

# Understanding the Relationship Between Asthma and Sleep in the Pediatric Population

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## ABSTRACT

The Centers for Disease Control and Prevention reports that 9.5% of children have been diagnosed with asthma. Sleep disturbances affect 20% to 30% of the pediatric population. The prevalence of nocturnal symptoms of asthma is high, and most children regularly experience nighttime symptoms. Sleep is important for growth and development, and untreated sleep disturbances have adverse effects on school performance, mental health, physical health, and functioning. This review will explore the relationship between asthma and sleep disturbances. Clinicians need to assess children with asthma for sleep disturbance. *J Pediatr Health Care.* (2016) ■, ■-■.

## KEY WORDS

Pediatrics, asthma, sleep disturbance

Asthma is the most prevalent chronic illness experienced by American children today. It is estimated that approximately seven million children (9.5%) younger than 18 years have asthma ([Centers for Disease Control and Prevention \[CDC\], 2013](#)). The CDC reports

higher rates of asthma among non-Hispanic Black children (14%) and multi-race children (13.2%) compared with White children (7.4%; [CDC, 2013](#)). Among children younger than 15 years, asthma is the third-leading cause of hospitalizations ([American Lung Association \[ALA\], 2014](#)). Collectively, children with asthma miss an estimated 14.4 million days of school each year, making it one of the most frequent reasons for school absenteeism ([ALA, 2014](#)). Furthermore, in 2007, the health care costs associated with asthma were estimated to be \$56 billion, with indirect cost accounting for \$5.9 billion ([Barnett & Nurmagambetov, 2011](#)). The cost of asthma per person is \$3,259, which is up from \$1,005 in 2004 ([Barnett & Nurmagambetov, 2011](#)). Since 1999, the number of deaths related to asthma has decreased by 8.5%; nonetheless, 3,630 deaths were still attributable to asthma, including 218 children younger than 18 years of age ([CDC, 2015](#)).

Sleep is an important part of promoting healthy living. In pediatrics, approximately 20% to 30% of children are affected by a sleep disturbance ([Gerber, 2014](#); [Singareddy et al., 2009](#); [Teng, Bartle, Sadeh, & Mindell, 2011](#)). Sheares and colleagues found that the prevalence of sleep disturbance in a minority urban, early school age population was 94%, and they suggested that sleep disruptions in urban minority populations were more prevalent than previously thought, underreported by parents, and affected by low income, overcrowding, exposure to tobacco, community violence, maternal depression, and poorly controlled asthma ([Sheares et al., 2013](#)). Consequences of sleep disorders in children are altered immune function, anxiety, attention deficit problems, behavioral issues, depression, hormone imbalance, risk factors affecting the cardiovascular and metabolic systems, poor academic performance, and substance abuse

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(Beebe, 2011; Gregory & Sadeh, 2012; National Institutes of Health [NIH], 2011; Roberts, Roberts, & Duong, 2008). Persistent nocturnal asthma symptoms and sleep disorders have been reported in about 59% of children with asthma (Fagnano, Bayer, Isensee, Hernandez, & Halterman, 2011). Nighttime waking and daytime sleepiness is a chronic problem in children with asthma (Li et al., 2013; van Maanen et al., 2013), and a sleep assessment is an important part of every well-child visit and integral part of caring for children with asthma (Li et al., 2013).

The national asthma guidelines recommend periodic assessment of key areas of quality of life related to nighttime sleep disturbances (National Heart, Lung, and Blood Institute [NHLBI], 2007). The goal of asthma therapy is to improve quality of life and reduce symptoms, exacerbations, and asthma-related deaths (NHLBI, 2007). To reduce impairment and risk for children with asthma, identification and control of nocturnal symptoms are important to improve pulmonary function and quality of sleep.

The goal of this review is to explore the relationship between asthma and sleep disturbance in children. Because of the high morbidity and mortality rates related to asthma and the economic and social implications, it is imperative that health care providers have an understanding of the relationship between pediatric asthma and sleep. Thus the purpose of this review is to (a) describe the historical perspective of asthma and sleep, (b) review the pathophysiology of asthma and sleep, (c) critically review the literature on sleep problems and asthma in children, and (d) discuss the role of the advance practice registered nurse (APRN) in managing these two co-occurring problems. In addition, implications for future research to improve our understanding of the relationship between asthma and sleep and its treatment will be discussed.

