ISSN: 2755-6344

Journal of Family Medicine and Preventive Medicine

SCIENTIFIC Research and Community

Review Article

Open Access

Understanding Sleep Patterns in Pediatric Patients: A Comprehensive Review

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ABSTRACT

According to world journal of clinical pediatric there is a complex relationship between sleep disorders and childhood neurodevelopment, emotional, behavioral and intellectual disorders (NDEBID). NDEBID include several conditions such as attention deficit/hyperactivity disorder, autism spectrum disorder, cerebral palsy, epilepsy and learning (intellectual) disorders.

Up to 75% of children and young people (CYP) with NDEBID are known to experience different types of insomnia, compared to 3% to 36% in normally developing population. Sleep disorders affect 15% to 19% of adolescents with no disability, in comparison with 26% to 36% among CYP with moderate learning disability (LD) and 44% among those with severe LD. Chronic sleep deprivation is associated with significant risks of behavioural problems, impaired cognitive development and learning abilities, poor memory, mood disorders and school problems. It also increases the risk of other health outcomes, such as obesity and metabolic consequences, significantly impacting on the wellbeing of other family members.

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Received: July 10, 2025; **Accepted:** July 14, 2025; **Published:** July 23, 2025

Keywords: REM: Rapid-Eye-Movement, CYP: Children and Young People, Sleep, Emotional, Behavioural Difficulties, Neurodevelopment Disorders, Pharmacotherapy, Non-Pharmacologic Interventions, Cognitive Therapy

Introduction

Sleep is a critical aspect of health and development in pediatric patients. It influences cognitive function, physical growth, emotional regulation, and overall well-being. Understanding the sleep patterns in children and adolescents is essential for identifying and managing sleep disorders that can impact development. Sleep is a fundamental component of health and development in children and adolescents. Adequate sleep is essential for cognitive function, emotional regulation, physical growth, and overall well-being. Pediatric sleep patterns and needs differ significantly from those of adults, varying across different developmental stages. Disruptions in sleep can lead to a range of health issues, highlighting the importance of understanding normal sleep patterns and identifying sleep disorders in pediatric populations.

Impact of Sleep Pattern

The impact of sleep patterns on pediatric patients is profound, influencing nearly every aspect of a child's physical, cognitive, and emotional development. Addressing sleep issues early on is essential to ensure that children have the best possible foundation for healthy growth and development. Understanding how sleep patterns affect pediatric patients can inform healthcare practices, parental guidance, and policies aimed at promoting healthy sleep habits from a young age.

Cognitive Development and Academic Performance

- **Memory and Learning:** Adequate sleep is essential for memory consolidation and learning in children. Disrupted sleep patterns can lead to difficulties in retaining information and impair cognitive functions, which can negatively affect academic performance.
- **Attention and Focus:** Children who do not get enough sleep or who experience poor-quality sleep often exhibit problems with attention and concentration, which can contribute to learning difficulties and behavioral issues in school.

Emotional and Behavioral Health

- **Mood Regulation:** Sleep deprivation or irregular sleep patterns can lead to mood swings, irritability, and emotional instability in children. Persistent sleep issues have been linked to an increased risk of anxiety and depression in pediatric populations.
- **Behavioral Problems:** Sleep problems are often associated with behavioral disorders such as ADHD. Children with inconsistent sleep patterns may exhibit hyperactivity, impulsiveness, and difficulty controlling their emotions, leading to challenges in social interactions and school settings.

Physical Health

- **Growth and Development:** Sleep is a critical time for growth and development, particularly during deep sleep stages when growth hormone is released. Disrupted sleep can interfere with physical growth and development in children.
- **Immune Function:** Sleep plays a vital role in maintaining a healthy immune system. Pediatric patients with inadequate

sleep are more susceptible to infections and may have a longer recovery time when sick.

- **Obesity:** Poor sleep patterns, including insufficient sleep duration and irregular bedtimes, have been associated with an increased risk of obesity in children. This is partly due to hormonal imbalances that affect appetite regulation and metabolism.

