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Review Article

Sleep Disorders in Children: A Narrative Review

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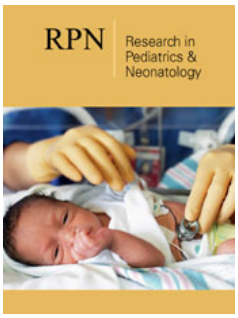
ISSN: 2576-9200



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Submission: March 29, 2024
Published: May 01, 2024

Volume 8 - Issue 2

How to cite this article: Tiffany Field*. Sleep Disorders in Children: A Narrative Review. Res Pediatr Neonatol. 8(2). RPN. 000683. 2024. DOI: 10.31031/RPN.2024.08.000683

Abstract

The recent literature on sleep disorders in children has primarily focused on prevalence data and on predictors/risk factors. Sleep disorders have typically been parent-reported or measured by actigraphy. The prevalence rates starting at 0-1 year of age have been highly variable, ranging from a low of 12% in New Zealand to a high of 72% in South India, a variability that may relate to different types of sleep data and/or cross-cultural variation as well as demographic differences. Negative effects of sleep disorders have included depression and academic performance problems. Predictors/risk factors have included parental sleep problems, parental overprotection, excessive screen time and comorbidities like ADHD. Only a couple interventions could be found in this recent literature on sleep in children including cognitive behavioral therapy and melatonin. Potential underlying mechanisms for sleep disorders in children include pre and perinatal melatonin deficits in the children's mothers and concordance in parent and child sleep patterns. Although the data highlight the severity of sleep problems in children, they have been primarily based on parent-report surveys that have yielded mixed results across samples.

Introduction

Sleep disorders reflect both behaviorally based (e.g. insomnia) and medically based sleep diagnoses (e.g. sleep disordered breathing) (Lupini et al, 2023). This review is focused on the behaviorally based sleep disorders and includes 48 papers that were derived from a search on PubMed and PsycINFO using the terms sleep disorder and 2019–2023. Exclusion criteria included case studies and non-English language papers. The publications can be categorized as prevalence data, negative effects of sleep disorders, predictors/risk factors for sleep disorders, interventions, and potential underlying biological mechanisms. This review is accordingly divided into sections that correspond to those categories. Although some papers could be grouped in more than one category, 14 papers are focused on prevalence, 12 on negative effects of sleep disorders, 24 on predictors/risk factors, 6 on Interventions and 2 papers on potential mechanisms.

Prevalence of sleep disorders in children

The prevalence of sleep disorders in children ranges widely from a low of 12% in New Zealand to a high of 72% in South India (see Table 1). However, most researchers have reported a prevalence ranging from 30 to 40%. Much of this variability is related to different demographics of the samples as well as different measures of sleep disorders. For example, in a paper entitled, "Chronic insomnia of early childhood: phenotypes and pathophysiology", insomnia was categorized as 3 different types: 1) insomnia with motor restlessness; 2) no difficulty falling asleep, but early morning awakening; and 3) difficulty falling asleep and several awakenings [1].

Although 14 to 17 hours of sleep have been recommended for infants, in the U.S. more than 20% of caregivers report that their infants are receiving less than 10 hours and less than 12 hours in Japan and less than 13 hours in New Zealand [2]. By school age (6 to 11 years-old), as many as 55% of caregivers say their kids are getting less than nine hours of sleep.

In the very low incidence study from New Zealand (N= 6288), 12% of children received less than 11 hours of sleep and 17% experienced night waking [3]. The researchers noted that these

sleep problems were associated with excessive consumption of soft drinks/snacks/fast foods/milk/cheese/yogurt as well as excessive screen time and exposure to maternal smoking. Less risk was noted in those who consumed vegetables.

Table 1: Prevalence of sleep disorders in children (and first authors).

