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Nocturnal Asthma Symptoms and Poor Sleep Quality among Urban School Children with Asthma

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Abstract

Objective—To describe nocturnal asthma symptoms among urban children with asthma and assess the burden of sleep difficulties between children with varying levels of nocturnal symptoms.

Methods—We analyzed baseline data from 287 urban children with persistent asthma (ages 4–10) enrolled in the School-Based Asthma Therapy trial; Rochester, NY. Caregivers reported on nocturnal asthma symptoms (# nights/2 weeks with wheezing or coughing), parent quality of life (Juniper's PACQLQ), and sleep quality using the validated Children's Sleep Habits Questionnaire. We used bivariate and multivariate statistics to compare nocturnal asthma symptoms with sleep quality/quantity and quality of life.

Results—Most children (mean age 7.5yrs) were Black (62%); 74% had Medicaid. Forty-one percent of children had intermittent nocturnal asthma symptoms, 23% mild persistent, and 36% moderate to severe. Children's average total sleep quality score was 51 (range 33–99) which is above the clinically significant cut-off of 41, indicating pervasive sleep disturbances among this population. Sleep scores were worse for children with more nocturnal asthma symptoms compared to those with milder symptoms on total score, as well as several subscales including night wakings, parasomnias, and sleep disordered breathing (all $p<.03$). Parents of children with more nocturnal asthma symptoms reported their child having fewer nights with enough sleep in the past week ($p=.018$) and worse parent quality of life ($p<.001$).

Conclusions—Nocturnal asthma symptoms are prevalent in this population, and are associated with poor sleep quality and worse parent quality of life. These findings have potential implications for understanding the disease burden of pediatric asthma.

Keywords

asthma; childhood; symptoms; sleep; quality of life; smoke

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Background

Asthma is one of the most common chronic diseases affecting children in the United States.[1, 2] In particular, underserved and minority populations are significantly burdened by asthma morbidity and also suffer higher rates of asthma-related emergency department visit, hospitalization, and death.[1]

Illnesses like asthma, which often include nighttime symptoms, can negatively affect the quantity and quality of a child's sleep. Poor sleep can cause daytime sleepiness, poor school attendance and performance, and parental work absenteeism.[3] Additionally, childhood sleep problems may have significant and lasting effects on mental health as they have been linked to anxiety and depression, aggressive behaviors, and attention problems in adulthood.[4]

Existing research suggests a relationship between asthma and sleep problems.[5–7] Asthma has been associated with poorer sleep quality, even among children with well-controlled, stable symptoms.[8] However, it is not clear how the relationship between sleep quality and asthma is affected by varying degrees of nocturnal asthma symptoms or how it contributes to the burden of asthma on families. The extent of sleep problems among urban school children with asthma merits further investigation.

Understanding the burden of nocturnal asthma symptoms and poor sleep quality is important in understanding the total impact of asthma on the child and the family. Additionally, sleep quality may be an area that warrants more attention from health care providers in the treatment and control of pediatric asthma. Our objectives for this study were to describe nocturnal asthma symptoms among a group of urban children with persistent asthma, and to assess the burden of sleep difficulties among children in this group with varying levels of nocturnal symptoms. We hypothesized that nocturnal asthma symptoms affect the majority of these children, and that increased nocturnal symptoms would negatively affect the children's quality of sleep, as well as children and parent's quantity of sleep and parent quality of life.

Methods

We used baseline data from the School-Based Asthma Therapy (SBAT) trial in Rochester, NY (September 2007- June 2009).[9] We identified children (age 3–10 years) with asthma in the Rochester City School District through school health forms, and performed telephone screening with primary caregivers to assess the severity of the child's asthma. Children were eligible for the SBAT trial if they had physician diagnosed asthma and parent-reported persistent symptoms at the time of screening (primary study's participation rate: 74%). Children were excluded if they had significant medical conditions that could interfere with assessment of asthma outcomes, were unable to speak English, or were planning to leave the school district during the study period. Data for this analysis are from an in-home baseline assessment conducted at the start of the school year (September-November), prior to the initiation of the intervention. During this time period**,** 304 children were enrolled. The University of Rochester's Institutional Review Board approved this study. Informed consent was obtained from all caregivers, and assent from all children ≥7 year old.