## SLEEP AND ASTHMA: HISTORICAL PERSPECTIVES

The word *asthma* is derived from the Greek word *aazein*, meaning to exhale with an open mouth or panting, which included many conditions. Asthma was first described in the second century by Aretaeus, a physician from Greece (Karamanou & Androutsos, 2011). Aretaeus recognized the relationship between asthma and exercise, thick secretions caused by

coldness and humidity, the increased incidence in women, and that children recovered faster from the breathing problems than did adults (Karamanou & Androutsos, 2011). In the 1860s, Dr. Salter discussed the role of asthma and the relationship with viral respiratory infections. Dr. Salter described asthma as having pathologic changes in the respiratory tract and disordered physiology (Cohen, 1997). He understood the role of infection, heredity, allergens, environment, weather, diet, emotions, and the variations in daytime and nighttime symptoms (Cohen, 1997). In the 19th century, treatment was smoking a specific Indian herb called *Datura stramonium* (thorn apple) or “asthma cigarettes,” which contained an atropine-like alkaloid and acted as a bronchodilator (Holgate, 2011). In the 1920s, asthma was better defined, but treatment was limited to “asthma cigarettes” and removal of allergens (von Mutius & Drazen, 2012). Inhaled therapy was introduced in 1940s with epinephrine as the drug of choice (von Mutius & Drazen, 2012). Spirometry was developed in the 1840s but not used until the late 1940s and early 1950s. Forced exhalation measurements and the ability to show a response to bronchodilators helped with the diagnosis of asthma (von Mutius & Drazen, 2012). In 1950, glucocorticoid steroids were introduced as a systemic therapy followed by inhalation therapy as we know it today (von Mutius & Drazen, 2012). Therapeutic options have increased during the past couple of decades, but the disease is a more complex disorder than was once thought (Holgate, 2011).

In the early centuries, interest in sleep was related to dreams (Todman, 2007). Insomnia was first recorded in the ancient Egyptian texts, with the use of opium to treat this condition (Todman, 2007). In 1913, a French research and author, Henri Pieron, described sleep as a physiological entity, and his book was considered the first of modern times.

Electroencephalography was developed in 1929 and was used to examine brain activity during sleep. Dr. Nathaniel Kleitman, the father of American sleep studies, began his work in the 1920s on sleep rhythms (Colten & Altevogt, 2006). In 1953, Dr. Kleitman and colleagues first observed rapid eye movement during sleep and Dr. Dement went on to describe the stages of sleep (Colten & Altevogt, 2006). Since the 1950s, researchers of other medical disciplines have become interested in the effect of sleep on different organs. In 1993, The National Center of Sleep Disorders Research, which is part of the NIH, was developed to conduct and support research related to understanding sleep and sleep disturbances.

## PHYSIOLOGY AND PATHOPHYSIOLOGY OF SLEEP AND ASTHMA

Sleep is an essential part of promoting health. In pediatrics, sleep is needed for adequate growth and development. Circadian rhythm begins to regulate in the

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newborn between 10 to 12 weeks of age (Galland, Taylor, Elder, & Herbison, 2012). Infants become less nocturnal with the aid of parents, but night awakenings are common (Galland et al., 2012). Between 1 to 4 years of age, naps decrease in number and nighttime sleep increases to maintain adequate sleep requirements. Over time, sleep requirements decrease and are affected by many factors, including behavioral, environmental, social issues, school schedules, acute and chronic disease, psychiatric disorders, and cultural practices (Galland et al., 2012; Jenni & Werner, 2011; Lewandowski, Ward, & Palermo, 2011; Owens & Mindell, 2011).

Biology plays an important part in sleep behavior (Jenni & Werner, 2011). Alterations in the sleep-awake cycle are affected by a complex system of biological, psychological, developmental, and cultural influences (Wyatt, 2011). Circadian rhythm and the sleep homeostasis system are important in the regulation of sleep and wakefulness (Wyatt, 2011). The circadian rhythm is controlled by a group of cells called the suprachiasmatic nucleus in the hypothalamus that responds to the 24-hour light-dark cycle. The signal is responsible for regulating the sleep-awake rhythm (Wyatt, 2011). Hormones such as cortisol and melatonin also play a role in the regulation of the sleep-awake cycle.