Prevalence	First Author
12% insufficient, 17% night waking-New Zealand	Rio-Hernandez
72% sleep disorder-South India	Sivakumar
74% varying by age-oldest (5-12-yr-olds) most severe	Tedford
63%> 1 insomnia symptom, 85% > 1 poor sleep health behavior	Williamson
33% insufficient sleep	Lin
35% sleep problems	Mindell
22% infants and 55% insufficient sleep	Reynolds
66% insomnia and 38% insufficient sleep noted by caregivers and 10% insomnia and 0% insufficient sleep noted by clinicians	Carson
51% nightmares, 26% night terrors in foster children	McGlinchey
39% sleep problems in Colombia	Ruiz
36% insomnia in children with ADHD	Sciberras
4% hypersomnia, 2% sleep terrors	Lin
17-21% sleep terrors	Laganiere
1-7% sleep terrors	Leung

At the other extreme of prevalence data, 72% of children from South India were reported to have sleep disorders (N= 791) [4]. This high prevalence was based on being above the cut point (41) on the Children's Sleep Habits Questionnaire. The researchers related this high prevalence to excessive screen time (21% engaging in more than two hours per day of screen time), being overweight (10%), bedtime resistance, sleep anxiety, night waking, sleep disordered breathing, parasomnias and daytime sleepiness. Although they didn't mention overconsumption of unhealthy food and inadequate exercise, those were likely additional contributory factors.

An even higher prevalence was reported at 74% (N=218) (Tedford et al, 2022). But this prevalence significantly varied by age of the children with 46% for the zero to one-year-old children, 67% for the 2 to 4-year-olds and 85% for the 5 to 12-year-olds. The highest prevalence in the oldest group was surprising as children would be expected to normalize their sleep patterns as they developed. As might be expected, a similarly high prevalence was reported for 3-year-old children (Williamson et al, 2021). In this sample (205 caregiver-child dyads), 63% of the children had more than one insomnia symptom and 85% had more than one poor sleep health behavior.

The prevalence of sleep disorders in children has more frequently ranged from 30-40%. In the National Survey of Children's Health in the U.S. (N=4609 youth 4-17 years-old), for example, 33% experienced insufficient sleep [5]. Surprisingly, a similar prevalence of sleep problems (35%) was noted for very young children (N=2219, range =0-3 years old, mean age= 14 months) based on the Brief Infant Sleep Questionnaire (Mindell et al, 2022). This low prevalence for very young children might relate to 96% of the caregivers expressing their desire for a change in their child's sleep patterns, with 76% suggesting they wanted a change in three or more categories including falling asleep (80%), night waking (67%) and napping (74%). These data were similar for the children of the different age groups and countries in this sample.

Discrepancies have been noted between caregiver-reported childhood sleep problems and those reported by clinicians. For example, in a sample of maternal caregivers (N= 170 caregiver child dyads, mean age=3.3 years with a range of 2–5 years), as many as 92% reported at least one sleep problem (66% insomnia, 64% electronics, 38% insufficient sleep, 21% caffeine and 17% snoring) [6]. But as few as 20% of clinicians for these families reported children's sleep problems (10% insomnia, 7% electronics, 0% Insufficient sleep, 3% caffeine and 4% snoring). Most of the caregivers apparently had not reported their children's sleep problems to their pediatricians and the clinicians apparently were not screening for sleep problems in their pediatric patients. This sample was atypical of most in the literature by being skewed demographically with as many as 64% of the caregivers being black and as few as 20% being non-Hispanic white.

More severe sleep problems have been noted by foster caregivers (N=485 foster caregivers in the U.S., mean age child=6 years, range= 4 to 11 years) [7]. These included insomnia (defined as 46 minutes to falling asleep), staying asleep (34 minutes awake), moving to someone else's bed (86%), nightmares (51%), night terrors (26%), snoring (33%), bed wetting (32%), and teeth grinding (22%). These authors also noted increased fear and anxiety at bedtime, which likely contributed to the children's sleep problems, although these were not submitted to a regression analysis to determine the amount of variance in sleep problems that was explained by each of these emotions. Although depression has been a variable in this literature, fear and anxiety are rarely mentioned let alone measured.

Other factors like income and comorbid conditions have contributed to a greater prevalence of sleep disorders. For example,

in a study on children living in low-income urban areas in Colombia (N= 1989 6 to 12-year-olds), 39% had sleep problems [8]. And in a sample of children with ADHD (N= 392 5 to 13-year-old youth), insomnia was experienced by 36%, difficult sleep onset problems by 25%, anxious/bedtime resistance by 11% and overnight apnea and parasomnias by 5% [9]. Those children who had bedtime resistance and insomnia had more emotional and conduct symptoms, anxiety problems as well as greater ADHD and their parents also had mental health problems. Those with anxious bedtime resistance had comorbid depression and teacher-reported symptoms. As these are cross sectional data, not longitudinal data, directionality cannot be determined. Likely the sleep and emotional/behavioral problems are bi-directional with each exacerbating the other.

