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Asthma-related lung function, sleep quality, and sleep duration in urban children☆,☆☆

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ABSTRACT

Objectives: Examine (1) the extent to which changes in objectively measured asthma-related lung function (forced expiratory volume in 1 second) within a sleep period are associated with sleep quality and sleep duration during that sleep period in a group of urban children with persistent asthma, (2) associations between morning and evening asthma-related lung function and sleep quality and duration on the adjacent night, and (3) whether these associations differ by ethnic group.
Design: Cross-sectional, multimethod approach. Children completed a clinic assessment of asthma and allergy status and used home-based objective measurements of asthma-related lung function and sleep.
Setting: Children and their caregivers participated in a clinic assessment at an asthma and allergy clinic and completed additional assessments at home.
Participants: Two hundred and sixteen African American, Latino, and non-Latino white urban children, ages 7-9 years, and their primary caregivers.
Measurements: Participants took part in a clinic assessment of asthma and allergy status, completed interview-based questionnaires including a diary to track asthma symptoms and sleep patterns, and used actigraphy and home-based spirometry daily across a 4-week period to assess sleep and lung function.
Results and conclusions: Results from analyses using structural equation modeling revealed an association between worsening asthma-related lung function and poor sleep quality in the full sample, as well as better asthma-related lung function at night and more optimal sleep efficiency that night. Ethnic group differences emerged in the association with morning or nighttime lung function measurements and sleep quality. Urban minority children with asthma may be at heightened risk for poorer quality sleep. Timing of lung function worsening may be important when considering when and how to improve both asthma health outcomes and sleep quality within specific groups.

Introduction

Good quality sleep (with no interruptions) and a developmentally appropriate amount of sleep are integral to children's optimal daytime functioning and physical health.[1,2] Children with asthma are particularly vulnerable to poor quality sleep, as nocturnal asthma symptoms can make it difficult to initiate and maintain sleep.[3,4] Furthermore, when asthma is poorly controlled, children may awaken often during the night.[5–7] Those with severe, persistent asthma are more at risk, as nocturnal asthma symptoms may occur more frequently and disrupt sleep continuity.[3,8] Cross-sectional studies of

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children with asthma have shown associations between caregiver reports of nighttime symptoms and disturbed or insufficient sleep, as well as links between disturbed sleep and increased daytime sleepiness,[9,10] poorer school performance, and more school absences.[8,11] Results from a few small studies using polysomnography also have shown that adults with asthma have longer sleep onset latencies than healthy controls.

Disrupted and shortened sleep also may affect the occurrence of asthma symptoms, although research to date is sparse and is based on studies with very small samples. In two experimental studies of adults with asthma, acute sleep restriction was associated with increased bronchoconstriction.[12,13] A study of adolescents with asthma showed that sleep restriction resulted in an average 7%-8% decrease in overnight lung function.[14] Thus, asthma can affect sleep, and shorter sleep may impact nocturnal asthma,[15–17] although more research is needed to assess this bidirectional relationship.

Multilevel factors (eg, pathophysiological, environmental, individual, and family related) can contribute to the association between nocturnal asthma and sleep disruption.[4] Briefly, increased exposure to home environmental triggers,[18] pollen counts, poorer adherence to daily controller medications,[19] and sleep posture can facilitate mucus production and inflammation, and increase risk for nocturnal symptoms and night awakenings.[20,21] Furthermore, urban minority children with asthma are exposed to a range of contextual and cultural risk factors that can increase asthma symptoms,[2,3,22] challenge symptom management,[23] and affect optimal sleep.[3,24] These urban risks, detailed elsewhere,[3,22] include increased poverty, which can contribute to higher levels of stress within the home; neighborhood stressors (eg, crime); and acculturative stress and discrimination.[25] Furthermore, urban stressors (eg, noise, crowded housing) can affect children's sleep environment[2] and sleep behaviors (eg, inconsistent sleep/wake times).[26] Urban children with asthma are at greater disadvantage for poor sleep quality and shortened sleep due to combined risks related to asthma status and urban poverty.