According to Bruni O, Giallonardo M, study on the impact of lockdown on sleep patterns of children and adolescents with ADHD. Nine hundred ninety-two parents of children and adolescents with ADHD filled out an anonymous online survey through the ADHD family association website. The survey investigated the sleep patterns and disturbances (using a modified version of the Sleep Disturbance Scale for Children) and screen exposure time before and during lockdown. Sleep duration, in contrast, resulted in 2 opposing processes with more children and adolescents sleeping either less than 6 hours/night or 10–11 hours/night. Among children and adolescents, respectively, 19.9% and 22% slept less than they did before lockdown, whereas 21.4% and 27.4% slept for more hours. Bedtime delay and decreased sleep duration were associated with an increase in screen time exposure. Moreover, patients with ADHD reported an increase in sleep disturbances when compared to their previous condition, mainly including difficulties falling asleep, anxiety at bedtime, night awakenings, nightmares, and daytime sleepiness.

Concept of Sleeping Pattern

Sleep is essential for recovery from illness. As Researchers have shown a growing interest in the sleep of hospitalized patients. Although many studies have been conducted over the past years. Of all studies, 76% reported poor sleep quality and insufficient sleep duration in hospitalized patients. Children sleep on average 0.7–3.8 hours less in the hospital than recommended.

Hospitalized adults sleep 1.3–3.2 h less than recommended for healthy people. This underscores the need for interventions to improve sleep during hospitalization to support recovery. Sleep is an active process associated with physiological changes that involve multiple organ systems, and is vital for the maturation and daily functioning of infants, children and adolescents.

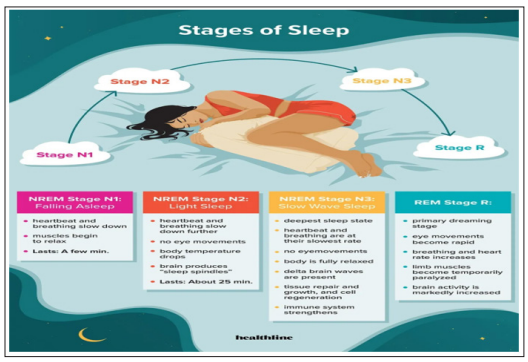
Short Term Consequences of Insufficient sleep

Daytime sleepiness, reduced alertness, poor emotion regulation, increased pain perception, memory loss and difficulties with decision-making . It is also associated with an increased risk of fall incidents and delirium.

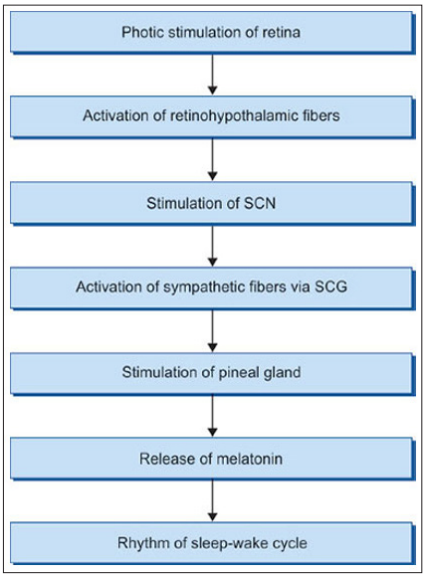
Long-Term Health Consequences of Insufficient Sleep

Anxiety, hypertension, cardiovascular disease, weight-related issues, dyslipidemia, and type 2 diabetes mellitus.

Physiology of Sleep Pattern NREM Flow Chart



Stages of Sleep



Physiology of Sleep.