Assessment of Child's Nocturnal Asthma Symptoms

To assess nocturnal asthma symptoms we asked parents: "Over the past 2 weeks (14 days), how many nights did your child have any wheezing, coughing, tightness in the chest or trouble breathing?" We then used National Heart Lung and Blood Institute (NHLBI) guidelines[10] to categorize the level of nocturnal asthma severity for each child. Based on the symptoms reported, children were categorized into 3 groups. Those with intermittent

symptoms experienced 0 or 1 night of asthma symptoms in the previous 2 weeks. Children with mild persistent symptoms experienced 2–4 nights of asthma symptoms, and those with moderate/severe persistent symptoms had more than 4 nights of asthma symptoms in the previous 2 weeks.

Assessment of Child's Sleep Quality

We used the abbreviated version of the Children's Sleep Habits Questionnaire (CSHQ)[11] to assess quality of sleep for the children. This is a previously validated 33-item scale comprised of 8 subscales, with a recall period of the previous week. Responses are recorded as "usually," "sometimes," or "rarely." Each question is scored 1–3, (1 = rarely, 2 = sometimes and 3 = usually), and then summed to create a Total Sleep Score (with the total ranging from 33 to 99). Higher scores indicate worse quality of sleep. A total sleep score of 41 on the CSHQ has been reported as a clinical cut off for identification of probable sleep problems.[12]

Appendix A shows the 8 subscales for the Children's Sleep Habits Questionnaire: bedtime resistance (5 items), sleep onset delay (1 items), sleep duration (3 items), sleep anxiety (3 items), night wakings (3 items), parasomnias (7 items), sleep disordered breathing (3 items), and daytime sleepiness (8 items). An example of a question from each subscale is shown.

Assessment of Child's Sleep Quantity

We assessed child's sleep quantity using the following question: "During the past week (7 nights), on how many nights did your child get enough sleep for his/her age?" The mean number of days with enough sleep (range 0–7) is reported. We also asked parents to report the length of time the child usually sleeps each day, including nighttime sleep and naps.

Assessment of Parent's Sleep and Quality of Life

To assess parent's sleep, we asked, "Over the past 2 weeks (14 days), how many nights did you wake up or lose sleep because of your child's asthma?" Parent's quality of life was assessed using Juniper's Pediatric Asthma Caregivers Quality of Life Questionnaire (PACQLQ).[13] This 13-item scale measures the degree to which the child's asthma interfered with the parent's normal daily activities over the past week. Responses range from 1 ("All of the time") to 7 ("None of the time"). The scores are averaged for a mean quality of life score ranging from 1–7, with higher scores indicating better quality of life.

Assessment of Covariates

We assessed children's demographic variables including age, gender, race (Black, White, other), ethnicity (Hispanic, non-Hispanic) and insurance (Medicaid, other). We also collected information regarding the child's exposure to environmental tobacco smoke, and several caregiver measures, including caregiver education (<High School, ≥ High School), and parent depression.

We measured parent depression using the Kessler Psychological Distress Scale (K10).[14] The K10 is a 10-item scale which rates the frequency of experiencing specific instances of depression and anxiety over the past 4 weeks. Each item is scored on a scale of 1 ("None of the time") to 5 ("All of the time") for a range of 10–50, with higher scores indicating a higher risk of depression. A score of ≥ 20 on the K10 was used to define mild to severe depressive symptoms, based on prior use of this scale.[15]

The child's exposure to environmental tobacco smoke was measured both by parent report and by the child's cotinine values. We recorded the number of smokers living in the child's home (how many people living in the child's home smoke?), the smoking status of the

primary caregiver (does the child's primary caregiver smoke?), and the household rules regarding in-home smoking and smoking bans.[16] To further evaluate children's smoke exposure, we also measured salivary cotinine. Salivary cotinine is a biological byproduct of nicotine and can be used as an objective indicator of smoke exposure.[17, 18] Cotinine has been shown to indicate smoke exposure from a period of one to one and a half days prior to sampling.[19] Saliva was collected by program staff members using standard techniques, and samples were transported to Salimetrics Inc. where they were assessed with a standard enzyme-linked immunosorbent assay (ELISA). Results were reported in nanograms per milliliter (ng/ml).

