

# Clinical management of behavioral insomnia of childhood

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**Abstract:** Behavioral insomnia is highly prevalent, affecting approximately 25% of children. It involves difficulties initiating and maintaining sleep and frequently results in inadequate sleep, leading to an array of negative effects for both the child and the child's family. In this paper, we describe a variety of empirically supported behavioral interventions for insomnia from infancy through adolescence. We explore how biological, cognitive, and psychosocial developmental changes contribute to behavioral insomnia and how these changes may affect sleep and behavioral interventions. We also discuss barriers that prevent families from accessing interventions, including why many empirically-supported behavioral interventions are overlooked by health care providers.

**Keywords:** sleep, behavioral insomnia, treatment, infants, children, adolescents

## Introduction

As we develop from polyphasic-sleeping newborns (multiple scattered naps throughout the day and night) to night-prowling adolescents, our sleep undergoes substantial changes. We consolidate nocturnal sleep, discontinue naps, decrease sleep duration, and shift bedtimes later and later. Sleep plays an undeniably important role throughout our lives, across all stages of development. Unfortunately, sleep loss plagues modern societies, with negative consequences on our physiological, cognitive, and emotional functioning.

Sleep problems are highly prevalent in infants, children, and adolescents. A recent review of the literature revealed that approximately 25% of children experience difficulties with some aspect of sleep.<sup>1</sup> Furthermore, a national survey conducted in the US found that 27% of children are sleeping less than the recommended amount for their age.<sup>2</sup> Although the prevalence of sleep disorders is high, it is important to note that rates vary greatly depending on the specific sleep disorder. For example, behavioral insomnia, the most common sleep disorder, has a very high prevalence rate (20%–30%), whereas the prevalence rates are much lower for disorders such as sleep apnea (1%–3%), sleep related movement disorder (2%–8%), and parasomnias such as night terrors (5%–35%).<sup>3</sup>

The high prevalence rates of sleep problems are particularly alarming given that a great deal of evidence suggests that untreated sleep problems may persist across a range of developmental stages.<sup>4</sup> In addition, there is mounting evidence suggesting dramatic negative consequences of inadequate sleep.<sup>5</sup> The daytime consequences of inadequate sleep have been well documented in adults, with several systematic reviews

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and meta-analyses concluding that poor sleep in adults results in impaired cognitive and emotional functioning.<sup>6</sup> Furthermore, chronic sleep restriction has been linked to an array of medical conditions such as heart disease and diabetes,<sup>7</sup> obesity<sup>8</sup> and mood and anxiety disorders.<sup>9</sup> Although not as well studied in pediatric populations, inadequate sleep has been found to have negative effects on a variety of areas of functioning such as cognitive development, regulation of affect, attention, health outcomes, overall quality of life, and parent and family functioning.<sup>5</sup>

## Behavioral insomnia of childhood

There is no clear consensus among sleep specialists as to the exact definition of childhood insomnia. The three subtypes of behavioral insomnia of childhood (BIC) defined by the International Classification of Sleep Disorders (ICSD), 2nd Edition are: BIC sleep-onset association type; BIC limit-setting type; and BIC combined type.<sup>10</sup> All three types include the primary difficulties of falling asleep independently or frequent night wakings.

BIC sleep-onset association type results from negative sleep associations, which contribute to prolonged sleep onset or frequent night wakings.<sup>11</sup> For example, young children learn to settle to sleep by relying on parents through behaviors such as rocking or nursing to help the child fall asleep. For older children, sleep-onset may be associated with watching television or the presence of a parent. In contrast, BIC limit-setting type encompasses refusal to go to bed and/or repeated requests used as attempts to delay bedtime. For example, children will use a variety of strategies to avoid bedtime (eg, asking to use the bathroom, one more story). BIC combined type occurs when a child has a negative association with sleep coupled with resistance or refusal to go to bed due to a lack of limit-setting by caretakers.

For older children and adolescents, problems with initiating and maintaining sleep are typically referred to as psychophysiological insomnia, a term also used in the adult literature. According to the ICSD, this form of insomnia involves an excessive amount of anxiety and worry regarding sleep and sleeplessness.<sup>10</sup> The individual's heightened anxiety makes falling asleep more challenging, which in turn makes sleep a more negative experience, and leads to a potentially vicious cycle.

Notably, very few studies actually use the ICSD criteria to screen their research participants. Rather, researchers have used a number of definitions from a variety of other sources (eg, researchers own criteria, Diagnostic and Statistical

Manual of Mental Health Disorders<sup>12</sup>). A consensus definition for pediatric insomnia "... repeated difficulty with sleep initiation, duration, consolidation, or quality that occurs despite age appropriate time and opportunity for sleep, which results in some form of daytime functional impairment for the child and/or family" was recently proposed by Mindell et al.<sup>13</sup> It is hoped that this new consensus definition will result in more consistency in the populations studied for future research.

## Assessment for behavioral insomnia of childhood

In order to assess children for behavioral insomnia, it is critical that health care providers routinely ask parents and/or the child about sleep. As noted by Fallone et al,<sup>14</sup> at a minimum, routine screening for sleep problems in children should include questions about regularity and duration of sleep, bedtime resistance and sleep onset delay, night wakings, symptoms of sleep-disordered breathing and signs of increased daytime sleepiness. In addition, a variety of brief sleep screening questionnaires have been developed such as the BEARS (<http://www.kidzzsleep.com>), a 5-item screener that is the acronym for the following important areas to screen: Bedtime Issues, Excessive Daytime Sleepiness, Night Awakenings, Regularity and Duration of Sleep, and Snoring. Alternatively, in cases where a sleep problem is suspected, health care professionals may opt for a more detailed questionnaire such as the Children's Sleep Habits Questionnaire.<sup>15</sup> Spruyt et al<sup>16</sup> provide a review on the most common pediatric sleep questionnaires. If sleep issues require further investigation, the health care professional may consider asking the parent or child to complete a sleep diary for two weeks.<sup>11</sup> Sleep diaries typically include daily information pertaining to bedtime, wake time, and number, timing, and duration of night wakings. A child-friendly sleep diary can be ordered from the National Sleep Foundation at <http://www.sleepfoundation.org/> or downloaded from <http://www.kidzzsleep.com>. In addition, Moore et al<sup>11</sup> suggest that questions regarding the impact of the child's sleep problems on the family and a discussion of previous intervention strategies should also be included in the assessment.

