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Consequences of Short Sleep Duration or Poor Sleep in Young Children

Dominique Petit, PhD, Jacques Montplaisir, MD, PhD, CRCPc

Center for Advanced Research in Sleep Medicine, Centre intégré universitaire de santé et de services sociaux du Nord-de-l'île-de-Montréal – Hôpital du Sacré-Cœur de Montréal and Université de Montréal, Canada

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Introduction

Sleep is a major factor in a child's overall development. Yet the total duration of sleep among children (and even among very young children) is decreasing from one decade to the next.[1] A growing number of studies are showing that poor sleep, or sleep of insufficient duration, has deleterious consequences in all areas of child development.

Subject

The expressions "to sleep like a baby" or "to sleep like a child" are synonymous with having an excellent sleep. Yet epidemiological studies carried out in several countries around the world tell us that a significant percentage of young children have sleep problems. In fact, between one quarter and one third of children aged 1 to 6 years are reported to have sleep problems.[2-6] This prevalence is lower when estimated by pediatricians.[7] The two types of dyssomnias most common

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in young children are frequent night wakings and sleep onset problems (either bedtime resistance or difficulty falling asleep).

At 6 months of age, infants have the physiological maturity to sleep at least six consecutive hours during the night. This is what parents call “sleeping through the night.” In fact, studies from the Quebec Longitudinal Study of Child Development (QLSCD) show that about 75% of children in Quebec sleep through the night at 5 months.[8] If this “learning” is delayed for too long and the child is still not sleeping though the night at 18 months, the chances of the child becoming a good sleeper without any intervention decrease significantly.[8] It is normal for children to wake up spontaneously during the night. A study using videosomnography[9] showed that children between ages 1 and 3 years wake up about three times a night. The difference between a “good sleeper” and a “poor sleeper” is the child’s ability or inability to fall back asleep on his own after a nocturnal awakening. The good sleeper will self-soothe and fall back asleep quickly. The “poor sleeper” will signal his awakenings to his parents by crying (or by calling them), creating a high level of physiological activation and also prolonging the waking time through interaction with the parent. A study carried out using the QLSCD data[8] showed that 2-and-a-half-year-olds who had not learned to sleep through the night slept, on average, at least 1 hour 22 minutes less per night than good sleepers of the same age. This loss of sleep was not compensated by more sleep time during the day (naps); both groups slept about 2 hours during the day. Therefore, young children who have not learned to sleep through the night often have a chronic lack of sleep. The learning of independent sleep habits begins at bedtime. Children who learn to fall asleep on their own at bedtime know they will be able to fall back asleep on their own after a nocturnal waking.

Dyssomnia criteria adapted to young children have been established to guide clinicians.[10] For frequent night wakings, the occurrence of two or more signalled wakings per night (in children age 12 to 23 months) or one or more signalled awakenings per night (in children age 2 or over) constitutes a sleep disorder if it has been occurring every night (or almost every night) for more than one month and if the time spent awake totals at least 20 minutes. Children are considered to have a sleep onset problem if it takes them more than 30 minutes to fall asleep at age 12 to 24 months or more than 20 minutes to fall asleep at age 2 years or over. As well, a child is considered to have a sleep onset problem if a parent must stay with him until he falls asleep or if the child demands the presence of a parent more than two times an evening at the age of 12 to 23 months or more than once an evening at the age of 2 years or over.

Recent Research Results

Does fragmented sleep or sleep of insufficient duration really have measurable harmful consequences in children? The results of several recent studies show that insufficient sleep has a major impact in several areas of child development.

Sleep and behaviour

Lack of sleep manifests itself differently in preschool children than in adults. While adults display apathy and yawning, young children will display hyperactivity, irritability and a lower tolerance threshold. In children, short sleep duration and sleep problems are associated with behaviour problems.[11,12] Data from the QLSCD[13] showed that children who slept less than 9 hours before age 3 (even if the amount of sleep increased thereafter) were more likely to have a high score on the hyperactivity-impulsivity scale at 6 years than children who had slept at least 10 hours throughout their early childhood. This longitudinal study, which examined a myriad of variables linked to child development, allowed for the control of factors that could have influenced this relationship. Another longitudinal and population-based study found that short sleep duration (≤10 hours) and frequent nocturnal awakenings (≥3 times) in 18-month-old children predicted concurrent and later behavioural problems at 5 years.[14]