We performed analyses using SPSS version 17 software (Statistical Product and Service Solutions 17.0; SPSS Inc, Chicago, IL). We used bivariate and multivariate statistics to compare nocturnal asthma symptoms and sleep quality, sleep quantity and quality of life. Anova tests were used to compare mean sleep scores and nocturnal asthma severity. We conducted general linear model regression analysis predicting children's quality of sleep and controlling for standard demographic variables (child age, parent education), and parent depression as this measure was significantly different between groups at baseline. Using cotinine as a marker, we also controlled for smoke exposure which has been shown to influence sleep quality.[20] Because the cotinine data were not normally distributed, we used the natural log function to transform the data prior to analysis. A 2-sided alpha <.05 was considered statistically significant.

Results

Among 304 children enrolled in the School-Based Asthma Therapy trial, 287 (94%) were included in this study. We excluded children under the age of four for these analyses because the Children's Sleep Habit Questionnaire (CSHQ) is not validated for children in that age range (n=13). Children with incomplete data also were excluded (n=4).

Of the 287 children in our final data set, only 41% had intermittent nocturnal symptoms, and the remaining 59% had persistent nocturnal symptoms (23% mild persistent, and 36% moderate to severe persistent). On average, children had at least one night with symptoms per week. Overall, parents reported that their children usually slept for a total of 9.0 hours each day (SD 1.6). Table 1 shows the sample population demographics by nocturnal asthma symptoms. The average age of the children was 7.5 years. Most of the children (59%) were male, Black (62%), and had Medicaid insurance (74%). Many of the children used controller medications, with 67%, 73%, and 64% (intermittent, mild persistent, and moderate/sever respectively) reporting current use of a preventive medication. Many of the children's parents never graduated high school (43%) and 35% had symptoms of mild to severe depression. More than half (53%) of the children lived with one or more smokers, 38% of the primary caregivers smoked, and 41% of families had no ban on smoking in the home. The children's total mean cotinine level was 1.28 nanograms per milliliter (SD 2.2).

There was a significant association between parent depression and nocturnal asthma symptoms in this population; with a higher prevalence of parent depressive symptoms among children with more significant nighttime symptoms (intermittent 22%, mild persistent 41%, moderate/severe 45%, p=.001). Compared to children with fewer symptoms, there was a trend for children with more severe nocturnal asthma symptoms to have higher cotinine levels (p=.058). Further, more children with moderate/severe nocturnal asthma symptoms were living in a home with at least one smoker compared to children with less severe symptoms (43%, 59%, 62%, for intermittent, mild persistent, and moderate/severe symptoms respectively, p=.011). Parents of children with more significant nighttime symptoms were also more likely to report not having a home smoking ban.

Table 2 shows nocturnal symptom severity and quality of sleep for this population of children. Overall quality of sleep, as measured by the total sleep score of the CSHQ, was worse for children with more nocturnal asthma symptoms compared to those with milder symptoms (49.8 vs. 50.7 vs. 53.5, for children with intermittent, mild persistent, and moderate/severe persistent nocturnal symptoms, respectively, p=.012). The mean total sleep score for children in each asthma severity level was above the clinically significant CSHQ cut-off of 41, indicating pervasive sleep disturbances among this population of children with asthma. Additionally, there was a trend for the percentage of children above the CHSQ cut-off to increase with increased symptom severity (82.9%, 87.9%, and 92.3% for children with intermittment, mild perisistent, and moderate/severe persistent nocturnal symptoms, respectively, p=.108.) There were also significant associations between nocturnal symptom severity and scores on several sleep subscales, including night wakings, parasomnias, and sleep disordered breathing. These relationships remained significant when controlling for potentially confounding variables including child's age, parent education, parent depression, and smoke exposure (data not shown). There also was a trend for children with more severe nocturnal asthma symptoms to have higher daytime sleepiness scores compared to those with less severe symptoms (14.8, 14.8, 15.9, p=.06). There were no associations between nocturnal asthma symptoms and bedtime resistance, sleep onset delay, sleep duration, and sleep anxiety.