Some more serious problems leading to medical conditions have been reported by researchers using polysomnography for diagnosing pediatric sleep problems. For example, in one study, obstructive sleep apnea was noted in 51%, snoring in 26%, limb movement sleep disorder in 8%, hypersomnia in 4%, central apnea in 3%, enuresis in 2%, narcolepsy in 2%, and sleep terrors in 2% [5]. These data highlight the sensitivity of polysomnography which used to be a cumbersome and costly measure, although recently wearable measuring devices like fit bits and smart watches have made this measure more convenient.

In a study on sleep terrors, their frequency was recorded at six-month intervals from 12 to 36 months and the Child Behavior Checklist was given at 48 and 60 months (N=324) (Laganiere et al, 2022). Sleep terrors were associated especially with emotionally reactive, anxious/depressed and somatic complaints. The prevalence of sleep terrors ranged from 17 to 21% and remained stable across early childhood. The stability of the sleep terrors across early childhood in this rare longitudinal study highlights the importance of longitudinal studies and the need for early interventions.

In a review on sleep terrors, a prevalence of one to 7% was noted in 1 to 12-year-olds, although most commonly in children between four and 12 years of age [10]. The sleep terrors most frequently occurred during stage three or four of non-– rem sleep. These children were in a high arousal state experiencing hyperventilation, rapid heartbeat, flushed faces, dilated pupils, agitation and tremulousness. The authors suggested that children who were frequently experiencing this should be awakened an hour before the expected episode. However, parents are not likely to follow this advice because of the difficulty getting their children to sleep again.

Negative effects of sleep disorders in children

Several researchers have suggested that insomnia (problems with initiating and maintaining sleep) is one of the most prevalent disorders in children. Many negative effects have been reported for sleep disorders in children (see Table 2). These include lower quality of life, negative affect, internalizing behavior, emotional and behavior problems, impaired academic performance, eating behavior changes leading to obesity and health problems in fathers.

In a study on sleep change effects on Health-Related Quality of Life Scale in healthy children from New Zealand (N= 100 children 8–12 years of age), sleep restriction of one hour and sleep extension of one hour were assessed using actigraphy for a week, and the PROMIS sleep disturbance scale and the health-related quality of life scale were administered [11]. Sleep restriction resulted in 39 minutes less sleep than sleep extension as well as less sleep disturbance at night, but greater sleep impairment during the day and lower health-related quality of life.

Table 2: Negative effects of sleep disorders in children (and first authors).

Negative Effects	First Authors
Lower quality of life	Taylor
Emotional overeating and undereating	Morrison
Social jetlag	Giannoumis, Chao, Sun
Internalizing and externalizing behaviors	Giannoumis, Williamson
Inferior academic performance	Sun, Sivakumar
Depression	Marino
<health in fathers,>depression in mothers	Coles

In a randomized controlled trial (N= 105 12-year-old children), sleep restriction of one hour later was conducted for seven nights and sleep was measured by actigraphy [12]. Sleep restriction resulted in emotional overeating as well as undereating.

In a study on children less than six years of age (N=78), 25% had social jetlag (discrepancy between circadian and social clocks or between sleep on weekdays and weekends) [13]. Social jetlag was greater in preschoolers. Greater sleep duration was correlated with negative affect, which in turn contributed to internalizing behavior (e.g. depression or low self-esteem). Similarly, in the study on caregiver child dyads, 85% of the children had more than one poor sleep health behavior, including insomnia. When insomnia was combined with other risk factors, internalizing behaviors as well as externalizing behaviors resulted [14].

In another study on social jetlag among preschoolers, social jetlag was defined as the difference between the sleep midpoint on weekdays and the midpoint on weekends [15]. Those preschoolers with greater social jetlag had more emotional behavior problems based on the Strengths and Difficulties Questionnaire (N= 27, 200 children 3 to 6 years of age).

In a review of 72 studies from Asia, the difference between sleep duration during the week and sleep duration on the weekend was associated with emotional and behavior problems including depression (Sun et al, 2019). This difference was also related to inferior academic performance, overweight/obesity, substance abuse and suicidality.

