhim A, Babak G, Alimohammad A, Shabnam J, Alireza A, Forough F. High prevalence of sleep problems in school- and preschool-aged children in Tehran: a population based study. Iran J Pediatr 2013;23(1):45–52.
35. Snell EK, Adam EK, Duncan GJ. Sleep and the body mass index and overweight status of children and adolescents. Child Develop 2007;78(1):309–323.
36. Rudnicka AR, Nightingale CM, Donin AS, Sattar N, Cook DG, Whincup PH, et al. Sleep duration and risk of type 2 diabetes. Pediatrics. 2017;140(3):e20170338.
37. Lytle LA, Pasch KE, Farbakhsh K. The relationship between sleep and weight in a sample of adolescents. Obesity. 2011;19(2):324–331.
38. Howie EK, Joosten J, Harris CJ, Straker LM. Associations between meeting sleep, physical activity or screen time behaviour guidelines and academic performance in Australian school children. BMC Public Health 2020;20(1):520.
39. Peigneux P, Laureys S, Delbeuck X, Maquet P. Sleeping brain, learning brain. The role of sleep for memory systems. . Neuroreport 2001;12(18):A111–A124.
40. Walker MP, Stickgold R. Sleep, memory, and plasticity. Ann Rev Psychol 2006;57(1):139–166.
41. Meijer AM, Wittenboer G. The Joint contribution of sleep, intelligence and motivation to school performance. Personal Individ Differen 2004;37:95–106.
42. Kosticova M, Husarova D, Dankulincova Z. Difficulties in getting to sleep and their association with emotional and behavioural problems in adolescents: does the sleeping duration influence this association? Int J Environm Res Pub Health 2020;17(5):1691.
43. Shochat T, Cohen-Zion M, Tzischinsky O. Functional consequences of inadequate sleep in adolescents: a systematic review. Sleep Med Rev 2014;18(1):75–87.
44. Galland BC, Taylor BJ, Elder DE, Herbison P. Normal sleep patterns in infants and children: a systematic review of observational studies. Sleep Med Rev 2012;16(3):213–222.
45. Dayal R, Kumar P, Garg N, Kumar D, Sinha V. Sleep disorders and their effect on academic performance in school going children. Indian J Pediatr 2017;84(6):487–488. DOI: 10.1007/s12098-017-2321-5.
46. O'Dea JA, Dibley MJ, Rankin NM. Low sleep and low socioeconomic status predict high body mass index: a 4-year longitudinal study of Australian schoolchildren: Low sleep and low SES predict high BMI. Pediatric Obesity 2012;7(4):295–303. DOI: 10.1111/j.2047-6310.2012.00054.x.