We next considered the relationship between nocturnal asthma symptoms and the quantity of the child's and parent's sleep, while controlling for pertinent confounders (Table 3). Overall, 46% of parents reported that their child did not get enough sleep for at least one night in the prior week. Parents of children with more severe nighttime asthma symptoms reported fewer nights that their child had enough sleep over the past week (5.9 vs. 5.5 vs. 5.2, p=.018, by increasing asthma severity level), and several more days per 2-week period in which they, themselves lost sleep (0.2 vs. 1.6 vs. 4.3, p<.001). Additionally, we found that parents reporting more nocturnal asthma symptoms had significantly lower quality of life scores compared to parents reporting fewer symptoms (5.9, 5.3, 5.0; p<.001). There was no difference in total number of hours of sleep reported for children with different levels of asthma severity.

Discussion

In this study, we found a substantial burden of both nighttime asthma symptoms and poor sleep among urban children with significant asthma. Overall, 59% of children had persistent nighttime asthma symptoms, and nearly half (46%) of children had at least one night per week of inadequate sleep. Children's sleep quality, indicated by the total sleep score on the CSHQ and several subscales, decreased as their nocturnal asthma symptoms increased. The likelihood of the child having inadequate sleep, the parent having lost sleep and poorer parental quality of life incrementally increased as the frequency of nocturnal asthma symptoms increased. Importantly, we found that the mean total sleep score for children in each asthma severity level was above the clinically significant CSHQ cut-off of 41, indicating pervasive sleep disturbances among this population of children with asthma.

A few prior studies have assessed the relationship between sleep disturbance and asthma. Stores et al. explored both subjective and objective sleep disturbances among children with nocturnal asthma, compared to a non-asthmatic control group.[5] Compared to controls, children with nocturnal asthma experienced worse sleep in both polysomnography tests and questionnaires. They also found improvement in sleep after treatment of the nocturnal asthma symptoms. Similarly, Sadeh et al. explored sleep disturbances among children with well controlled asthma using wrist actigraphs to measure sleep disturbances and peak-flow meters to measure pulmonary function.[8] The investigators found that well controlled

asthmatic children experienced poorer sleep quality compared to controls, and peak-flow measures were correlated with sleep quality. However both of these studies were limited by small sample sizes and targeted recruitment from respiratory clinics. Our study is unique in assessing sleep disturbances among a large community sample of young, urban school children with significant asthma symptoms. Unlike previous studies, we examined sleep quality in relation to varying degrees of asthma severity and included important covariates, such as parent depression and smoke exposure. Further, our study explored the burden of nocturnal asthma symptoms on both children and families by considering various forms of childhood sleep disruption, parental sleep and quality of life.

Our use of the Children's Sleep Habits Questionnaire (CSHQ) allowed for collection of information about sleep from a validated sleep quality measure for school-aged children. It was designed to provide comprehensive information including both clinical sleep problems and parent-reported individual sleep concerns that may fall outside of clinical definitions of sleep disorders.[11] The use of a sleep quality scale in this group allows for a thorough base of information on the variety of ways that sleep problems may manifest among children with asthma.

Overall, we found that children with moderate to severe nocturnal asthma symptoms had significantly worse sleep scores on several sleep subscales including night wakings, parasomnias, and sleep disordered breathing. Previous research has shown that night wakings in children can significantly impact daytime functioning for both children and their parents. This can include daytime sleepiness, increased behavior problems, decreased neurocognitive functioning and family stress.[21] Further, parasomnias have often been associated with negative outcomes, particularly daytime sleepiness,[22] and the relationship between sleep disordered breathing and behavior problems also has now been well documented.[23–26] Importantly, sleep problems in early life have been linked to emotional and behavioral difficulties, including anxiety, depression, aggressive behaviors and attention problems in adulthood.[4]

Among children with asthma, sleep disturbance due to nocturnal symptoms can greatly influence health and wellbeing, and may contribute significantly to their disease burden. Previous studies have shown that children who suffer from nocturnal asthma symptoms have negative outcomes in daytime functioning. Nocturnal asthma symptoms are associated with both poorer school attendance and school performance.[3] Possibly linked to increased school absence, asthmatic children have been found to have poorer school performance and increased risk of learning difficulties compared to their healthy counterparts.[27, 28] This negative effect may be especially pronounced in lower-income asthmatic children who are at greater risk of grade failure.[27] Additionally, exploratory studies indicate that sleep disturbances in children with nocturnal asthma may affect cognitive functioning as well as mood and behavior.[5]

Nocturnal asthma symptoms may also affect the functioning of the parent or caregiver. Prior studies have shown that parents of children with frequent nocturnal symptoms are more likely to miss work which may result in lost wages.[3] Further, parents experiencing sleep disturbances related to their child's illness may have increased daytime fatigue themselves as well as negative mood.[6] We found that parents of children with frequent nighttime symptoms reported more nights of lost sleep as well as lower quality of life, even when controlling for depressive symptoms.