A referral to a sleep laboratory for a polysomnography (PSG) study may be needed. PSG is not necessary to diagnose behavioral insomnia, but rather to examine a number of primary sleep disorders such as sleep-related breathing disorders, narcolepsy, and periodic limb movement disorder.

These disorders may present similarly to behavioral insomnia as daytime sleepiness is a common symptom.

## Interventions for behavioral insomnia of childhood

Medication is the most common treatment for behavioral insomnia in both children and adults.<sup>17</sup> Stojanovski et al<sup>18</sup> performed a chart review in outpatient health centers and found that approximately 80% of children who presented with a sleep disorder were prescribed medications. This is particularly worrisome as there are no FDA approved medications for treatment of insomnia in children, and there are concerns about the safety and side effects of these medications.<sup>19</sup> Moreover, the evidence indicates that although pharmacological treatments may have rapid short-term effects on sleep problems, medications typically do not have long-term positive effects on sleep.<sup>20</sup> Consequently, pharmacological interventions should generally not be the first line of treatment. If health care practitioners feel very strongly that medication is most appropriate for a particular case, it is best to use medications in combination with behavioral interventions.<sup>19</sup>

Behavioral treatments are increasingly being recognized as the most appropriate first line of treatment for behavioral insomnia. These interventions are based on principles of learning and behavior, including reinforcement. The primary goals typically involve some combination of developing positive sleep-related associations, establishing routines, and implementing relaxation skills.<sup>21</sup> These interventions also frequently rely on parent training to effect changes in the parent's behavior, which facilitate changes in the child's behavior. A growing body of literature suggests that behavioral interventions for childhood insomnia are effective, particularly during the first few years of life. Mindell et al<sup>22</sup> conducted a review of 52 studies examining behavioral interventions for bedtime problems and night waking. They reported that 94% of studies demonstrated clinically significant effects. The research indicated that behavioral interventions not only lead to improvements in children's sleep, but also to improvements in child behavior and parental well-being.<sup>23</sup>

In this paper, we focus on behavioral interventions that have been found to be well-established and strongly supported including extinction, graduated extinction, and early intervention/parent education and those that are considered probably efficacious or supported including scheduled awakenings and bedtime fading/positive routines.<sup>20,22,24</sup> These interventions are described in detail below. In addition,

readers may wish to consider the resources suggested in Table 1.

It is important to note that while there is much evidence to support behavioral interventions for sleep problems in infants and young children, there are few well-controlled studies examining behavioral interventions for older children and adolescents. For the most part, many interventions recommended for older children and adolescents are based on case studies, research with adult populations, and clinical judgment. However, regardless of age, the ultimate goals of these interventions typically include creating positive associations with sleep, establishing routines, and learning relaxation or self-soothing skills.

For each developmental stage, including early infancy, late infancy/toddlerhood, early childhood, middle childhood and adolescence, we review key changes in sleep and development, as well as common sleep problems and interventions. The developmental information is based on that presented by Berk.<sup>25</sup>

When describing sleep in each developmental period, we attempt to give averages, but it is also important to be aware of the high degree of individual variability within and across each developmental period. We suggest why some behavioral interventions might be better suited for certain developmental periods, but it is important to recognize that many of these interventions can be applied to a variety of age ranges. Choosing an intervention should involve carefully considering what intervention is most suitable to the unique individual child and family needs.

**Table 1** Resources for clinical interventions for behavioral insomnia

Books	<ul style="list-style-type: none"> <li>• Durand VM. <i>When Children Don't Sleep Well: Therapist Guide: Interventions for Pediatric Sleep Disorders (Treatments that work)</i>. New York: Oxford University Press; 2008.</li> <li>• Mindell JA, Owens JA. <i>A Clinical Guide to Pediatric Sleep: Diagnosis and Management of Sleep Problems</i>. 2nd ed. Philadelphia, PA: Lippincott Williams &amp; Wilkins; 2009.</li> <li>• Sheldon SS, Ferber R, Kryger MH. <i>Principles and Practice of Pediatric Sleep Medicine</i>. 1st ed. Philadelphia, PA: W.B. Saunders; 2005.</li> <li>• Stores G, Wiggs L. <i>Sleep Disturbance in Children and Adolescents with Disorders of Development: Its Significance and Management</i>. London, UK: MacKeith Press; 2001.</li> </ul>
Websites	<ul style="list-style-type: none"> <li>• Kidszzzsleep: <a href="http://www.kidzzzsleep.org/index.htm">http://www.kidzzzsleep.org/index.htm</a></li> <li>• National Sleep Foundation: <a href="http://www.sleepfoundation.org">http://www.sleepfoundation.org</a></li> </ul>

## Sleep and behavioral treatments Newborns/young infants (0–6 months)

### Sleep

Newborns require much more sleep than any other age group, typically sleeping 16–18 hours per day. The sleep of newborns is equally distributed across the 24-hour clock.<sup>26</sup> Around 2–3 months of age, the sleep of infants shifts from polyphasic (characterized by brief sleep periods throughout the 24-hour period) to being more consolidated nocturnal sleep. At first, the infant's sleep schedule is mainly influenced by hunger and satiety. As the infant ages, he/she becomes more sensitive to light-dark cues, which helps to consolidate nocturnal sleep.<sup>27</sup> Most infants have a fairly consolidated nighttime sleep by about 6 months of age, sleeping approximately 10–12 hours during the night and having a couple of daytime naps that account for an additional 2–4 hours of sleep.<sup>28</sup> Infants aged 6 months tend to sleep on average about 14–16 hours.<sup>29</sup>

### Development

Developmentally, infants aged 0–6 months require that their physical needs are met by caregivers. Infants have growing recognition of familiar people and are becoming more adept at social engagement. These developmental changes set the stage for either successful or problematic infant–parent interactions in terms of sleep. Moreover, many parents believe that they must immediately respond to their infant's needs in order to develop trusting and caring relationships. This interactional style can negatively affect sleep in young infants and sets the stage for problematic sleep habits.