Sleep and socioemotional development

Emotional regulation (or control) and emotional information processing are cornerstones of social competence. Yet, studies have shown that insufficient sleep affects emotional control and emotional information processing in children and adolescents.[14-17] Moreover, short sleep duration and nocturnal awakenings in toddlers were associated with social-emotional problems in a dose-response manner.[18] When compared to children with consolidated sleep, those with fragmented sleep displayed higher awakening cortisol levels and this correlated with higher ratings of negative emotionality.[16] We also noted more aggressive behaviours in 6-year-old children with sleep-onset difficulties that had persisted up to that age.[19]

Sleep and cognitive development

Several studies have shown that sleep deprivation affects the cognitive performances of adults. This relationship is less known in children but it is nonetheless very real and begins very early in their development.[20-22] It has been observed, for example, that the time slept at 12 to 18 months is associated with several executive function skills, such as working memory, impulse control and mental flexibility.[20] A study derived from the QLSCD[13] also shows that even short-term sleep

deprivation at a young age (before 3 years) leads to deficits in verbal cognitive abilities (Peabody Picture Vocabulary Test) and non-verbal cognitive abilities (Wechsler Block Design subtest) later on (at ages 5 and 6). This effect of deprivation was still present after controlling for several potentially confounding variables such as birth weight, breastfeeding, parental age and education level, parental immigrant status, socioeconomic level, etc. Toddlers sleeping within the recommended 11-14 hr had more favorable cognitive development at age 6 compared with toddlers sleeping less than 11 hours or more than 14 hours.[23]

Sleep and language development

Language development has a cognitive basis and, consequently, is altered by sleep deprivation. The sleep-wake circadian rhythm at 7 months is predictive of language abilities at age 3.[21] A recent study carried out in twins[24] showed that poor sleep consolidation (calculated by the ratio of daytime to night time sleep) at 6 and 18 months was associated with poorer language skills 3.5 years later. This study also revealed that at 6 months, sleep consolidation is mostly determined by genetic factors, while at 18 months it is mostly determined by environmental factors. For example, it was shown that parental behaviours surrounding the sleep period of the young child were environmental factors that affected the child's sleep.[8] The results of this study[24] also suggest that sleep continues to play a role in language development throughout early childhood.

It seems that adequate sleep helps structure the foundations of language beginning at 6-7 months of age and fosters its development throughout early childhood. This suggests that the higher faculties, such as cognitive abilities and language, are dependent on proper development of physiological processes such as sleep organization, very early in the child's life.

Sleep and healthy weight

As afore-mentioned, children are sleeping less and less from one generation to the next, mainly because of later bedtimes.[1] Parallel to this, the incidence of childhood overweight and obesity is growing exponentially nearly everywhere in the world, especially in industrialized countries. Are these two phenomena related? Independent of several factors potentially associated with overweight, data from the QLSCD showed that for children who had generally slept 9 hours or less per night throughout early childhood (from 2.5 to 6 years), the risk of overweight or obesity at age 6 was four times greater than for children who had slept 11 hours per night during this same period.[25] This association was also shown in adults (see reference [26] for a review) and in

younger children.[27] In fact, short sleep duration from 6 months to 2 years is a risk factor for overweight even at 3 years of age.[27] The mechanism underlying this relationship is becoming better understood. Even partial sleep deprivation leads to a deficit in glucose metabolism and changes the circulating levels of hormones such as ghrelin and leptin.[26] It has been shown that partial sleep deprivation carried out in a laboratory (4 hours of sleep) for two consecutive nights was enough to increase the secretion of ghrelin (appetite hormone) and to decrease that of leptin (satiety hormone).[28] This had the effect of increasing not only overall appetite, but especially appetite for carbohydrates. Moreover, it was shown that a trajectory of short sleep duration during early childhood was associated with less favourable dietary intakes at 6 years (e.g., lower consumption of fruits and vegetables and higher consumption of soft drinks).[29] In addition, boys who had had shorter sleep durations in early childhood were also more likely, at 6 years of age, to eat at irregular hours, or to eat too much or too fast, than boys with longer sleep duration patterns.[29]