And in a study from South India, 72% of the sample (N=791 children) received scores above the cut point (41) on the Children's Sleep Habits Questionnaire [4]. Ninety-three percent of those children had received C grades in the previous term.

In a paper entitled "Assessing bi-directional, longitudinal associations between disturbed sleep and depressive symptoms in children, the sample was drawn from the Quebec Longitudinal Study of Child Development (N =1689) [16]. A bi-directional association was noted between disturbed sleep and depression. Disturbed sleep included shorter sleep duration, time awake in bed, daytime sleepiness, sleep talking and walking, night terrors, and nightmares.

Children's Sleep Habits Questionnaire has also been associated with fathers' health and well-being in a systematic review of 29 studies [17]. Sleep was measured by actigraphy and father report, but not by mother report. Sleep problems in the children were related to general health and well-being in fathers as well as depression in the mothers. And they were related to the relationship between parents and the relationship between parents and the children. The negative effects of children's sleep problems on parents are not surprising as the parents likely also had sleep problems.

The sleep problems and the negative effects are likely bi-directional. However, directionality cannot be determined in most of these cross-sectional studies. Nonetheless, the severity of the negative effects highlights the need for identifying predictors/risk factors for sleep disorders in children.

Predictors/risk factors for sleep disorders in children

Most of the recent literature on sleep disorders in children relates to predictors or risk factors (see Table 3). At least 24 papers could be categorized as early life predictors, parental risk factors, environmental effects and comorbidities. The early life factors include experiencing less sleep during infancy, adverse childhood experiences (ACEs), and maltreatment. The parental factors include maternal insomnia, parent sleep problems, concordance of sleep patterns between parents and children, parental stress, laxness, overprotection, and the dissolution of the marital relationship. The environmental factors include high altitude, safety, air traffic noise, and excessive screen time or media. The comorbidities include having greater body mass, medical conditions, tinnitus, asthma, depression and ADHD.

Table 3: Predictors/risk factors for sleep disorders in children (and first authors).

Predictors/Risk Factors	First Authors
Early life predictors	
Shorter sleep in infancy	Kocevska
Adverse childhood experiences	Lin, Schonning
Parental predictors/risk factors	
Maternal insomnia	Zreik
Concordance parent and child sleep patterns	Varma, Werner, Merrill
Parental laxness	Shetty
Parental overprotection	Pizzo
Parental relationship dissolution	Lannes
Environmental risk factors	
High altitude and low income	Ruiz
Exposure to crime and violence	Mayne
Aircraft noise	Lee
Excessive screen time	Liu, Lund
Comorbid conditions	
Overweight/obesity	Durracio
Chronic medical conditions	Adavadkar
Tinnitus	Hwang
Asthma	Reiter
ADHD	Gomes, Gissandaner

Early life predictors

A paper entitled "A longitudinal study of stress during pregnancy and children's sleep" suggested that a shorter duration of sleep in infants at two months was related to exacerbated sleep problems later in childhood at six years of age (N= 2063) [18].

In a sample from the National Survey of Children's Health (N= 46,209, children 6 to 17 years old), 50% experienced at least one adverse childhood experience and 33% had insufficient sleep [2]. Those children who had two or more ACEs were twice as likely to have sleep disorders based on sleep duration as the outcome variable. Each individual ACE was associated with more than one hour less sleep recommended. Based on logistic regression models, of those exposed to ACEs, 40% had insufficient sleep duration.

In a meta-analysis of 26 studies on the relationship between childhood maltreatment and sleep in children, childhood maltreatment was significantly associated with insomnia, shorter sleep duration and nightmares [19]. Unfortunately, the meta-analysis was methodologically limited by the heterogeneity of measures across the studies.

Parental predictors/risk factors

As already mentioned, parental predictors/risk factors included maternal insomnia, parental sleep problems, concordance of parents' and children's sleep patterns, parental stress, laxness, overprotection and dissolution of the marital relationship. In a paper entitled "Maternal insomnia and depressive symptoms and early childhood sleep among Arab and Jewish families in Israel", 253 Arab mothers and 244 Jewish mothers were given the Insomnia Severity Index, the Edinburgh Postnatal Depression Scale and the Brief Infant Sleep Questionnaire [20]. As might be expected, maternal insomnia and depression were correlated. And there was a significant correlation between maternal insomnia and children's sleep problems. The Arab mothers had greater depression and insomnia and they were more likely to have scores that were higher than the cut-off scores on each of the measures.