### Sleep disorders and treatment

Since polyphasic sleep and multiple awakenings are considered developmentally appropriate, a diagnosis of behavioral insomnia is usually not considered prior to 6 months of age.<sup>30</sup> However, during the first 6 months, parents should begin to establish healthy sleep habits to prevent later sleep problems. The best strategy for reducing sleep problems in infants is educating parents to prevent sleep issues from starting. Stremler et al<sup>31</sup> conducted an early postpartum behavioral-educational intervention to promote infant sleep. The intervention consisted of an 11-page brochure and a 45-minute session with a nurse. The intervention focused on teaching mothers good sleep hygiene with respect to their own sleep as well as their infant's sleep (eg, sleep structure, strategies to promote self-soothing). The researchers found that by 6 weeks of age the infants of those mothers that received the intervention had fewer night wakings and longer

sleep than controls. Furthermore, mothers who received the intervention also had more nighttime sleep than the control mothers in the study.

## Older infants (6–12 months)/toddlers (12–24 months)

### Sleep

Over this developmental period sleep duration decreases slightly, from 14 hours per day for young infants to 13 hours per day for toddlers.<sup>29</sup> Between 6 and 9 months, most infants begin sleeping through the night. However, night wakings are common, with 20% of infants and toddlers waking up at least one time per night and 50% waking up at least one night per week.<sup>29</sup> Children in this age range continue to have naps, although the frequency of naps decreases from an average of two naps per day for older infants to one nap per day at the end of the toddler years. As well, the total daytime sleep changes from about 3 to 2 hours per day.<sup>29</sup>

### Development

From the ages of 6 months to 2 years, a number of developmental changes occur that have a potential impact on child–parent interactions related to sleep. Early in this developmental period, infants develop a true attachment with their caregiver, which also gives rise to separation anxiety. Based on the interactions of the parent and infant during this developmental period, the infant develops an “internal working model” of relationships which sets the stage for relationships in the future, including interactions related to sleep behaviors. It is not until the end of this period, that toddlers begin to be more comfortable with caregiver absences. Moreover, there is increased mobility and language development which can make it challenging to ignore the baby's protests when left alone to sleep in his/her crib.

### Sleep problems

One of the main sleep problems that arise during this developmental period is difficulty with self-soothing. Although it is normal to have arousals throughout the night (this happens at the end of each sleep cycle), what is critical is whether or not the infant is able to self-soothe or needs the direct attention of a parent to get back to sleep. It is hypothesized that infants/toddlers may learn to associate parental presence with falling asleep and become dependent on the parent to be present for them to initiate sleep. These infants fail to develop self-soothing skills.<sup>30</sup> Meltzer et al<sup>3</sup> suggested approximately 20%–30% of infants in this age range meet criteria for BIC and most of these infants have sleep-onset association type.

## Treatment

Extinction has been found to be an effective intervention for sleep problems in infants and very young children.<sup>32</sup> In fact, most behavioral methods for treating sleep problems in these age groups incorporate principles of extinction.<sup>30</sup> Extinction is based on the hypothesis that night wakings and attention-seeking behaviors are positively reinforced by parental attention and other behaviors.<sup>30</sup> Thus, extinction involves parents helping their children to establish self-soothing skills (eg, parents are told to put their infants to bed drowsy, but not asleep, which helps the child learn to settle to sleep on his/her own). The parent is not to respond to their child's attempts at re-engaging the parent to provide external soothing techniques (eg, feeding, rocking, singing). The goal is for the child to learn to self-soothe.

Many parents find it distressing to ignore their child when crying and thus, compliance is often poor.<sup>33</sup> Parents' lack of comfort with these procedures typically leads to inconsistent ignoring, which can actually reinforce, and thus increase, the infant's signaling behaviors such as crying.<sup>30</sup> Tikotzky and Sadeh<sup>30</sup> reported that it can be helpful and encouraging to inform parents that research has not found that limiting parental involvement in order to promote self-soothing results in adverse effects on the infant's emotional well-being or on the parent-child relationship.

For parents who are opposed to unmodified extinction, other variants of extinction, such as graduated extinction or parental presence extinction, may be a better intervention alternative. Graduated extinction involves parents ignoring disruptive bedtime behaviors for a predetermined period. If the child has not settled at the end of that time, the parent settles the child back in bed, but minimizes interaction with the child. Extinction with parental presence involves the parent lying down in a separate bed in the infant's room during settling and awakening. Parents feign sleep and do not attend to the infant directly. Parents follow this procedure for 1 week, after which they follow an unmodified extinction procedure. This technique has been found to reduce the extinction burst (increase in signaling behaviors) that is typically seen when using unmodified extinction.<sup>34</sup>

Another technique that is not as rigorously studied as extinction, but has been found to be effective with this age group is scheduled awakening.<sup>32</sup> Scheduled awakening entails establishing a baseline of the number and timing of spontaneous nighttime wakings. Then a pre-emptive waking schedule wherein parents awaken their child approximately 15–30 minutes before typical spontaneous nighttime waking is implemented. As the treatment progresses, the time

between scheduled awakenings is increased until eventually there are no awakenings. When parents awaken the child, they are instructed to engage in their typical behaviors (eg, feeding, rocking, soothing) as if the child had awakened spontaneously.<sup>24</sup>

Scheduled awakenings appear to increase the duration of consolidated sleep,<sup>22</sup> but the mechanisms behind why this intervention decreases nighttime awakenings are not well understood. Scheduled awakenings are a treatment option for frequent nighttime awakenings, but are not appropriate for problems with sleep initiation.<sup>22</sup> Also, compared to extinction, it can be more complicated to carry out and may take several weeks rather than days before improvements are seen.<sup>22</sup>

## Early childhood (2–6 years)

### Sleep

This developmental period is usually ushered in by the young child transitioning from a crib to a bed. Total sleep duration changes from 13 to 11 hours with the decrease in sleep being a result of a decline in daytime napping.<sup>29</sup> As noted, the majority of 2-year-olds have daily naps, but less than 10% of 6-year-olds nap.<sup>35</sup> Night wakings continue to be problematic, with 10% of children in this age range waking at least once per night and 50% waking at least once per week.