Developmental Stages in Sleep Pattern

3.	Stage	Age	Pattern of Sleep
3.1	Newborns	(0-3 months)	Sleep Duration: Newborns typically sleep 14-17 hours per day, with sleep distributed irregularly throughout the 24-hour period. Sleep Cycle: Frequent waking for feeding is normal, and sleep cycles are shorter than those in older children and adults. REM Sleep: A significant portion of sleep time is spent in REM sleep, which is vital for brain development.
3.2	Infants	(4-11 months)	Sleep Duration: Infants require about 12-15 hours of sleep per day. Sleep Consolidation: Sleep becomes more consolidated with longer nighttime sleep and fewer daytime naps. Circadian Rhythms: Circadian rhythms start to establish, leading to more predictable sleep patterns.
3.3	Toddlers	(1-2 years)	Sleep Duration: Toddlers need 11-14 hours of sleep per day. Sleep Patterns: Typically, they have one long nap during the day and extended nighttime sleep. Sleep Challenges: Night awakenings and bedtime resistance are common as toddlers test boundaries and assert independence.
3.4	Preschoolers	3-5 years	Sleep Duration: Preschoolers should get 10-13 hours of sleep per day. Sleep Consolidation: The need for daytime naps decreases, and sleep is more consolidated during the night. Common Issues: This age group is prone to nightmares and night terrors.
3.5	School-Age Children	6-13 years	Sleep Duration: 9-11 hours of sleep per day is recommended. Sleep Stability: Sleep patterns become more stable and consistent. Influences: Increased academic and extracurricular activities can impact sleep duration and quality.
3.6	Adolescents	(14-18years)	Sleep Duration: Adolescents require 8-10 hours of sleep per day. Circadian Shifts: Biological changes lead to a natural shift toward later sleep and wake times. Sleep Deprivation: Common due to early school start times, academic pressures, social activities, and technology use

Importance of Sleep Pattern

Sleep problems and poor sleep hygiene are not uncommon in children. Significant contributory factors to these were reduced physical activity in children and screen time more than 2 hours per day. Parents, educators and health professionals should be aware of the importance of good sleep hygiene in ensuring good health not only in childhood but also in adulthood. Sleep is essential to refresh and rejuvenate the body and mind. An average person spends a third of their life sleeping (122 d every year). It is a good practice to emphasise the benefits of sleep to provide a positive message to children, parents, and carers. Measures must be taken to promote physical activities and reduce screen time in children to ensure good sleep hygiene to avoid sleep problems. This can go a long way in reducing the morbidity caused by sleep problems and promoting good health especially in adulthood

Assessment & Evaluation of Sleep Pattern

Assessing and evaluating sleep patterns, especially in pediatrics, involves a combination of subjective reports from parents or caregivers, clinical interviews, sleep diaries, and objective tools such as actigraphy or polysomnography. The aim is to gather a comprehensive understanding of a child's sleep behaviors, routines, and any potential disruptions

Clinical History and Interviews

1. **Sleep History:** Detailed information is gathered from the child's parents or caregivers. This includes questions about:
- Bedtime routines
- Sleep duration (time spent sleeping and in bed)
- Sleep onset latency (time taken to fall asleep)
- Night awakenings (frequency, duration, and cause)
- Sleep environment (e.g., bedroom conditions)
- Daytime functioning (mood, behavior, attention span)

2. **Medical History:** Investigating whether any underlying medical conditions such as allergies, asthma, or obstructive sleep apnea are contributing to sleep disturbances.
3. **Psychosocial Factors:** Inquiring about stressors in the child's life, including anxiety, school difficulties, or family dynamics.

Sleep Questionnaires and Scales

Standardized tools are used to quantify and evaluate sleep behaviors, sleep quality, and potential sleep disorders.

- **Children's Sleep Habits Questionnaire (CSHQ):** Assesses common sleep behaviors in children and screens for sleep disorders.
- **Pediatric Sleep Questionnaire (PSQ):** Often used to screen for sleep-disordered breathing and snoring.
- **Epworth Sleepiness Scale for Children and Adolescents:** Assesses daytime sleepiness levels, a common indicator of poor nighttime sleep.
- **Sleep Disturbance Scale for Children (SDSC):** Evaluates various domains such as bedtime resistance, sleep onset delay, and parasomnias.

Sleep Diaries

Parents or older children keep a record of the child's sleep patterns over a period (typically one to two weeks). This diary captures:

- Bedtime and wake-up time
- Time taken to fall asleep
- Night awakenings and duration
- Naps during the day
- Sleep environment factors (noise, temperature, light)

Sleep diaries help in identifying patterns and potential triggers for disrupted sleep, as well as distinguishing between weekdays and weekends.

Objective Sleep Monitoring

- **Actigraphy:** A wrist-worn device that measures movement and estimates sleep-wake cycles over time. Actigraphy is

useful for assessing sleep patterns in a naturalistic home environment, particularly for children with suspected sleep disorders like insomnia or delayed sleep phase syndrome.