Childhood obesity is now a major public health concern, owing to its high prevalence and its association with many health problems such as diabetes, hypertension, cardiovascular diseases, chronic inflammation, bone deformations, orthopedic complications, hepatic sclerosis, precocious puberty, polycystic ovaries in girls and hypogonadism in boys, asthma, sleep apnea, exercise intolerance, not to mention low self-esteem and depression.[30] Given all these potential consequences of childhood obesity and the fact that, in 60 to 85% of cases, it tracks into adulthood,[31] it is imperative to prevent obesity in children. Ensuring that children get an adequate amount of sleep is one easy step in this direction. Notably, the relationship between increased sleep duration and decreased odds of being overweight or obese is particularly strong for children of low early socioeconomic status.[32] In addition to favouring a healthy weight, sufficient sleep would benefit several other areas of development.

Key Research Questions

The existence of a critical period at an early age for the beneficial effects of sleep requires further exploration. Sleep in the first three years of life is characterized by a very high percentage of REM sleep which occupies 50% of the sleep time of newborns and about 30% of sleep time from 6 months to 3 years, compared to rates of 20 to 25% after age 5. The percentage of *REM sleep* of a species is a function of its neonatal maturity (for a review, see reference [33]), which suggests that REM sleep plays a role in brain and body development. We know that human beings are very immature at birth compared to other animal species. Could this be the reason for

this critical period?

By what physiological mechanisms does sleep influence development? What are the most important key elements: the total duration of sleep, the duration of nocturnal sleep only, consolidation (that is, non-fragmentation) of sleep, the duration of certain sleep phases (slow-wave sleep, REM sleep)? Are these elements different for different aspects of development? We now know, for example, that naps are essential to the development of various abilities in early childhood because the nighttime sleep is too far removed from the learning moments at this age to allow their transfer into memory; without naps, the new information is lost.

It would also be important to study dyssomnias caused by chronic health problems or slower biological maturation (linked to the genetic component found at 6 months) and to verify whether these lead to different consequences than those resulting from poor sleep habits (commonly called behavioural insomnia).

Conclusions

It now appears evident that sleep, of good quality and of sufficient duration, is a cornerstone of normal physical, cognitive, language and emotional development. The National Sleep Foundation's updated recommendations[34] are that newborns (0-3 months) sleep 14-17 hours per 24 hrs, infants (4-11 months) sleep 12-15 hours per 24 hrs, toddlers (1-2 years) sleep 11 to 14 hours per 24 hrs, and preschoolers (3-5 years) sleep 10-13 hours per 24 hrs . The data from the QLSCD tell us that a sufficient amount of sleep for children age 6 months to 3 years is crucial for an optimal development. Otherwise, certain unfavourable and irreversible effects on development occur even if the sleep duration later becomes normal. This suggests the existence of a critical maturation period of the nervous system during which sleep plays a key role. It is therefore vital to treat severe dyssomnias as early as possible to foster optimal development in children.

Implications for Policy and Services

It is of utmost importance that the entire population be informed about the crucial role of sleep in young children's development so that there is rapid intervention when a problem is detected. To foster sleep health in general, a bilingual Canadian public health campaign on sleep was launched in September 2019. The goal of this awareness campaign is to demystify sleep for the public, promote its importance, offer solutions to deal with sleep disorders and make healthy

sleep a public health priority. The campaign website[35] presents, in a simple and original way, scientifically valid knowledge.

Early detection of sleep problems requires setting up monitoring structures adapted to pediatric populations. It would therefore be highly desirable for people working in pediatric and family services to receive extensive training on the prevention, detection and treatment of dyssomnias in young children. In fact, a new form of therapy has come into existence over the last 2 decades. Online evaluation and intervention programs are being established, given the paucity of easily accessible specialized services in pediatric sleep medicine. In Canada, an online intervention program called “Better Nights/Better Days: A program for parents with children who have sleeping problems”[36] has been developed through the collaboration of researchers and clinicians from various provinces. It has even been adapted to treat insomnia in children with obstructive sleep apneas and in children with neurodevelopmental disorders. There is still much to be done, however, to respond to this urgent need.

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