### Development

This developmental period is marked by a growth in the child's initiative and independence. At the same time, children in this age group become increasingly sensitive to rewards and punishments used as discipline by caregivers. Bedtime problems frequently arise with this developing independence, often a result of children testing the limits to determine boundaries and exert their independence.<sup>11</sup> In addition, continued cognitive and language development sets the stage for the further development of fantasy and imagination which for some children may lead to increased nighttime fears and potentially result in bedtime problems.

### Sleep problems

In contrast to infancy where BIC sleep-onset association type is common, BIC limit-setting type is common in early childhood affecting up to 30% of young children.<sup>36</sup> This subtype occurs when a child resists or refuses to go to bed (eg, verbal protests, crying, clinging) and/or includes repeated requests (eg, for drinks, stories) as attempts to delay bedtime. Typically the resistance or refusal is a result of negative associations with sleep coupled with a lack of limit-setting by caretakers

(eg, conceding to requests, lack of consistent bedtime). When patterns of these behaviors lead to significant impairment, it typically warrants a diagnosis of BIC limit-setting type.<sup>22</sup> Additionally, many young children develop nighttime fears (eg, fears of the dark and monsters). Muris et al<sup>37</sup> found that more than 70% of young children reported nighttime fears. These fears can also lead to bedtime resistance, difficulty initiating sleep, and an increase in nightmares.<sup>35</sup>

## Treatment

As with all age groups, sleep hygiene is an important first step in treating sleep problems in young children. Sleep hygiene plays an important role in virtually all sleep interventions and typically involves a combination of creating an environment that is conducive to sleep and engaging in healthy sleep habits. In terms of environment, the bedroom should be quiet, dark, and a cool temperature.<sup>38</sup> In addition, the bedroom should be envisioned as a calming, relaxing sleep sanctuary. For this reason, televisions, video games, and other electronic devices should not be kept in the bedroom<sup>39</sup> and parents should not use the bedroom as a place to send the child when they are punished.<sup>40</sup> The above strategies will work best when used in combination with healthy sleep hygiene habits. These include implementing a regular bedtime routine (eg, bathe, get in pajamas, brush teeth, read book, say goodnight) and a consistent sleep schedule, avoiding stimulating activities (eg, watching television or playing video games) prior to bedtime, limiting caffeine (eg, cola and chocolate) intake before bed,<sup>40</sup> and engaging in daily physical activity.<sup>41</sup>

As with infants and toddlers, parents play a crucial role in treating sleep problems in this age group. It is important that parents model and begin to teach their preschoolers about healthy sleep hygiene. With their parents help, preschoolers can begin to play a more active role in choosing appropriate sleep hygiene options (eg, choosing to read a book rather than watch television right before going to sleep). The earlier sleep hygiene habits are established the better, as sleep habits developed in childhood shape sleep habits exhibited in adulthood.<sup>42</sup>

Addressing nighttime fears in this age group can help reduce negative associations with sleep and may be another important aspect of intervention that should be considered. A common intervention for nighttime fears in children is for the parent to make the child feel safe and secure by co-sleeping (eg, allowing the child to sleep in the parent's bed).<sup>43</sup> Although this intervention offers short-term alleviation of symptoms, parents often find themselves

co-sleeping for extended periods of time. This habit can be challenging to change and often results in the need for an intervention for co-sleeping. For this reason, this method is not typically advised.<sup>30</sup>

Components of Cognitive Behavior Therapy (CBT) used to treat more general fears, phobias, and anxiety in children may be useful in treating nighttime fears. These include muscle relaxation, deep breathing, guided imagery, and systematic desensitization.<sup>44</sup> Unfortunately, the evidence for the effectiveness of other interventions that address nighttime fears is limited. One relatively large study ( $n = 142$ ) examined an intervention wherein 4- to 6-year-olds used their imaginations and creativity to draw a monster and write it a letter in an effort to decrease their fear. Following intervention, the children reported a significant decrease in fears compared to a control group that did not receive the intervention.<sup>45</sup>

## Middle childhood (6–11 years)

### Sleep

It is typically recommended that children aged 6–11 years get 10–11 hours of sleep per night.<sup>35</sup> In North America, daytime napping is very rare in this age group. Sadeh et al<sup>46</sup> compared sleep of second graders to sleep of sixth graders and found that children in the sixth grade go to sleep approximately 1 hour later than those in the second grade. However, this result does not necessarily mean that these children need less sleep as parental report indicated that many of the sixth graders in this study were more likely to unintentionally fall asleep than were the second graders. Furthermore, the sixth graders also reported more morning sleepiness than the second graders. Interestingly, there is some evidence that sex differences start to become evident during this developmental stage, with girls sleeping slightly more than boys.<sup>47</sup> Also, circadian sleep phase preference (ie, night owl vs morning lark) becomes more evident during this stage.<sup>26</sup>

### Development

One of the key developmental changes that takes place during middle childhood is the increasing importance the child places on their peer relationships. During this developmental stage, peer relationships become more positive and engaging. Children in this age range seek out opportunities to engage in peer relationships, including the use of computer-based interactions (eg, email, social networking sites). Middle childhood is also a time of increased anxiety in general and social anxiety in particular. Much of the child's time is now spent outside of the home, at school or engaged in extracurricular activities.

## Sleep problem

Sleep in school-aged children is also affected by increasing school and social obligations. In addition, more now than ever before, children have access to multiple stimulating activities (eg, internet, cell phones, television) at all hours of the day including hours when they should be sleeping. Furthermore, like toddlers and preschoolers, many school-aged children have fears and anxious thoughts, which increase arousal levels and can lead to negative associations with sleep. Similar to early childhood, BIC limit-setting type is common in school-aged children, affecting approximately 15%.<sup>36</sup>

## Treatment

Children at the younger end of this spectrum will benefit from some of the interventions discussed for early childhood. As children age, these interventions become less well established, less appropriate, and less acceptable. Unfortunately, the literature examining sleep interventions for older children and adolescents is limited and typically interventions are based on strategies that have been found to be effective for adults.