- **Polysomnography (PSG):** The gold standard for diagnosing sleep disorders. It involves an overnight study conducted in a sleep lab, measuring brain waves (EEG), muscle activity (EMG), eye movements (EOG), heart rate (ECG), and breathing patterns. PSG is especially useful in diagnosing sleep apnea, parasomnias, and periodic limb movement disorders.

Behavioral and Psychological Assessment

- **Cognitive and Emotional Evaluation:** In cases where sleep issues may be linked to anxiety, depression, or ADHD, a psychological evaluation may be necessary to assess any underlying emotional or behavioral issues that could be affecting sleep.
- **Daytime Functioning:** Assessing how poor sleep affects the child during the day, such as through mood disturbances, attention deficits, or behavioral changes.

Parental Reports

Parent-reported observations are essential, especially for younger children who cannot provide reliable accounts of their sleep problems. Parents are often asked to describe:

- Bedtime routines and rituals
- Sleep behaviors (snoring, kicking, sleepwalking, etc.)
- Frequency and duration of night wakings
- Perceived daytime consequences of poor sleep

Sleep Disorder Screenings

- **Obstructive Sleep Apnea (OSA):** If there's concern about OSA, snoring, gasping, and breathing pauses are evaluated. Polysomnography is often used to confirm OSA.
- **Restless Legs Syndrome (RLS):** If RLS is suspected, a clinical history of discomfort in the legs, especially at night, and an evaluation of iron levels might be required.
- **Insomnia:** Sleep onset issues or night wakings are evaluated, particularly in older children and adolescents.
- **Parasomnias:** Disorders such as sleepwalking, night terrors, and nightmares are assessed based on behavioral descriptions provided by the parents.

Evaluation of Environmental and Lifestyle Factors

- **Screen time:** Assessing the use of electronic devices before bed and the impact of blue light exposure on melatonin production.
- **Sleep Environment:** Evaluating whether the child's room is conducive to sleep (e.g., lighting, noise, comfort).
- **Bedtime Routines:** Understanding the consistency of pre-sleep activities, as irregular routines can lead to fragmented sleep.

Feedback from School

Teachers may provide feedback about a child's daytime behavior and attention span, which can be indirectly related to sleep problems, especially for older children.

Disorders Related to Sleep

Sleep problems suffer from under-reporting by parents and under-diagnosis by primary care physicians, but are conservatively estimated to occur in approximately 25% of healthy children younger than 5 years and in up to 80% of children with special health care needs. Estimates of prevalence of sleep disorders in children vary more widely for behavioral sleep problems like insomnia than organic sleep problems like OSA.

Consequently, disruption of the complex interplay between sleep and other physiological processes can lead to significant medical consequences. Sleep disorders, like obstructive sleep apnea (OSA) can lead to derangements in function that contribute to significant morbidity and even mortality. Sleep can also be disrupted by many organ-specific diseases like asthma, sickle cell disease, renal failure, or depression that alter the course of a particular medical condition and result in a poorer quality of life.

Sleep disturbances in children are classified as behavioral insomnias of children, sleep-related breathing disorders, parasomnias, sleep-related movement disorders, circadian rhythm disorders or hypersomnias. These sleep disorders may be associated with excessive daytime sleepiness (rare in young children), hyperactivity–impaired attention, poor school performance from impaired concentration and vigilance, and behavior problems including irritability.

Childhood Insomnia

Childhood insomnia occurs when a child has difficulty falling and staying asleep at least three days a week. Refusal to go to bed or difficulty falling asleep without the help of a parent or object, such as a favorite toy or blanket, are common types of childhood insomnia.

Delayed Sleep Phase Syndrome

Delayed sleep phase syndrome, also known as "sleepy teen" syndrome, is an exaggerated form of the normal shift in circadian rhythm, or biological clock, that occurs during late childhood or early adolescence.Children with this disorder are unable to fall or stay asleep until two or more hours past their normal bedtime, making it difficult to wake up in the morning in time for school or other activities. Children with delayed sleep phase syndrome also tend to sleep much later than normal on the weekends.