Exposure to environmental tobacco smoke has been shown to be an important factor influencing both nocturnal asthma symptoms and sleep quality. In a recent study, Yolton et al. found that sleep is negatively affected by environmental tobacco smoke exposure among

asthmatic children.[20] Similarly, Morkjaroenpong et al. indicate that nocturnal symptoms are particularly sensitive to ETS.[29] Since as many as 50% of urban children with asthma live with a smoker, smoke exposure likely is a very pertinent factor in amplifying sleep difficulties in this population.[16, 30] Our findings further support the contribution of ETS to nocturnal asthma symptoms and reinforce the need for further investigation into the relationship between ETS and sleep difficulties among urban children with asthma.

The importance of nocturnal asthma symptoms is highlighted in the national asthma guidelines, since the presence of nighttime symptoms receives greater severity weighting compared to the other symptoms.[10] Many parents may underreport their children's and their own sleep difficulties to primary medical care providers, which may lead to a lack of awareness and subsequent inadequate prescription of preventive therapy.[31, 32] The goals of asthma therapy specifically include helping individuals with asthma control their symptoms so that they can sleep well. Clearly, these goals are not being met by numerous individuals, and our study adds to the emerging body of literature indicating that nocturnal asthma symptoms and poor sleep warrant further attention.

There are some limitations to this study. First, this is a cross-sectional study and we cannot determine causality or directionality from these analyses. Second, while a validated sleep scale was used, quality of sleep was only assessed by parent report and was not confirmed by more objective assessment. Similarly, child and parent sleep quantity were measured at one time point by parent report only. Additionally, this study lacks a healthy control group for comparison, and therefore these results can only be generalized to a similar urban, pediatric population with significant asthma. We purposely selected a group of children with persistent asthma symptoms at the time of screening for this study, yielding a relatively homogenous group. Despite this, the prevalence of nocturnal symptoms among this group is striking. Some sources of unmeasured confounding such as child's weight status, stress, family history of poor sleep, allergies, seasonal outdoor irritants, and additional indoor irritants, should be considered in future studies. Finally, additional investigation is needed to further explain the relationship between sleep quality and nocturnal asthma, and to assess daytime functioning and academic consequences of nocturnal asthma symptoms and disturbed sleep.

There are several potential implications from this work. Many urban children with asthma are experiencing nocturnal asthma symptoms and sleep disturbances. However, the full burden of nocturnal symptoms on a child and his or her family may not be recognized by primary care providers. This may be a consequence of under-report by parents and lack of systematic screening. Our data suggest that primary care providers should routinely ask about nighttime asthma symptoms and sleep difficulties during their interactions with patients with asthma and emphasize the importance of nighttime symptom control and adequate sleep to caregivers. In addition, many children with asthma receive suboptimal preventive care.[33] A full understanding of the level of burden experienced by the child and family is needed to activate all parties in developing an effective treatment plan including guideline-based preventive medications and avoidance of potentially harmful triggers, in particular ETS. Such improvements in care are needed to help alleviate nocturnal asthma symptoms and improve quality of sleep for pediatric patients with asthma, which could have important implications both for the child's daytime functioning, behavior, school attendance and performance, as well as the parents overall sleep and quality of life.