Asthma is a chronic inflammatory respiratory condition causing repeated episodes of wheezing, shortness of breath, chest tightness, and nighttime or early morning coughing (Maslan & Mims, 2014). The specific cause of asthma is not known, but genetics plays a role in its development. Pathologic features of asthma include bronchoconstriction, shedding of the airway epithelium, airway inflammation, and mucus plug formation. Airway inflammation is considered to be a key factor in the pathogenesis of asthma. Airway inflammation in asthma contributes to airway hyper-responsiveness, airflow limitation, and disease chronicity. Persistent airway inflammation can lead to airway remodeling and irreversible changes (Maslan & Mims, 2014).

Nocturnal asthma symptoms are characterized by cough, wheezing, shortness of breath, chest tightness, nighttime awakening, and disturbed sleep (Atanasov & Calhoun, 2007; Greenberg & Cohen, 2011). Factors that may contribute to nocturnal symptoms or increase bronchoconstriction at night include nocturnal variations in circadian rhythm, exposure to environmental allergens and cold air, co-morbid medical conditions such as gastroesophageal reflux disease, obstructive sleep apnea, obesity, or sleep positions that result in decreased lung volume (Atanasov & Calhoun, 2007; Greenberg & Cohen, 2011). Poor sleep quality, daytime sleepiness, and decreased quality of life can affect immune function, learning, and emotional well-being (Atanasov & Calhoun, 2007; Gerber, 2014).

## REVIEW OF LITERATURE ON SLEEP PROBLEMS AND ASTHMA

Before 1990, few studies regarding the effects of nocturnal asthma symptoms were performed with children (Diette et al., 2000). Diette and colleagues (2000) described the impact of nighttime symptoms on school attendance, academic performance, and missed days of work for parents. They found that half of children with one to three night awakening per month missed school, their school performance suffered, and their parents missed 1 day of work in the month (Diette et al., 2000).

Sleep disturbances in children with asthma have reported as daytime sleepiness and tiredness, difficulty maintaining sleep, and awakening early in the morning (Chugh, Khanna, & Shah, 2006; van Maanen et al., 2013). In one study it was found that even children with stable asthma did not report sleep disturbances, and these investigators recommended that providers screen for sleep disturbances (Chugh et al., 2006). Multiple studies of urban children with asthma have been performed, and it was found that 59% had nighttime symptoms and almost half (46%) had one night per week of disrupted sleep (Fagnano et al., 2011). These findings are related to missed days from school, limitation of activities, including sports, more emergency department (ED) visits, and a decrease in the caregiver's quality of life (Daniel, Boergers, Kopel, & Koinis-Mitchell, 2012). In urban adolescents, researchers found sleep-wake behavior problems and undiagnosed asthma (Koinis-Mitchell, Kopel, Williams, Cespedes, & Bruzzese, 2015). The study results highlight the importance of considering asthma as a cause of sleep disturbance (Koinis-Mitchell et al., 2015).

In a systematic review of the literature, a significant relationship between asthma severity and quality of life in children was found (Everhart & Fiese, 2009). This review emphasized the importance of assessing asthma severity when health care providers evaluate patients and the importance of controlling asthma symptoms (Everhart & Fiese, 2009).

Poor asthma control has been found to be associated with poor quality of life, poor quality of sleep, and daytime sleepiness (Li et al., 2013; van Maanen et al., 2013). The authors emphasize the importance of evaluating nighttime and daytime symptoms when evaluating patients with asthma (Li et al., 2013; Molzon et al., 2013).

The relationship between asthma control and sleep has been studied. The use of asthma controller medications has been found to reduce nighttime symptoms and daytime sleepiness (Garrison, Lozano, & Christakis, 2011). The use of leukotriene inhibitors has also had a positive effect on sleep problems; the researchers suggest that this positive effect may be due to the high rates of obstructive sleep apnea (OSA) and

allergic rhinitis among children with asthma (Garrison et al., 2011). The researchers also evaluated controller adherence rates and found a decrease in daytime sleepiness when patients adhered to their medication (Garrison et al., 2011).