Hypersomnia

A child or adolescent with hypersomnia has excessive daytime sleepiness. One condition that can result in hypersomnia is narcolepsy, a neurological condition that causes frequent daytime dozing, a temporary loss of muscle control, and hallucinations that occur as a child falls asleep or wakes up. Other conditions that disrupt sleep, such as delayed sleep phase syndrome or obstructive sleep apnea, can cause hypersomnia. Excessive daytime sleepiness can also be a sign of a concussion, epilepsy, or other medical problems. Careful diagnosis is critical to identifying the best treatment for hypersomnia in children.

Parasomnias

Parasomnias are undesirable physical events or experiences that are common in younger children while they are falling asleep; during deep, or rapid eye movement (REM), sleep; or during arousal from nonrapid eye movement sleep. Common parasomnias—such as sleepwalking; awakening in a confused state; and sleep terrors, in which a child suddenly becomes frightened in the middle of the night—typically occur during arousal from non-REM sleep. During REM sleep, children can have vivid nightmares. Some children are temporarily unable to move the body, head, or limbs during the period between sleep and wakefulness, and others have hallucinations as they begin to wake up from sleep.

Movement Disorders

Movement disorders, such as restless legs syndrome and periodic limb movement disorder, are neurological conditions that cause unpleasant sensations in the legs and an overwhelming urge to move them. Symptoms tend to be worse at night and can interfere with your child's sleep. These two movement disorders frequently occur together.

Obstructive Sleep Apnea

Obstructive sleep apnea interferes with a child's breathing during sleep. Children with the condition snore or gasp for air and are awakened frequently throughout the night. Obstructive sleep apnea is common in children who have enlarged tonsils or adenoids or in those who have structural problems of the face or head, such as cleft lip and palate. Sleep apnea also can occur in children with neuromuscular disorders, such as muscular dystrophy, which weaken the muscles involved in breathing.

Behavioral and Mental Health Disorders

Children with behavioral disorders, such as autism spectrum disorder and attention deficit hyperactivity disorder, or mental health problems—such as anxiety and mood disorders—often have insomnia. The medications prescribed for these conditions can also interfere with sleep.

While some childhood sleep disorders need only medical history to be properly diagnosed and managed, some infants and children require an analysis of the child actually sleeping, called an overnight sleep study or polysomnography (PSG), to accurately diagnose their sleep-related condition. During an overnight PSG, the sleeping child's physiological signals are recorded under the direct supervision of specially trained sleep technicians, who attach monitoring sensors to special computer software and adjust them during the night. The technician also provides observations about the child's sleep that are invaluable in making an accurate diagnosis. Video monitoring is also incorporated into the PSG, allowing review of movements necessary to diagnose nocturnal seizures, which occur in about 20% of children with epilepsy. Te physiological data collected during a PSG provide a picture of clinically useful information about different sleep stages, sleep disruption, respiratory status during different sleep stages, leg movements, and changes in cardiac rate and rhythm during sleep. For instance, episodes of OSA may consist of decreased airflow in spite of normal respiratory effort in thoracic and abdominal belts, changes in electroencephalogram (EEG) pattern called arousals, cardiac deceleration, and oxygen desaturation. These findings may be mild during non-random eye movement (non-REM) sleep but profound during REM sleep.

Prevention & Management strategies Of Sleep Disorders

Children and adolescents benefit from healthy sleep behaviors and habits. If your child has trouble falling asleep, behavioral changes can help. Behavioral treatment is the first-line treatment of choice for insomnia and should always be included. Establish a regular bedtime routine for your child, so that he or she goes to sleep and wakes up at a similar time every day. Put your child to sleep in a room that is dark, quiet, and cool. Keep electronic devices, such as digital screens and televisions, out of your child's bedroom.