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References

1. Akinbami LJ. The state of childhood asthma, United States, 1980–2005. Adv Data. 2006; 381:1–24. [PubMed: 17180851]
2. Adams PF, GEH, Marano MA. Statistics CfDCaPNCfH. Current estimates from the National Health Interview Survey, 1996. Vital Health Stat. 1999; 10(200)
3. Diette GB, Markson L, Skinner EA, Nguyen TT, Algatt-Bergstrom P, Wu AW. Nocturnal asthma in children affects school attendance, school performance, and parents' work attendance. Arch Pediatr Adolesc Med. 2000; 154(9):923–928. [PubMed: 10980797]
4. Gregory AM, Van der Ende J, Willis TA, Verhulst FC. Parent-reported sleep problems during development and self-reported anxiety/depression, attention problems, and aggressive behavior later in life. Arch Pediatr Adolesc Med. 2008; 162(4):330–335. [PubMed: 18391141]
5. Stores G, Ellis AJ, Wiggs L, Crawford C, Thompson A. Sleep and psychological disturbance in nocturnal asthma. Arch Dis Child. 1998; 78(5):413–419. [PubMed: 9659086]
6. Meltzer LJ, Moore M. Sleep disruptions in parents of children and adolescents with chronic illnesses: prevalence, causes, and consequences. J Pediatr Psychol. 2008; 33(3):279–291. [PubMed: 18084038]
7. Janson C, Gislason T, Boman G, Hetta J, Roos BE. Sleep disturbances in patients with asthma. Respir Med. 1990; 84(1):37–42. [PubMed: 2371419]
8. Sadeh A, Horowitz I, Wolach-Benodis L, Wolach B. Sleep and Pulmonary Function in Children with Well-Controlled, Stable Asthma. Sleep. 1998; 21(4):379–384. [PubMed: 9646382]
9. Halterman JS, Borrelli B, Fisher S, Szilagyi P, Yoos L. Improving care for urban children with asthma: design and methods of the School-Based Asthma Therapy (SBAT) trial. J Asthma. May; 2008 45(4):279–286. [PubMed: 18446591]
10. National Asthma Education and Prevention Program. Expert Panel Report II: Guidelines for the Diagnosis and Management of Asthma. Bethesda, MD: National Institutes of Health, National Heart, Lung, and Blood Institute; 1997. NIH Publication No. 97–4051
11. Owens J, 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):1043–1051. [PubMed: 11145319]
12. Goodlin-Jones BL, Sitnick SL, Tang K, Liu J, Anders TF. The Children's Sleep Habits Questionnaire in Toddlers and Preschool Children. Journal of Developmental & Behavioral Pediatrics. 2008; 29(2):82–88. [PubMed: 18478627]
13. Juniper EF, Guyatt GH, Feeny DH, Ferrie PJ, Griffith LE, Townsend M. Measuring quality of life in parents of children with asthma. Qual Life Res. 1996; 5(1):27–34. [PubMed: 8901364]
14. Kessler RC, Barker PR, Colpe LJ, et al. Screening for serious mental illness in the general population. Arch Gen Psychiatry. Feb; 2003 60(2):184–189. [PubMed: 12578436]
15. Andrews G, Slade T. Interpreting scores on the Kessler Psychological Distress Scale (K10). Aust N Z J Public Health. Dec; 2001 25(6):494–497. [PubMed: 11824981]
16. Halterman JS, Fagnano M, Conn KM, Szilagyi PG. Do parents of urban children with persistent asthma ban smoking in their homes and cars? Ambul Pediatr. Mar-Apr;2006 6(2):115–119. [PubMed: 16530150]
17. Vine, MF.; Hulka, BS. Chapter 5: Biological Markers of Exposure. In: Talbott, EO.; Craun, GF., editors. Introduction to Environmental Epidemiology. CRC Press Inc; 1995. p. 63-77.
18. Dolcini MM, Adler NE, Lee P, Bauman KE. An assessment of the validity of adolescent self-reported smoking using three bilogical indicators. Nicotine Tob Res. Aug; 2003 5(4):473–483. [PubMed: 12959785]
19. Willers S, Axmon A, Feyerabend C, Nielsen J, Skarping G, Skerfving S. Assessment of environmental tobacco smoke exposure in children with asthmatic symptoms by questionnaire and cotinine concentrations in plasma, saliva, and urine. J Clin Epidemiol. Jul; 2000 53(7):715–721. [PubMed: 10941949]
20. Yolton K, Xu Y, Khoury J, et al. Associations Between Secondhand Smoke Exposure and Sleep Patterns in Children. Pediatrics. 2010; 125(2):e261–e267. [PubMed: 20083521]