Concordance has been reported for parents' and children's sleep in a 14-night study on 20 parents of 2 to 12-year-olds (280 nights of data) [21]. Sleep concordance was measured by actigraphy and the children sleep habits questionnaire was completed by the parents. Seventy-one per cent of the sleep/wake states of the parents matched those of their children and the parents awakened within

10 minutes of their children's awakening. Parents of children with sleep problems had more variability in their bedtime and wake time after sleep onset.

In another study, mothers and fathers did not differ on their reports of children's sleep problems (N=131 German parents of 2-47-month-old children) [22]. The similarity of parent reports is not surprising given that both parents were likely experiencing the children's sleep problems. Also not surprisingly, parents with greater parenting self-efficacy in this study had children with fewer sleep problems.

Further concordance between parents' stress and their children's sleep problems is highlighted in a study entitled "Relating parental stress with sleep disorders in parents and children" [23]. In this sample, parents' stress was 90% greater if their child had a sleep disorder, 89% greater if the child had insomnia and 81% greater if the child had sleep apnea.

Parental laxness was another predictor/risk factor in a study on bedtime reactivity in children age 2 to 10 (N=407) (Shetty et al, 2022). In their data analysis, parental laxness moderated the relationship between bedtime reactivity and sleep problems in the children. At the other extreme, parental overprotection has predicted children's sleep problems [24]. In this sample (N=197 children 2-6 years-old), both maternal and paternal overprotection was associated with their children's sleep problems. This relationship is not clear, although it may have related to "hovering" over the child while trying to facilitate the child's sleep.

Parental relationship dissolution is still another risk factor for children's sleep problems. Not surprisingly, this relationship was reported in a review of 14 studies that included 6 longitudinal studies and 8 cross-sectional studies [25].

Environmental predictors of sleep disorders in children

Several environmental predictors of sleep disorders have appeared in this literature. These include high altitude, safety factors, air traffic noise, excessive screen time and social media. In the study already described on sleep problems in low income, urban areas of Colombia, 39% of children were noted to have sleep problems [8]. In this sample of 1989 2-12-year-old children, those from the highest altitude had the most frequent sleep disorders (17%). Safety problems including exposure to crime and violence were, not surprisingly, predictors of sleep problems among children in a review of 85 studies [26]. These predictors/risk factors were noted in 86% of the studies which suggested that they were related to shorter duration and later timing of children's sleep as well as a greater prevalence of sleep apnea.

In a paper entitled "Effect of noise on sleep and autonomic activity in children according to source", grade school children in two cities in South Korea (N= 474) were assessed on heart rate variability and sleep problems related to noise [27]. Air craft noise was associated with night waking, but road traffic noise had no effects. And noise had no effect on heartrate variability which was a surprising result given that heart rate has been attuned to sound rhythms in other studies.

In a review on excessive screen time or screen media overuse, those problems were related to poor sleep quality, shorter sleep duration and greater overweight [28]. These problems were also associated with inferior academic performance (including lower executive function scores) and with increased internalizing as well as externalizing behaviors. In a systematic review of the effects of electronic media use on sleep in children (N = 49 studies), sleep problems were noted [29]. These problems were noted more frequently in 6 to 12-year-old children than 0 to 5-year-old children including delayed bedtime and poor sleep quality. These data were surprising given that older children would be expected to have more self-regulation as well as more experience with initiating and maintaining sleep.

Conditions comorbid with sleep disorders in children, several conditions have been comorbid with sleep disorders in children. They include excessive weight /obesity, tinnitus, asthma, depression and ADHD.

In a study on the relationship between overweight/obesity and insomnia severity (N=133 participants age 2 to 18 years), the Insomnia Severity Index was given [30]. Greater body mass was negatively correlated with total sleep time, suggesting the comorbidity of body mass and insomnia.

Chronic medical conditions in general have been associated with sleep disorder diagnoses. In a sample from the Coordinated Health Care for Complex Kids (N= 16,609 birth to 18-year-old youth), 14% had at least one chronic medical condition [31]. Sleep disorders were more frequently noted in those with chronic medical conditions.