Pharmcological Management

Pharmaceutical	Class	Mechanism of action	Half life (h)	Site of metabolism	Peak concentration	Interactions	Effect on sleep
Hydroxyzine Diphenhydramine	Antihistamine	H1 agonist. Crosses blood-brain barrier	4-6	Hepatic	Fast absorption. Fast onset of action. Peak at 2-4 h	CNS depressants	Reduces latency. May decrease quality
Hydroxyzine	Antihistamine	H1 agonist. Crosses blood-brain barrier	6-24	Hepatic	Fast absorption. Fast onset of action. Peak at 2-4 h	CNS depressants	Reduces latency. May decrease quality
Melatonin	Neuro-hormone	Hypnotic	90% excreted in 4	Hepatic	30-60 min	Unknown	Reduces latency. Maximum circadian effect
Clonazepam	Benzodiazepine	Central GABA receptors	30-40	CYP 450 3A oxidation	60-240 min	Fluoxetine	Suppresses slow-wave sleep. Reduces arousal
Flurazepam	Benzodiazepine	Central GABA receptors	2-100	CYP 450 3A oxidation	30 min to 13 h	Fluoxetine	Suppresses slow-wave sleep. Reduces arousal
Zolpidem	Z-drug	Benzodiazepine-like	2.5-3	CYP 450 3A oxidation	90 min		Reduces latency. Weak effect on sleep architecture
Clonidine	Alpha agonist	Inhibits noradrenaline release	6-24	50%-80% in urine	Fast absorption 100% bioavailability. Onset of action: 1 h. Peak effect: 2-4 h		Reduce REM. Reduces slow-wave sleep

Conitive Behavioral Therapy

Cognitive-behavioral therapy (CBT) that are effective in treating a broad range of childhood behavioral sleep problems. The effectiveness of CBT for childhood sleep disorders has been well demonstrated in controlled studies and clinical case reports.

CBT uses relatively straightforward and safe strategies for enhancing overall parenting effectiveness as well as ameliorating the aforementioned problems. Such strategies include the following:

- **Extinction Technique:** This technique involves the parents putting their child to bed at a designated time and ignoring the child's or infant's protests until an established time the next morning
- **Graduated Extinction:** Many parents may experience or perceive pure extinction as overly taxing or cruel; therefore, a graduated extinction technique may be used, which may include progressive time delays in responding to bedtime protests or refusals (ie, a checking technique) or may involve comforting for increasingly shorter intervals when checking on the child

- **Positive Routine-Stimulus Control Technique:** This technique involves developing a consistent, pleasurable, and calming nighttime routine, with pleasurable activities being halted if the child protests or throws a tantrum; the child is then put to bed
- **Scheduled Awakenings:** Parents awaken the child approximately 15 minutes before his or her typical nightly awakening times; the scheduled awakenings then are gradually stopped or tapered off

Behavioural Strategies

- **Alarm Clock Method:** An alarm is set before the most probable time of the event (as suggested by preceding enuretic episodes); the alarm may be set for a predetermined time, such as 2-3 hours after usual onset of enuresis; children eventually avoid wetting themselves before the alarm is triggered (in contrast with the bell and pad method); longer treatment duration results in a higher success rate.
- **Parent Education:** Parents need to know that sleep hygiene practices serve as prevention of enuresis; fluid restriction, bedtime voiding, and parent awakening later are components of sleep hygiene (see Patient Education); the earlier the child begins practicing sleep hygiene, the better; individual families may require creative combinations of the aforementioned interventions.

Conclusion

Sleep difficulties and sleep disorders are more prevalent in children and adolescents with NDEBID. They can result in a significant impact on the child's cognitive development, behaviour, physical and mental health. This can also affect peer and family relationships. It is important for clinicians to evaluate for sleep disorders when assessing children and adolescents with cognitive, behavioral, and emotional problems. Assessment can include screening tools such as BEARS questionnaire, Child Sleep Habit Questionnaire, a 2-wk sleep diary and relevant physical examination in order to identify sleep schedule and duration and any underlying potential sleep disorders. Parents/carers should be provided with sleep/psychoeducation. Sleep hygiene measures and also specific behavioral interventions where appropriate should be offered as first line management for sleep disorders such as behavioral insomnia and certain parasomnias [1-5].

This narrative review of the extant literature provides a brief overview of sleep physiology, aetiology, classification and prevalence of sleep disorders among CYP with NDEBIDs. It outlines various strategies for the management, including parenting training/psychoeducation, use of cognitive-behavioral strategies and pharmacotherapy. Practical management including assessment, investigations, care plan formulation and follow-up are outlined in a flow chart.

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