21. Moore M, Meltzer LJ, Mindell JA. Bedtime problems and night wakings in children. Prim Care. 2008; 35(3):569–581. [PubMed: 18710671]
22. Liu X, Hubbard JA, Fabes RA, Adam JB. Sleep disturbances and correlates of children with autism spectrum disorders. Child Psychiatry Hum Dev. 2006; 37(2):179–191. [PubMed: 17001527]
23. Rosen CL, Storfer-Isser A, Taylor HG, Kirchner HL, Emancipator JL, Redline S. Increased behavioral morbidity in school-aged children with sleep-disordered breathing. Pediatrics. 2004; 114(6):1640–1648. [PubMed: 15574628]
24. Gottlieb DJ, Vezina RM, Chase C, et al. Symptoms of sleep-disordered breathing in 5-year-old children are associated with sleepiness and problem behaviors. Pediatrics. 2003; 112(4):870–877. [PubMed: 14523179]
25. Stein MA, Mendelsohn J, Obermeyer WH, Amromin J, Benca R. Sleep and behavior problems in school-aged children. Pediatrics. 2001; 107(4):E60. [PubMed: 11335781]
26. Fagnano M, van Wijngaarden E, Connolly HV, Carno MA, Forbes-Jones E, Halterman JS. Sleep-disordered breathing and behaviors of inner-city children with asthma. Pediatrics. Jul; 2009 124(1):218–225. [PubMed: 19564303]
27. Fowler MG, Davenport MG, Garg R. School functioning of US children with asthma. Pediatrics. 1992; 90(6):939–944. [PubMed: 1437438]
28. Halterman JS, Montes G, Aligne CA, Kaczorowski JM, Hightower AD, Szilagyi PG. School readiness among urban children with asthma. Ambul Pediatr. Jul-Aug;2001 1(4):201–205. [PubMed: 11888401]
29. Morkjaroenpong V, Rand CS, Butz AM, et al. Environmental tobacco smoke exposure and nocturnal symptoms among inner-city children with asthma. J Allergy Clin Immunol. Jul; 2002 110(1):147–153. [PubMed: 12110834]
30. Kattan M, Mitchell H, Eggleston P, et al. Characteristics of inner-city children with asthma: the National Cooperative Inner-City Asthma Study. Pediatr Pulmonol. Oct; 1997 24(4):253–262. [PubMed: 9368259]
31. Storms WW, Bodman SF, Nathan RA, Byer P. Nocturnal asthma symptoms may be more prevalent than we think. J Asthma. 1994; 31(4):313–318. [PubMed: 8040155]
32. Raherison C, Abouelfath A, Le Gros V, Taytard A, Molimard M. Underdiagnosis of nocturnal symptoms in asthma in general practice. J Asthma. 2006; 43(3):1999–1202.
33. Halterman JS, Aligne CA, Auinger P, McBride JT, Szilagyi PG. Inadequate therapy for asthma among children in the United States. Pediatrics. Jan; 2000 105(1 Pt 3):272–276. [PubMed: 10617735]

Appendix A: Assessment of Quality of Sleep

8 Subscales within the Childhood Sleep Habits Questionnaire

	# of items in scale	Sample Question
Bedtime Resistance	5	Child struggles at bedtime (cries, refuses to stay in bed)
Sleep-Onset Delay	1	Child falls asleep within 20 minutes after going to bed
Sleep Duration	3	Child sleeps too little
Sleep Anxiety	3	Child is afraid of sleeping in the dark
Night Wakings	3	Child awakes more than once during the night
Parasomnias	7	Child sleepwalks during the night
Sleep Disordered Breathing	3	Child seems to stop breathing during sleep
Daytime Sleepiness	8	Child takes a long time becoming alert in the morning

What's New

Nocturnal asthma symptoms are prevalent among urban children with asthma, and are associated with poor sleep. These findings have potential implications for children's daytime functioning and parents' sleep and quality of life. The burden of nocturnal asthma symptoms and poor sleep warrants further consideration.