In a paper entitled "Association of sleep terror, walking or talking and tinnitus", sleep terrors were associated with a greater incidence of tinnitus (N=970 with tinnitus and 1937 without tinnitus) [32]. This study not only had the problem of an unequal sample size but a huge age range from age 7 in children to age 91 in adults.

A research group studying sleep disorders in children with asthma classified the disorders into 6 groups [33]. These included insomnia, hypersomnia, movement disorders, circadian disorders and sleep-related breathing disorders. Those with asthma had more insomnia including difficulty falling asleep and sleep disruption and the insomnia and asthma were bidirectional, as might be expected.

Children with attention deficit hyperactivity disorder(ADHD) also have sleep problems. In a study on preschoolers from Porto Portugal (N= 381), 13% had ADHD and 46% had scores above the cut-off score (48) on the Children's Sleep Habits Questionnaire [3]. In this sample, ADHD was correlated with short sleep duration, parasomnias (sleepwalking, sleep terrors, sleep talking and sleep paralysis) as well as sleep disordered breathing and narcolepsy (daytime sleepiness related to a lack of hypocretin). In the National Survey of Children's Health (N= 41,541 six-to-seventeen-year-old youth), 55 to 74% of youth with ADHD had sleep disorders and 27% of youth with oppositional defiant disorder had sleep disorders. The sleep disorders in these children would likely exacerbate their

ADHD and oppositional defiant disorder, although that assessment was not made in these studies.

Interventions for children with sleep disorders

Several intervention studies have appeared in this recent literature on children with sleep disorders (see Table 4). They include cognitive behavioral therapy, meditation, light therapy and melatonin.

Table 4: Interventions for children with sleep disorders (and first authors).

Interventions	First Authors
Cognitive Behavioral Therapy	Schnatschmidt
Vitamins, meditation and Mediterranean diet	Deshpande
Doctor Lullaby	Tedford
Melatonin	Jalilolghadr, Mombelli

Cognitive behavioral therapy for children typically involves bedtime shifts (including sleep restriction), stimulus control, thought-challenging, psychoeducation and relaxation techniques [34]. In a pilot study on parental sleep intervention for sleep-disturbed young children(N=60 in Germany), six sessions of cognitive behavioral therapy were provided [35]. The results suggested a decrease in sleep onset latency and a decrease in the frequency and duration of night-time awakenings. The authors also reported an increase in sleep duration and efficiency and a decrease in crying. This study was limited by attrition (only 39 of 60 participants completed the six-session protocol) and highlights the need for a randomized controlled trial.

In a review entitled "Complementary and integrative approaches to sleep disorders in children", several interventions were suggested [36]. These included interventions for low ferritin levels and vitamin D3 deficiency as well as consuming omega-3 fatty acids, probiotics and a Mediterranean diet and practicing meditation. In a study that provided 11 families with the doctor lullaby app (designed to help the entire family sleep), improvement was noted in 73% for time to sleep, 55% for total time sleeping, 64% for time awake with a mean improvement of one hour and 3 minutes total sleep time (Tedford et al, 2022).

At least one study and one review have focused on melatonin as an intervention for sleep problems in children. In a double-blind randomized controlled trial (N=60 7-to-12-year-old children with sleep problems), 3 milligrams of nocturnal dose melatonin were given [37]. The results suggested greater improvement in initiation and maintenance of sleep, sleep onset delay, duration of night awakenings, parasomnias and daily performance. But the intervention was ineffective for bedtime resistance and sleep disordered breathing.

In a review paper entitled "Non-pharmacological and melatonin interventions for pediatric sleep initiation and maintenance problems", a meta-analysis was performed on 15 studies [38]. The results suggested that for sleep onset latency, light therapy and melatonin interventions were the most effective. For waking after sleep onset, psychological therapies or psychological therapy plus light therapy were the most effective. For total sleep time, psychological therapy plus light therapy were also the most effective. The studies in this review, however, were limited by the lack of randomized controlled trials that were stratified by age.