At this age, parents continue to play an important role in limit-setting and developing realistic and consistent bedtime rules,<sup>30</sup> however, it is important that school-aged children become more active agents in sleep interventions. For example, sleep hygiene continues to play an important role in sleep interventions in school-aged children and educating parents is important, but as a child gains maturity and independence, it becomes critical to also educate the child on healthy sleep habits. Furthermore, older children can be involved in more decisions pertaining to their sleep, such as establishing an appropriate bedtime. Typically the limit-setting components need to be adjusted during this phase. That is, limit-setting with young children may involve limiting the number of times the child can make a request, whereas limit-setting for school-aged children often revolves around how late the child can watch television, do homework or go on the internet.

Faded bedtime is an alternative behavioral intervention for children in this age range for whom extinction may not be appropriate. Faded bedtime, often used in combination with sleep hygiene, involves determining a time at which it is likely the child will fall asleep within about 15 minutes of going to bed. Once the child falls asleep at this time with little resistance, the bedtime is set earlier after a series of successful nights until the desired bedtime is achieved. Also, the child's wake time is set at the same time each day and the child is not allowed to sleep outside the prescribed sleep times. A modified version of this technique, faded bedtime

with response cost, involves bedtime fading, as described above. However, if the child does not fall asleep within a certain period of time, the child is removed from bed (response cost) to decrease the negative association between being in bed and awake and to increase the likelihood that the child will fall asleep. After a predetermined time (typically about 30 minutes during which time the child engages in a nonarousing activity), the child returns to bed. This procedure is repeated until the child falls asleep. Once successful at the target bedtime, an earlier bedtime is set as the goal. The aims of the treatment are in line with the goals of extinction: to increase appropriate behaviors and positive associations with sleep and to decrease arousal by helping the child to develop self-soothing skills and fall asleep independently.<sup>11</sup>

As noted, there are well-developed CBT interventions for children's fears, phobias, and anxiety disorders. In addition to the behavioral components described previously, children during middle childhood may benefit from more cognitively oriented components (eg, positive self-statements, discussing worries during the day rather than before bed, countering negative thoughts<sup>44</sup>). However, research in this area is limited.

## Adolescence (12–18 years)

### Sleep

Adolescents typically undergo a delay in the timing of sleep onset. This delay (~2 hour shift) appears to be driven by both biological and social factors. Among the intrinsic biological factors, changes in the underlying period of the circadian clock that regulates sleep-wake timing (delayed release of melatonin) has been hypothesized to be at least partly responsible for the delay in sleep onset.<sup>48</sup> This delay in sleep phase results in insufficient sleep during the weekdays (during which there are pre-set wake times) and therefore adolescents tend to increase their sleep on the weekend by waking up later.<sup>26</sup> Adolescents will also rely on caffeine to counteract their sleepiness. Sleep in adolescence has been on the decline over the past few decades, with 10- to 15-year-olds sleeping approximately 30 minutes less per night now compared to the sleep attained in the 1980s.<sup>49</sup> Dollman et al<sup>49</sup> suggest factors such as increased part-time work and greater availability of bedroom-based computers, televisions, and video games as trends that may explain this decrease.

### Development

In terms of development, adolescence is a time of decreased parental influence and increased socialization, academic demands, and employment demands. Moodiness and

parent–child conflicts also increase and then decline toward the end of this developmental period. The adolescent continues to strive for autonomy and to develop a self-identity.

### Sleep problems

The biological changes that occur during adolescence can result in a delay in sleep onset. This sleep onset delay combined with irregular bedtimes can lead to adolescents spending increased amounts of time in bed unable to fall asleep, which leads to negative associations with sleep. By adolescence, issues of sleep onset and/or sleep maintenance problems are typically referred to as primary (psychophysiological) insomnia, a term that is also used for adult insomnia. This type of insomnia includes conditioned anxiety around difficulty falling or staying asleep, resulting in heightened physiological and emotional arousal and negative associations with sleep. Many adolescents also develop poor sleep hygiene habits.<sup>50</sup>

### Treatment

As noted previously, literature examining the effectiveness of interventions for insomnia in older children and adolescents is limited and is typically based on strategies that work for adults.<sup>51</sup> Interventions for the adolescent population typically include sleep hygiene education, relaxation strategies, and sleep restriction (ie, limiting time in bed based on how long one actually sleeps) to create more positive associations with sleeping and a greater physiological pressure for sleep.<sup>30</sup> Furthermore, using the bed for sleep only and removing one's self from bed if unable to sleep are important aspects of this intervention. Relaxation techniques such as progressive muscle relaxation, deep breathing, and guided imagery have also been found to reduce sleep problems. In addition, negative cognitions associated with sleep (eg, "I must get 8 hours of sleep or I will not be able to function") are targeted.

One group of researchers examined the effectiveness of school-based sleep hygiene programs in improving sleep in adolescents. These programs have been found to have beneficial effects including reducing sleep irregularity and decreasing sleep onset latency.<sup>52</sup> Educating adolescents on healthy sleep habits, particularly keeping regular schedules and not sleeping in excessively on weekends (more than 1 hour later than week days), allows them an opportunity to consciously make informed choices about their sleep habits.

## Behavioral insomnia in special populations

Although the rates of behavioral insomnia in typically developing children are high, prevalence estimates of

behavioral insomnia in children and adolescents with mental health disorders are even greater. These include, but are not limited to, autism spectrum disorder (ASD), attention-deficit/hyperactivity disorder (ADHD), and anxiety and mood disorders.<sup>53,54</sup> Unfortunately, there is little empirical research examining behavioral interventions in populations with mental health disorders, which is particularly concerning given the high prevalence of sleep problems in these groups: ADHD (25%–50%),<sup>55</sup> ASD (50%–80%),<sup>56</sup> depression (up to 90%),<sup>53</sup> and anxiety (up to 88%).<sup>57</sup>

Many of the sleep problems that commonly occur in typically developing children are also common in children with mental health disorders. Examples include difficulties initiating and maintaining sleep.<sup>18</sup> In addition, a number of other sleep problems occur in these populations. For example, these children are more prone to bedtime fears, nightmares, and co-sleeping.<sup>35,59</sup> Furthermore, medication can exacerbate or maintain sleep problems in these populations. For example, psychostimulant medications which are often used to treat ADHD have been found to disrupt sleep in a variety of ways including delaying sleep onset and shortening total sleep time.<sup>60</sup> Antidepressants may also exacerbate sleep problems.<sup>35</sup>

As with typically developing children, the first line of treatment should be to improve sleep hygiene (eg, having a consistent bedtime routine and sleep schedule).<sup>61,62</sup> With special populations, it is important that additional behavioral interventions are tailored to the developmental level of the individual. For example, an individual at a lower developmental age may benefit from relaxation strategies to reduce nighttime fears whereas an individual functioning at a higher developmental level is likely to benefit from cognitive approaches such as restructuring sleep-onset expectations and countering negative thoughts to reduce pre-sleep worries and anxiety. Additionally, it is important to consider safety precautions when implementing behavioral interventions<sup>62</sup> as some interventions may be inappropriate (eg, extinction may not be appropriate for children with self-injurious behaviors).

