

Evidence Brief: Effects of inadequate sleep on the health of 0-19 year olds



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Issue and Research Question

Adequate sleep is known to play an important role in the health and well-being of children and youth. The Centers for Disease Control and Prevention note that there is no 'magic number' for an adequate amount of sleep as individuals' (children and adults) sleep needs vary.¹ The National Heart, Lung and Blood Institute in USA recommends 16 to 18 hours a day for newborns, 11 to 12 hours a day for pre-school aged children, at least 10 hours a day for school-aged children and nine to 10 hours a day for teens and seven to eight hours a day for adults.² However, a US national survey of children under 10 years old showed the mean number of hours children slept at night for infants, toddlers, preschoolers, and school aged children were only 9.0, 9.8, 9.6, and 9.4 hours, respectively.³ A meta-analysis found that children with shorter sleep duration have greater odds (58%) of becoming overweight or

obese.⁴ Thus, the impacts of inadequate sleep in children are of interest to public health.

There are different types of inadequate sleep. Sleep disruption (also known as sleep fragmentation) is associated with increased awakenings during sleep, reduced deep sleep, and can occur in children due to sleep walking, nightmares or selected medical conditions.^{5,6} Sleep restriction refers to the reduced sleep duration from required length of sleep time or partial sleep deprivation (often due to work, lifestyle or medical conditions).⁵ Total sleep deprivation refers to sleep loss of at least one night to prolong wake time such as a shift worker may experience.⁵

This Evidence Brief asks: What are the impacts of inadequate sleep on the whole child? What are the effects of strategies or interventions to promote adequate sleep as a preventative measure for overweight/obesity?

For the purpose of this review, whole child refers to the consideration of all aspects of the child's physical, mental/cognitive, and social well-being. This concept is based on the World Health Organization's definition of health, which refers to a complete state of physical, mental and social well-being.⁷

Methods

Two Ovid MEDLINE literature searches for reviews and primary studies and published between 2000 and 2014 were conducted between March 17, 2014 and March 20, 2014 by a Research Librarian. The first search focused on the health effects of inadequate sleep in children, and the second search focused on the impacts of sleep strategies for adequate sleep, or sleep-related interventions for the prevention of overweight/obesity.

English-language articles retrieved by the searches were assessed for eligibility by PHO staff. Titles and abstracts were screened by one reviewer. Full text articles were retrieved and reviewed, and relevant information was extracted from each article. The full search strategy can be obtained from PHO. Additional articles provided by field experts were also included

For the first search, articles that focused on the relationship between adequate sleep and physical, mental/cognitive and/or social health in children and/or adolescents 0-19 years of age were included.

For the second search, articles that examined the effects of adequate sleep strategies, initiatives or interventions targeting sleep behaviours in children and youth 0-19 years of age, which reported overweight or obesity-related outcomes (i.e., weight, Body Mass Index) were included. Relevant protocols were also included. Association studies or studies examining specific illnesses such as Sudden Infant Death Syndrome (SIDS) were excluded.

Main Findings

Impacts of inadequate sleep on the whole child

The first search identified 118 articles, of which only 15 articles (10 reviews and five primary studies) met inclusion criteria and were reviewed in more detail. Primary studies were included if their publication date was later than the review-level evidence.

Inadequate sleep in children and adolescents can impact the whole child in various ways, which include cognitive performance^{8,9}, behaviour problems^{8,10}, memory^{11,12}, school performance^{8,9} and risk of overweight and obesity.^{4,13-20}

A growing body of evidence supports the relationship between sleep duration and cognitive performance (for ages 5-17 year olds), as reported by two systematic reviews.^{8,9} These meta-analyses indicated that sleep duration was linked to less sleepiness and had a significant positive correlation with cognitive performance; specifically, on executive functioning, school performance, and multiple-domain cognitive functioning. However, the meta-analyses did not find any association between sleep and intelligence, sustained attention or memory.^{8,9}

Only two of the 15 included articles examined the impact of sleep restriction^{11,12}, one of which was a primary study.¹² The literature has shown mixed results on sleep restriction and cognitive effects for a brief period of time (one to three nights^{11,12}). An experimental study conducted by Potvin et al., (2012) found that adolescents ages 10-14 years old had a 20.6% increase in declarative memory (memories that are consciously recalled, e.g. factual information¹¹) following sleep compared to the group that had no sleep.¹² In contrast, a review by Kopasz (2010) indicated that a brief period of sleep restriction children and adolescents (ages nine to 15 years old) did not affect declarative memory function; impairment only occurred with prolonged sleep restriction or total sleep deprivation.¹¹ The ability to compensate for short periods of sleep restriction leads to the

question of the extent of sleep restriction that can be tolerated without cognitive impairment.