Potential underlying mechanisms for sleep disorders in children

Surprisingly, potential underlying mechanisms have rarely been addressed in this recent literature on sleep disorders in children (see Table 5). In one review of the literature, pre and perinatal melatonin deficits were suggested to be precursors to the development of sleep disorders in children [39]. Premature birth was also noted, although the current rate of premature birth (2%) is significantly lower than the prevalence of sleep disorders in children. And maternal perinatal insomnia was also noted to lead to sleep problems as well as depression and comorbid mood disorders in children [40].

Table 5: Potential underlying mechanisms for sleep disorders in children (and first authors).

Mechanisms	First Authors
Pre and perinatal melatonin deficit and prematurity	Reynolds
Maturation prefrontal area brain and amygdala	Reynolds
Air craft noise and excessive digital media	Lee

Brain maturation has been implicated as a factor, most especially the prefrontal area and the amygdala which are most affected by sleep deprivation [39]. The concordance between parents and children (the 71% match in parent and child sleep wake states) is another factor that may suggest genetic factors and explain the stability of children's sleep problems [21]. Although genetic and biological mechanisms are often explored as underlying abnormal psychological conditions, environmental factors have also been implicated including air craft noise and excessive digital media [27]. While intrusive noise has been explored, excessive light, light deprivation and air temperature effects have not been mentioned as potential factors. And unhealthy food has been implicated but not inactivity or the lack of exercise. These other risk factors could be explored in future research.

Methodological limitations and future research directions

This recent literature on sleep disorders in children has several methodological limitations that relate to definitions, diagnoses, sampling, measures, and methods. These limitations are highlighted by several systematic reviews that have been conducted but could not be submitted to meta-analyses because of significant heterogeneity of methods and measures across studies that resulted in their failure to meet criteria for meta-analyses.

The definitions and diagnostic criteria for sleep disorders have varied across studies with some researchers sampling children who meet the diagnostic criteria for sleep disorders and others referring to children's sleep problems as if they may be precursors to sleep disorders. And researchers have rarely traced the longitudinal

course of sleep disorders in the same children. Another sampling problem is the reliance on clinical samples of children with diagnosed sleep disorders without their being compared to non-clinical groups of children without sleep problems.

Heterogeneity of measurement by the use of different questionnaires in different studies has also made it more difficult to compare results of the different research groups. And, the reliance on parent-report and questionnaires has made the data more subjective and less definitive than the more objective physiological measures like actigraphy that could be conveniently measured by wearables like fit bits and smart watches.

Most of the studies have focused on single predictor variables rather than assessing multiple variables and conducting regression analysis, discriminant function analysis or structural equation models to determine the relative variance in the outcome variables that is explained by the predictor variables. In these single predictor variable studies, limited control for potential confounding variables and the omission of covariates in the data analyses suggests the possibility of confounded results. The occasional significance of mediating variables highlights the importance of assessing multiple variables in the same samples. The limited literature on the negative effects of sleep deprivation and the infrequent consideration of comorbidities is surprising given that research on adults has suggested that sleep deprivation is often accompanied by stress, anxiety and depression.

The recent intervention literature has primarily focused on light therapy and cognitive behavioral therapy which seem to be very different forms of physical versus psychological therapy, making it surprising that they are compared, although it suggests that sleep disorders are not simply a physical but also a psychological phenomenon. Cognitive behavioral therapy is one of the most popular therapies for adult sleep disorders, so its appearance in literature on sleep problems in children is not surprising. Other therapies like physical therapy, massage therapy, yoga, tai chi and exercise might be as effective for sleep disorders in children as they have been for sleep disorders in adults [41-43]. And, on parental education the risk factors that have appeared in this recent literature including their stress, laxness, and overprotectiveness and the concordance of their sleep states with those of their children would seemingly help parents alter their behaviors and, in turn, reduce their children's sleep problems.

The potential underlying mechanism literature is also very limited, possibly because research funding has been less available for the more expensive mechanism research. Although the few studies on polysomnography are suggestive of potential mechanisms, they need replication. Having limited this review to studies on humans may have meant overlooking an animal literature that might inform potential mechanisms.

Despite these methodological limitations, this literature has highlighted the prevalence of sleep disorders in children, with the possibility that the prevalence may have also increased as the overuse of social media has increased. The increasing prevalence of sleep disorders and the stability of sleep disorders in children highlight the need for more intervention research. The data on predictor variables will help identify children in need of therapy and the intervention data will inform clinicians on potential treatments for children with sleep disorders [44-49].

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