Although behavioral interventions may be more challenging to implement with these populations, some studies suggest that parents of individuals with mental health disorders prefer behavioral interventions over pharmacological interventions.<sup>63</sup> In addition, behavioral sleep interventions may be important not only in improving sleep problems, but also for improving daytime functioning in children with symptoms of mental health disorders.<sup>11</sup> Furthermore, behavioral interventions have been found to increase parents'



sense of competence and control and their ability to cope<sup>64</sup> and could, therefore, be particularly helpful for parents of children with mental health disorders because these parents often have increased levels of stress.<sup>65</sup>

Some promising interventions have been reported,<sup>58,66-68</sup> but more research is needed to support the efficacy of behavioral interventions in treating sleep disorders that co-occur with other mental health disorders in children. The relationships between sleep and all of these disorders are complex and bidirectional. Future research needs to be directed at addressing how best to tailor behavioral interventions to specific populations with mental health disorders.

## Treatment barriers, future directions, and conclusions

Compared to medication, behavioral methods of intervention for insomnia are often more effective, more acceptable to parents and practitioners, and have fewer harmful side effects.<sup>22</sup> There is strong evidence to support behavioral interventions, particularly in young children and infants, yet these interventions are rarely the first line of treatment. Two particularly significant challenges that help to explain why these interventions are so rarely the first line of treatment are: (1) parents' limited knowledge of, and access to, sleep interventions; and (2) a lack of training in sleep interventions among health care providers.

One of the additional complexities of diagnosing sleep problems in children compared to adults is that problems are often described by a parent, not the individual child experiencing the sleep problem.<sup>22</sup> Thus, parents need to first recognize that there is a sleep problem and then seek help. Unfortunately, parents often do not discuss sleep issues with health care professionals.<sup>69</sup> A number of reasons may explain why sleep issues are not discussed. These include the finding that many parents lack knowledge about pediatric sleep and sleep problems<sup>70</sup> and the fact that parents of children with sleep problems are likely to be experiencing increased levels of stress, are more prone to depression, and are often sleep deprived themselves. These issues may prevent them from seeking help from health care providers.<sup>3</sup> In addition, many parents do not seek help because they are inaccurately told that children will outgrow sleep problems<sup>71</sup> and parents are often unaware of some of the negative consequences associated with inadequate sleep.<sup>3</sup>

Health care professionals are also partly responsible for sleep problems in children and adolescents being underdiagnosed. Sleep-related issues are often not discussed with health care providers because health care providers often

do not ask about sleep.<sup>69</sup> Health care providers may avoid questions related to sleep due to a lack of training in dealing with assessment of sleep problems and they may not have confidence in their abilities to work with individuals with sleep problems.<sup>62</sup> Furthermore, like parents, health care providers may be unaware of the negative effects of insufficient sleep.<sup>3</sup> In addition, when treatments are recommended, health care providers only recommend behavioral interventions in a minority of cases.<sup>18</sup>

As discussed throughout this paper, a number of effective interventions can be used to treat behavioral insomnia in children. It is critical to consider the developmental level of the child in order to choose an appropriate intervention and also to target some of potential causes of the sleep problems. Regardless of age, the goals of most behavioral interventions typically include some combination of creating positive associations with sleep, establishing routines, and learning relaxation or self-soothing skills. Parent education on sleep and/or sleep hygiene is a particularly important component in all behavioral interventions. As children age it becomes important to also educate them about sleep hygiene and to include them as active agents in their own treatment.

Research examining sleep interventions for older children and adolescents as well as for special populations is limited. Given the high rates of sleep problems in these populations as well as the potential negative impact poor sleep can have on daytime functioning, there is a strong need for more research in these areas. In addition, most research examining behavioral interventions for sleep problems in children has employed families of middle-upper socioeconomic status<sup>30</sup> and there has been little research examining how behavioral sleep interventions can be applied to children and families from ethnic minority populations. These are important considerations because some interventions may be incongruent with certain cultural or societal norms (eg, extinction is unlikely to be an appropriate intervention for behavioral insomnia in families whose culture supports co-sleeping). Given the limited research in this area, future research should be directed at developing and evaluating appropriate interventions for these populations.

Once identified, behavioral insomnia is highly amenable to behavioral interventions. Early identification and treatment can have positive short- and long-term effects on the child, the parents, and the family as a whole. Efforts need to be made to increase parent knowledge of, and access to, behavioral sleep interventions. Concurrently, health care providers need to be educated on appropriate diagnosis and treatment of this highly prevalent disorder.