There is also limited literature on the effect of adequate sleep on behaviour, only two articles including one review were identified.^{8,10} A meta-analysis by Astill et al., (2012) showed that shorter sleep duration is associated with more behavioural problems, both internalizing and externalizing, in children ages five to 12 years old.⁸ Similarly, a cross-sectional study by Chen et al. (2006) proposed that adequate sleep plays an important role in the health status and health-related behaviours of adolescents ages 13 to 18 years old.¹⁰ The study found inadequate sleep during schooldays was significantly inversely associated to the following health status related factors: life appreciation, taking responsibility for own health, obtaining a healthy diet, stress management, and regular exercise for 30 minutes at least three times per week.¹⁰

Nine of the 15 included articles examined the relationship between sleep duration and development of overweight and obesity in children and adolescents^{4,13-20}, which is well-documented in the literature. Both systematic and critical reviews have shown that short sleep duration is strongly associated with an increased likelihood of obesity (age range from the reports included 2-19 years).^{4,13-16} Two meta-analyses estimated that children with shorter sleep duration were more likely to be obese (by 58 and 89%, respectively).^{4,16} Furthermore, a systematic review reported the likelihood of obesity increased to 92% when children with the shortest sleep duration were compared to children with longer sleep duration. A significant inverse, dose-dependent relationship was found between increased sleep and lower likelihood of overweight or obesity; however this was only in children ages under 10 years old.⁴ Review-level evidence has also shown that short sleep duration in early life is correlated with increased weight gain and likelihood of obesity in adolescence and adulthood.^{4,13,15,17,18} In addition, two primary studies, not included in those reviews, found inadequate and irregular sleep schedules were

associated with overweight and obesity in children and youth.^{19,20}

Effects of Adequate Sleep Interventions for the Prevention of Overweight and Obesity.

The database search examining the effects of interventions for adequate sleep on the prevention of overweight and obesity identified four papers (three protocols and one primary study) that met the inclusion criteria²¹⁻²⁶. Two additional primary studies^{22,23} provided by the field experts were also included for a total of six articles relating to interventions for adequate sleep. Review-level evidence was not available to address the impact of interventions for sleep.

Sleep hygiene refers to behavioural and environmental factors that precede sleep and may interfere with sleep.²⁷ Sleep hygiene behaviours (such as consistent bedtime, regular routines, and dark and quiet household conditions) were associated with each other (i.e., individuals employing one sleep hygiene strategy were more likely to employ several sleep hygiene strategies), and were more common in the high socioeconomic status compared to the low socioeconomic status group.²⁸

Tan et al., (2011), examined the effects of a sleep hygiene educational program called F.E.R.R.E.T (Food, Emotions, Routine, Restrict, Environment and Timing) targeting children and youth 10-18 years old with self-identified sleep problems.²¹ A private 90-minute education session with participants and one of their parents covered three main sleep hygiene categories (sleep routine, sleep environment and eating and drinking habits before bedtime). The session provided three simple rules for each category to encourage good sleep. Sleep, anthropometric and accelerometer data were collected at pre- and post-intervention intervals. They found that sleep quality, sleep hygiene and sleep disturbance improved significantly (all p-values < 0.01) post intervention. Additionally, participants' BMIs decreased significantly (p=0.001) post

intervention (16% decrease). Lastly, accelerometer data indicated a significant decrease in participants' sedentary behavior during the day, which may be due to the decrease in sleepiness.²¹ Overall, findings suggest that a sleep hygiene education program may be effective for improving sleep and reducing BMI; however, results should be interpreted with caution since additional components of the study such as food and drink restrictions before bed may have contributed to this outcome.