The extent to which sleep is disrupted due to asthma, or the frequency of nighttime awakenings, is a critical indicator of asthma control and severity.[27] Given that urban minority children with asthma are at increased risk for poor sleep, decreasing nocturnal asthma symptoms and enhancing sleep quality are important targets for intervention for this high-risk group. Yet, to date, there are no published studies that have objectively assessed the extent to which asthma is associated with sleep quality in urban children over time. In the current study, we used objective methods to assess asthma-related lung function (namely, FEV1 percent predicted, through home spirometry) and sleep quality (sleep efficiency, awakenings, and sleep duration through actigraphy) in real time over a 4-week period in a group of urban school-aged children with persistent asthma from non-Latino white, Latino and African American (AA) backgrounds. Specifically, we examined the extent to which changes in FEV1% predicted measured in the evening to the following morning of the sleep period were associated with sleep quality and sleep duration within the same sleep period. Based on prior work,[3,22] we expected that greater changes in asthma-related lung function (greater reduction in FEV1) would be associated with poorer sleep quality and shorter sleep duration in the entire sample and that the association would be more robust in children from Latino and AA backgrounds, given increased asthma morbidity documented in these groups.[28–31]

To further understand the extent to which the timing of asthma-related lung function worsening (ie, time of day) affects sleep in the children of our sample, we also examined the extent to which morning and evening lung function values were associated with sleep quality and duration on that adjacent night over the sleep period. Results from this analyses may more precisely inform targeted interventions integrating asthma and sleep for this high-risk group. Given published reports showing diurnal lung function variation in children with asthma, with the lowest lung function levels occurring during children's first awakening in the morning,[32–35] we expected the association between FEV1 in the morning and sleep quality and duration for the prior night to be more robust; however, we also recognized that lower FEV1 in the evening would certainly affect that night's sleep quality. This hypothesis was examined on an exploratory basis given that there is no prior literature that has tested this question in our targeted population.

Participant and methods

Data were collected for a larger study—Project Nocturnal Asthma and Performance in School—that assessed the cooccurrence of asthma, sleep quality, and academic functioning in urban children with persistent asthma and healthy controls across one academic year. The current study includes data from asthma participants.

Participants were recruited from the four largest and adjacent urban school districts in an urban Northeast US city, from hospital-based ambulatory pediatric clinics, and from a hospital-based asthma education program. “Consent to Contact” forms were distributed in these locations; these are forms that, when signed by the caregiver, allow study staff to call the family to describe the study and determine the child's eligibility and family's interest in participating. We also received direct referrals from these recruitment sources.

Eligibility criteria required that the child was between 7 and 9 years old; child's legal guardian was willing to participate and self-identified as Latino (Dominican or Puerto Rican), black/AA, or non-Latino white; child attended public school in 1 of the 4 targeted urban school districts and resided in 1 of these 4 targeted urban areas as defined by the family's zip code; and child had physician-diagnosed asthma or breathing problems in the previous 12 months. Additionally, at screening, each child could be classified as having persistent asthma either by caregiver report of a current prescription for an asthma controller medication or by report of recurrent daytime or nighttime symptoms, activity limitation, rescue medication use, or 2 or more oral steroid bursts the prior 12 months.[27] Exclusionary criteria included moderate to severe cognitive impairment as indicated by school placement, use of stimulant medication for attention-deficit/hyperactivity disorder, another pulmonary or chronic health condition, or a diagnosed sleep disorder (eg, restless leg syndrome, chronic insomnia) that would confound the primary hypotheses of the larger study. We elected to not exclude children with sleep-disordered breathing (SDB), as this is a highly comorbid condition in this population and we are ultimately interested in designing “real-world” interventions for this group. We did assess the extent of SDB using a well-validated caregiver report measure.[36]

Data included in the current report were collected during the fall and winter of each study year. Demographic information and information regarding asthma and allergic rhinitis (AR) medication use were collected at the initial study visit. The second session occurred at our hospital-based asthma and allergy clinic at least 2 weeks later, during which study clinicians evaluated children's asthma and AR diagnosis and severity and their allergy status, and confirmed asthma and AR medication use. Immediately following this visit, children and their caregiver participated in a 4-week home-monitoring period, during which the child used a portable device twice daily to assess lung function and wore an actigraph to assess sleep quality. Participants also completed a daily diary containing information relevant for processing and scoring objective sleep and asthma data (eg, times when actigraph was not worn, days child experienced illnesses other than asthma). Standardized training procedures on the use of these devices were implemented during the first visit and the subsequent clinic visit (see below). Midway through the monitoring period, study staff returned to the home to download and review