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## References

- Owens J. Classification and epidemiology of childhood sleep disorders. *Sleep Med Clin*. 2007;2:353–361.
- National Sleep Foundation. 2004 Sleep in America Poll: summary of Findings. National Sleep Foundation Web site. <http://www.sleep-foundation.org/sites/default/files/FINAL%20SOF%202004.pdf>. Published 2004. Updated 2004. Accessed February 21, 2011.
- Meltzer LJ, Johnson C, Crossette J, Ramos M, Mindell JA. Prevalence of diagnosed sleep disorders in pediatric primary care practices. *Pediatrics*. 2010;125(6):e1410–e1418.
- Kataria S, Swanson MS, Trevathan GE. Persistence of sleep disturbances in preschool children. *J Pediatr*. 1987;110(4):642–646.
- Sadeh A. Consequences of sleep loss or sleep disruption in children. *Sleep Med Clin*. 2007;2(3):513–520.
- Durmer JS, Dinges DF. Neurocognitive consequences of sleep deprivation. *Semin Neurol*. 2005;25(1):117–129.
- Foley D, Ancoli-Israel S, Britz P, Walsh J. Sleep disturbances and chronic disease in older adults: results of the 2003 National Sleep Foundation Sleep in America Survey. *J Psychosom Res*. 2004;56(5):497–502.
- Cappuccio FP, Taggart FM, Kandala NB, et al. Meta-analysis of short sleep duration and obesity in children and adults. *Sleep*. 2008;31(5):619–626.
- Ong SH, Wickramaratne P, Tang M, Weissman MM. Early childhood sleep and eating problems as predictors of adolescent and adult mood and anxiety disorders. *J Affect Disord*. 2006;96(1–2):1–8.
- American Academy of Sleep Medicine. The international classification of sleep disorders: diagnostic and coding manual, ICSD–2. *AASM*. 2005.
- Moore M, Meltzer LJ, Mindell JA. Bedtime problems and night wakings in children. *Sleep Med Clin*. 2007;2(3):377–385.
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. Fourth edition text revision. Washington, DC: American Psychiatric Association; 2000.
- Mindell JA, Emslie G, Blumer J, et al. Pharmacologic management of insomnia in children and adolescents: consensus statement. *Pediatrics*. 2006;117(6):e1223–e1232.
- Fallone G, Owens JA, Deane J. Sleepiness in children and adolescents: clinical implications. *Sleep Med Rev*. 2002;6(4):287–306.
- Owens JA, Spirito A, McGuinn M. The Children's Sleep Habits Questionnaire (CSHQ): psychometric properties of a survey instrument for school-aged children. *Sleep*. 2000;23(8):1–9.
- Spruyt K, Gozal D. Pediatric sleep questionnaires as diagnostic or epidemiological tools: a review of currently available instruments. *Sleep Med Rev*. 2011;15(1):19–32.
- Mindell JA, Moline ML, Zendell SM, Brown LW, Fry JM. Pediatricians and sleep disorders: training and practice. *Pediatrics*. 1994;94(2 Pt 1):194–200.
- Stojanovski SD, Rasu RS, Balkrishnan R, Nahata MC. Trends in medication prescribing for pediatric sleep difficulties in US outpatient settings. *Sleep*. 2007;30(8):1013–1017.
- Owens JA, Rosen CL, Mindell JA, Kirchner HL. Use of pharmacotherapy for insomnia in child psychiatry practice: a national survey. *Sleep Med*. 2010;11(7):692–700.
- Ramchandani P, Wiggs L, Webb V, Stores G. A systematic review of treatments for settling problems and night waking in young children. *BMJ*. 2000;320(7229):209–213.
- Reid GJ, Huntley ED, Lewin DS. Insomnias of childhood and adolescence. *Child Adolesc Psychiatr Clin N Am*. 2009;18(4):979–1000.
- Mindell JA, Kuhn B, Lewin DS, Meltzer LJ, Sadeh A. Behavioral treatment of bedtime problems and night wakings in infants and young children. *Sleep*. 2006;29(10):1263–1276.
- Mindell JA, Telofski LS, Wiegand B, Kurtz ES. A nightly bedtime routine: impact on sleep in young children and maternal mood. *Sleep*. 2009;32(5):599–606.
- Kuhn BR, Elliott AJ. Treatment efficacy in behavioral pediatric sleep medicine. *J Psychosom Res*. 2003;54(6):587–597.
- Berk LE. *Infants, Children, and Adolescents*. 4th ed. Toronto, ON: Allyn and Bacon; 2002.
- Jenni OG, Carskadon MA. Sleep behavior and sleep regulation from infancy through adolescence: normative aspects. *Sleep Med Clin*. 2007;2(3):321–329.
- Rivkees SA. Emergence and influences of circadian rhythmicity in infants. *Clin Perinatol*. 2004;31(2):217–228.
- Sadeh A. A brief screening questionnaire for infant sleep problems: validation and findings for an Internet sample. *Pediatrics*. 2004;113(6):e570–e577.
- Iglowstein I, Jenni OG, Molinari L, Largo RH. Sleep duration from infancy to adolescence: reference values and generational trends. *Pediatrics*. 2003;111(2):302–307.
- Tikotzky L, Sadeh A. The role of cognitive-behavioral therapy in behavioral childhood insomnia. *Sleep Med*. 2010;11(7):686–691.
- Stremmler R, Hodnett E, Lee K, et al. A behavioral-educational intervention to promote maternal and infant sleep: a pilot randomized, controlled trial. *Sleep*. 2006;29(12):1609–1615.
- Rickert VI, Johnson CM. Reducing nocturnal awakening and crying episodes in infants and young children: a comparison between scheduled awakenings and systematic ignoring. *Pediatrics*. 1988;81(2):203–212.
- Reid MJ, Walter AL, O'Leary SG. Treatment of young children's bedtime refusal and nighttime wakings: a comparison of "standard" and graduated ignoring procedures. *J Abnorm Child Psych*. 1999;27(1):5–16.
- France KG, Blampied NM. Modifications of systematic ignoring in the management of infant sleep disturbance: efficacy and infant distress. *Child Fam Behav Ther*. 2005;27(1):1–16.
- Meltzer LJ, Mindell JA. Sleep and sleep disorders in children and adolescents. *Psychiatr Clin North Am*. 2006;29(4):1059–1076.
- Liu X, Liu L, Owens JA, Kaplan DL. Sleep patterns and sleep problems among schoolchildren in the United States and China. *Pediatrics*. 2005;115(Suppl 1):241–249.
- Muris P, Merckelbach H, Ollendick TH, King NJ, Bogie N. Children's nighttime fears: parent-child ratings of frequency, content, origins, coping behaviors and severity. *Behav Res Ther*. 2001;39(1):13–28.
- Galland BC, Mitchell EA. Helping children sleep. *Arch Dis Child*. 2010;95(10):850–853.
- 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.
- Davis KF, Parker KP, Montgomery GL. Sleep in infants and young children: Part one: normal sleep. *J Pediatr Health Care*. 2004;18(2):65–71.
- Driver HS, Taylor SR. Exercise and sleep. *Sleep Med Rev*. 2000;4(4):387–402.
- Morgenthaler T, Owens J, Alessi C, et al. Practice parameters for behavioral treatment of bedtime problems and night wakings in infants and young children. *Sleep*. 2006;29(10):1277–1281.
- Johnson CM. Infant and toddler sleep: a telephone survey of parents in one community. *J Dev Behav Pediatr*. 1991;12(2):108–114.