TABLE 1

Population Demographics and Nocturnal Asthma Symptoms *

	Overall	Intermittent Nocturnal Symptoms	Mild Persistent Nocturnal Symptoms	Moderate/Severe Nocturnal Symptoms	P-Value
Overall (N)	287	117	66	104	
Child Age, Mean (SD)	7.5 ± 1.8	7.6 ± 1.7	7.6 ± 1.8	7.3 ± 1.8	.275
Child Gender (Male)	168 (59%)	68 (58%)	38 (58%)	62 (60%)	.959
Child Race					
Black	178 (62%)	76 (65%)	40 (61%)	62 (60%)	.789
White	21 (7%)	1 (6%)	4 (6%)	10 (10%)	
Other	88 (31%)	34 (29%)	22 (33%)	32 (31%)	
Child Ethnicity (Hispanic)	83 (29%)	33 (28%)	24 (36%)	26 (25%)	.275
Controller Med. (Yes)	193 (67%)	78 (67%)	48 (73%)	67 (64%)	.524
Insurance (Medicaid)	211 (74%)	81 (69%)	45 (68%)	85 (82%)	.059
Parent Education (< High School)	123 (43%)	46 (39%)	32 (35%)	54 (52%)	.055
Parent Depression (mild to severe depressive symptoms)	99 (35%)	25 (22%)	27 (41%)	47 (45%)	**.001**
Cotinine, Mean ng/ml (SD)	1.3 ± 2.2	1.1 ±1.6	1.1 ± 1.7	1.7 ± 2.8	0.058
Primary Caregiver Smokes	110 (38%)	36 (31%)	26 (39%)	48 (46%)	.062
≥ 1Smoker in Home	153 (53%)	50 (43%)	39 (59%)	64 (62%)	**.011**
No Home Smoking Ban	118 (41%)	39 (33%)	27 (41%)	52 (50%)	**.041**

* Data shown as N (%) unless otherwise indicated

TABLE 2

Nocturnal Symptom Severity and Quality of Sleep using Childhood Sleep Habits Questionnaire

	Overall	Intermittent Nocturnal Symptoms	Mild Persistent Nocturnal Symptoms	Moderate / Severe Nocturnal Symptoms	P-Value
Total Sleep Score	51.3 ± 9.5	49.8 ± 9.6	50.7 ± 8.5	53.5 ± 9.7	**.012**
Bedtime Resistance	8.9 ± 3.0	8.8 ± 3.0	8.7 ± 2.9	9.0 ± 3.0	.790
Sleep-Onset Delay	1.7 ± 0.9	1.8 ± 0.9	1.7 ± 0.9	1.7 ± 0.8	.487
Sleep Duration	4.2 ± 1.6	4.1 ± 1.6	4.0 ± 1.4	4.4 ± 1.8	.204
Sleep Anxiety	5.6 ± 2.1	5.4 ± 2.1	5.8 ± 2.0	5.7 ± 2.2	.460
Night Wakings	4.4 ± 1.4	4.1 ± 1.4	4.4 ± 1.3	4.7 ± 1.4	**.016**
Parasomnias	9.8 ± 2.3	9.3 ± 2.0	9.9 ± 2.4	10.4 ± 2.4	**.002**
Sleep Disordered Breathing	4.2 ± 1.5	4.0 ± 1.4	4.0 ± 1.2	4.5 ± 1.6	**.027**
Daytime Sleepiness	15.2 ± 3.8	14.8 ± 3.7	14.8 ± 4.0	15.9 ± 3.7	.064

Mean ± SD

TABLE 3

Regression Analysis of Quantity of Sleep and Caregiver Quality of Life by Nocturnal Symptom Severity

	Intermittent Nocturnal Symptoms	**Mild Persistent Nocturnal Symptoms**	**Moderate/Severe Nocturnal Symptoms**	**P-Value**
# of hours child usually sleeps each day	9.0 ± 1.6	8.9 ± 1.2	9.2 ± 1.8	.678
# of nights child had enough sleep (range 0–7) over past week	5.9 ± 1.8	5.5 ± 1.5	5.2 ± 2.3	**.018**
# of nights parent lost sleep (range 0–14) over past 2 weeks	0.2 ± 0.6	1.6 ± 1.6	4.3 ± 4.6	**<.001**
Parental Quality of Life * (range 1–7) over past week	5.9 ± 1.1	5.3 ± 1.1	5.0 ± 1.2	**<.001**

Regression analyses include; child age, parent education, smoke exposure based on salivary cotinine, and parent depression.

* Parent Quality of Life assessed using Juniper's PACQLQ which includes a 7-point Likert scale; 1= "all of the time" to 7= "none of the time."