In a crossover design study, children ages eight to 11 years old were alternated to a different sleep duration condition each week for three weeks: typical amount, increase or decrease by 1.5 hours per night.²² The study demonstrated that increased sleep duration was linked to significantly decreased caloric intake, fasting leptin level, and weight. However, there were no differences in children's desire to earn food rewards or fasting ghrelin level. The evidence showed the importance of understanding the association of sleep duration and weight status in children.²²

Haines et al., (2013) conducted a randomized control trial (RCT) to improve household routines known to be associated with childhood obesity in low income and ethnic minority families with children ages two to five years.²³ The home-based intervention included four home visits, four coaching telephone calls, mailed educational material, weekly text messages and incentives aimed to promote eating meals together, adequate sleep, limited TV time and removing TV from the child's bedroom.²³ The intervention had significant impacts on increasing sleep duration and decreasing weekend TV viewing, but not on the frequency of eating family dinners, weekday TV viewing or removing TV from bedrooms. Nevertheless, child BMI was decreased in the intervention group (mean of 0.18) and increased in the control group; (mean of 0.21), and this effect was not statistically significant ($p = 0.05$).²³

Protocols outline methods for studies that are planned or ongoing. The search strategy identified three RCT protocols combining sleep, diet and physical activity components into one intervention targeting obesity related factors for infants, toddlers and children.²⁴⁻²⁶ These three RCT protocols were included in this Evidence Brief due to the limited primary study evidence, and as emerging evidence to watch for in future. The first protocol study evaluates the effectiveness of early childhood obesity prevention interventions delivered to mothers in late pregnancy and the first two years of their infant's life. The three intervention groups included anticipatory guidance, extra education and support to encourage 1) positive diet and physical activity behaviors, 2) appropriate sleeping patterns, or 3) both interventions combined.²⁵

The second protocol study aims to prevent overweight in children two to six years old by providing families with optional individual guidance in optimizing diet and physical activity habits, reducing chronic stress and stressful events and improving sleep quality and quantity.²⁴ Anthropometric data (height and weight) are measured.

The last RCT protocol study by Sobko et al., (2011) called Early STOPP (STOCKHOLM Obesity Prevention Program) targets overweight and obese parents with infants. The intervention, delivered to the parents when the infants are one year old and ends when they are six years old, addresses obesogenic behaviours such as unhealthy eating, physical inactivity and disturbed sleeping patterns.²⁶ Specifically, the intervention coach provides advice on healthy food choices and eating patterns, increasing physical activity/reducing sedentary behavior and regulating sleeping patterns.²⁶ BMIs of the children are assessed at one and six years of age.

Together with existing evidence, these future studies will help identify the influence of sleep interventions in the prevention of overweight and obesity; however, because of the multicomponent nature of the interventions

(additional diet and physical activity components) it may be difficult to isolate the contribution of the sleep components alone.

Discussion and Conclusions

Overall, findings suggest that inadequate sleep in children and adolescents is associated with cognitive functioning impairments as well as increased likelihood of obesity and development of behaviour problems. The literature evaluating interventions targeting sleep behaviours for the prevention of overweight and obesity is limited in quantity and also limited in its ability to isolate the effects of the sleep components alone.

Implications for Practice

The link between inadequate sleep and obesity is well established in the literature. These findings are important public health implications on the growing concerns for the childhood obesity epidemic. Adequate sleep behaviour may be an important strategy to prevent or reduce childhood obesity.⁴ There is limited evidence on promoting adequate sleep as a preventive strategy for childhood obesity; more randomized interventions are needed to evaluate the impact of sleep behavior on obesity.

The impact of inadequate sleep on areas such as behavior problems, memory or school performance has received less attention. Given the variety of studies targeting different types of inadequate sleep and outcome; it is difficult to draw immediate conclusion on the consistency of the association. Future studies, such as longitudinal studies, are needed to better understand the impact of different variables and gain more knowledge on the variety of relationships. This research can provide valuable inputs to develop interventions or programs that improve those outcomes by changing sleep behaviour.^{8,9,11,12}

Specifications and Limitations

This Evidence Brief presents key findings from the best available evidence. Its purpose is to investigate a research question in a timely manner to help inform decision making. This report is not a comprehensive review of the literature, but rather a rapid assessment of research evidence. There may be relevant studies that are not included and these may alter the conclusions drawn from the document.

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