44. Gordon J, King NJ, Gullone E, Muris P, Ollendick TH. Treatment of children's nighttime fears: the need for a modern randomised controlled trial. *Clin Psychol Rev.* 2007;27(1):98–113.
45. Muris P, Verweij C, Meesters C. The "Anti-monster Letter" as a simple therapeutic tool for reducing night-time fears in young children. *Behav Change.* 2003;20(4):200–207.
46. Sadeh A, Raviv A, Gruber R. Sleep patterns and sleep disruptions in school-age children. *Dev Psychol.* 2000;36(3):291–301.
47. Crabtree VM, Williams NA. Normal sleep in children and adolescents. *Child Adolesc Psychiatr Clin N Am.* 2009;18(4):799–811.
48. Carskadon M, Acebo C, Jenni O. Regulation of adolescent sleep: implications for behavior. *Ann NY Acad Sci.* 2004;1021:276–291.
49. Dollman J, Ridley K, Olds T, Lowe L. Trends in the duration of school-day sleep among 10- to 15-year-old South Australians between 1985 and 2004. *Acta Paediatr.* 2007;96(7):1011–1014.
50. Giannotti F, Cortesi F, Sebastiani T, Ottaviano S. Circadian preference, sleep and daytime behaviour in adolescence. *J Sleep Res.* 2002;11(3):191–199.
51. Morin CM, Bootzin RR, Buysse DJ, Edinger JD, Espie CA, Lichstein KL. Psychological and behavioral treatment of insomnia: update of the recent evidence (1998–2004). *Sleep.* 2006;29(11):1398–1414.
52. de Sousa IC, Araújo JF, de Azevedo, Carolina Virginia Macêdo. The effect of a sleep hygiene education program on the sleep-wake cycle of Brazilian adolescent students. *Sleep Biol Rhythms.* 2007;5(4):251–258.
53. Ivanenko A, Crabtree VM, Gozal D. Sleep and depression in children and adolescents. *Sleep Med Rev.* 2005;9(2):115–129.
54. Ivanenko A, Crabtree VM, Gozal D. Sleep in children with psychiatric disorders. *Pediatr Clin North Am.* 2004;51(1):51–68.
55. Corkum P, Tannock R, Moldofsky H. Sleep disturbances in children with attention-deficit/hyperactivity disorder. *J Am Acad Child Psy.* 1998;37(6):637–646.
56. Richdale AL, Schreck KA. Sleep problems in autism spectrum disorders: prevalence, nature, and possible biopsychosocial aetiologies. *Sleep Med Rev.* 2009;13(6):403–411.
57. Alfano CA, Ginsburg GS, Kingery JN. Sleep-related problems among children and adolescents with anxiety disorders. *J Am Acad Child Adolesc Psychiatry.* 2007;46(2):224–232.
58. Dahl RE, Harvey AG. Sleep in children and adolescents with behavioral and emotional disorders. *Sleep Med Clin.* 2007;2(3):501–511.
59. Owens JA. A clinical overview of sleep and attention-deficit/hyperactivity disorder in children and adolescents. *J Can Acad Child Adolesc Psychiatry.* 2009;18(2):92–102.
60. Corkum P, Panton R, Ironside S, MacPherson M, Williams T. Acute impact of immediate release methylphenidate administered three times a day on sleep in children with attention-deficit/hyperactivity disorder. *J Pediatr Psychol.* 2008;33(4):368–379.
61. Corkum P, Davidson F, MacPherson M. A framework for the assessment and treatment of sleep problems in children with attention-deficit/hyperactivity disorder. *Pediatr Clin N Am.* 2011;58(3):667–683.
62. Jan J, Owens J, Weiss M, et al. Sleep hygiene for children with neurodevelopmental disabilities. *Pediatrics.* 2008;122(6):1343–1350.
63. Williams G, Sears L, Allard A. parent perceptions of efficacy for strategies used to facilitate sleep in children with autism. *J Dev Phys Disabil.* 2006;18(1):25–33.
64. Richman N, Douglas J, Hunt H, Lansdown R, Levere R. Behavioural methods in the treatment of sleep disorders – a pilot study. *J Child Psychol Psychiatry.* 1985;26(4):581–590.
65. Spratt EG, Saylor CF, Macias MM. Assessing parenting stress in multiple samples of children with special needs (CSN). *Fam Syst Health.* 2007;25(4):435–449.
66. Montgomery P, Stores G, Wiggs L. The relative efficacy of two brief treatments for sleep problems in young learning disabled (mentally retarded) children: a randomised controlled trial. *Arch Dis Child.* 2004;89(2):125–130.
67. Mullane J, Corkum P. Case series: evaluation of a behavioural sleep intervention for three children with attention-deficit/hyperactivity disorder and dyssomnia. *J Atten Disord.* 2006;10(2):217–227.
68. Moon EC, Corkum P, Smith IM. Case study: a case-series evaluation of a behavioral sleep intervention for three children with autism and primary insomnia. *J Pediatr Psychol.* 2011;36(1):47–54.
69. Stein MA, Mendelsohn J, Obermeyer WH, Amromin J, Benca R. Sleep and behavior problems in school-aged children. *Pediatrics.* 2001;107(4):E60.
70. Schreck KA, Richdale AL. Knowledge of childhood sleep: a possible variable in under or misdiagnosis of childhood sleep problems. *J Sleep Res.* April 26, 2011. [Epub ahead of print]. Available at: <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2869.2011.00922.x/full>.
71. Kuhn BR, Weidinger D. Interventions for infant and toddler sleep disturbance: a review. *Child Fam Behav Ther.* 2000;22(2):33–50.

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