A review by Khan, Mohsenin, and D'Ambrosio (2014) on asthma and sleep found that the cause of nocturnal asthma is not fully understood. Increased inflammation and airway resistance affects the airways and causes decreased airway flow rates during sleep (Khan et al., 2014). Bronchial hyper-reactivity is also increased during sleep and may be related to allergen exposure, airway cooling, hormonal changes, and parasympathetic tone (Khan et al., 2014).

## CLINICAL IMPLICATIONS

APRNs need to understand the impact of asthma on sleep when caring for patients with asthma. A detailed history is an important part of establishing an accurate diagnosis of asthma and identifying sleep disturbances. Health care providers should ask patients about coughing, especially coughing at night, and whether breathing problems are worse after physical activity or during a particular time of year. Providers should also ask about other symptoms, such as chest tightness, wheezing, and upper respiratory infections that last more than 10 days. Inquiring about a family history of asthma, allergy, eczema, other respiratory issues, and the home environment is also important. Family history may contribute substantially to the development of asthma and other atopic conditions and may be a clue to diagnosis. Adherence to treatment is an important aspect to consider when reevaluating patients with continued asthma symptoms, especially at night. Environment factors affecting asthma also need to be assessed to reduce nighttime symptoms.

Clinicians should be familiar with normal sleep patterns of children and routinely ask about sleep at each well-child and asthma-focused visit. Poorly controlled asthma can affect sleep and the quality of life of both the child and family and lead to chronic sleep deprivation, which affects patients in profound ways. Providers need to screen patients for nocturnal asthma symptoms and sleeping disturbances. Appropriate use of controller medication is important therapy to initiate and escalate as needed for better control, with careful follow-up because of the variation of the disease. Nurses need to educate the child and family on the

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importance of sleep, asthma control, and medication use. APRNs need to assess patients for other factors that cause or exasperate nocturnal asthma symptoms and sleep disturbances, such as allergic bronchopulmonary aspergillosis, allergic rhinitis, gastroesophageal reflux disease, obesity, OSA, sinusitis, chronic stress, depression, psychosocial factors, and nonadherence to medication (Khan et al., 2014; Koinis-Mitchell, Craig, Esteban, & Klein, 2012; NHLBI, 2007; Ross, 2013; Teodorescu et al., 2006). APRNs have an important role in studying interventions to reduce severity of asthma and improve quality of life for children with asthma. Referral to pulmonary medicine for poorly controlled asthma, symptoms of OSA, or a sleep disorder is recommended (Ross, 2013). It is also important to include the family in the focus of an intervention, including better education to effectively improve treatment. Providers need to understand the importance of poor asthma control on quality of life and sleep. APRNs can have a positive impact on patients and their families by identifying and treating asthma and sleep disorders.

The literature suggests that the burden of nocturnal asthma symptoms and sleep disturbance is a major concern. Future research should focus on the relationship between sleep deprivations and ways to improve health outcomes for children with nocturnal asthma. There is a need to develop an asthma-related sleep questionnaire for families and children to further assess sleep disturbance and to assess co-morbid conditions. The use of more objective data needs to be studied to better understand sleep disturbances in children with asthma.

**Routine screening for sleep disturbances and nocturnal asthma is an important part of caring for children with asthma.**

Sleep studies provide a more accurate assessment of sleep disturbance but are expensive and difficult for the families to undertake. The effects of co-morbidities on asthma also need to be studied to gain better insight on evaluation and treatment. Research on the effect of asthma, sleep, and children living in a poor urban population is another important area to study.

In summary, the relationship between sleep and asthma is important to consider when caring for children with asthma. The root cause of sleep disturbance in children with asthma is unclear. Sleep disturbances have a negative effect on the quality of life of patients and families and have resulted in impairments in cognitive functioning, academic achievement, and physical, behavioral, and mental health. Routine screening for sleep disturbances and nocturnal asthma is an important part of caring for children with asthma.

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