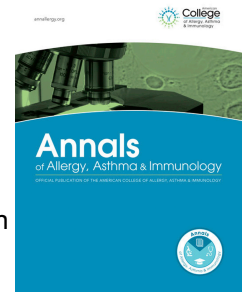


Accepted Manuscript

Asthma and Academic Performance in Urban Children

Daphne Koinis-Mitchell, PhD, Sheryl J. Kopel, MSc, Michael L. Farrow, MA, Elizabeth L. McQuaid, PhD, Jack H. Nassau, PhD



PII: S1081-1206(19)30146-2

DOI: <https://doi.org/10.1016/j.anai.2019.02.030>

Reference: ANAI 2838

To appear in: *Annals of Allergy, Asthma and Immunology*

Received Date: 23 October 2018

Revised Date: 25 February 2019

Accepted Date: 28 February 2019

Please cite this article as: Koinis-Mitchell D, Kopel SJ, Farrow ML, McQuaid EL, Nassau JH, Asthma and Academic Performance in Urban Children, *Annals of Allergy, Asthma and Immunology* (2019), doi: <https://doi.org/10.1016/j.anai.2019.02.030>.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Asthma and Academic Performance in Urban Children

Daphne Koinis-Mitchell, PhD,^{1,2,3} Sheryl J. Kopel, MSc,^{1,2} Michael L Farrow MA,¹ Elizabeth L. McQuaid, PhD,^{1,2,3} and Jack H. Nassau, PhD^{1,2}

Affiliations: ¹Bradley/Hasbro Children's Research Center, ²Alpert Medical School, Brown University, ³Hasbro Children's Hospital/Rhode Island Hospital, Providence, Rhode Island.

Address correspondence to: Daphne Koinis Mitchell, PhD, Bradley/ Hasbro Children's Research Center, 1 Hoppin St, Providence, RI 02903 USA. Phone: 401-793-8632, Fax: 401-350-2692, E-mail: dkoinismitchell@lifespan.org

Conflict of Interest: NA

Source of support: Eunice Kennedy Shriver National Institute of Child Health and Human Development R01 HD057220; PI, Koinis-Mitchell

Keywords: Asthma, academic performance, urban children

Word Count: 4,000

Figures: None

Tables: 6

Introduction

Urban minority children are at increased risk for asthma morbidity.¹ Factors related to urban living, such as exposure to urban stressors violence, neighborhood stress,^{2,3,4} environmental irritants and allergens,⁵ poorer medication adherence,⁶ and cultural factors related to ethnic background (e.g., acculturative stress, discrimination),⁷ place this group at greater risk for poorer asthma control and morbidity. When asthma is poorly controlled, children are at greater risk for decrements in other areas of functioning, such as academic performance. Children with asthma are more prone to school absences than their healthy peers,⁸⁻¹⁰ and urban minority children with asthma are at even greater risk.^{11,12} In some urban areas, children with asthma miss an average of up to 2 weeks more of school than those without asthma.^{13,14} Missing school can disrupt learning and school-based social activities. Further, frequency of absences is an important indicator of asthma morbidity in children¹⁵⁻¹⁷ and has been used as a proxy for academic performance in studies including children with asthma.^{10,12,18,19} Thus, school absences disrupt learning continuity, putting children with poorly controlled asthma and/or those with persistent/severe asthma at further risk for poorer academic performance.¹²

Another way in which asthma can affect academic performance is through its impact on sleep. Nocturnal asthma can affect children's sleep quality and duration,¹⁶ which can interfere with attention in school and impact the quality of school work. Moreover, urban minority children with asthma are exposed to increased environmental triggers^{5,20} and are found to have poorer adherence to asthma daily controller medications than their non-Latino white counterparts.²¹ These risks can increase symptoms at home and in school, which may impact learning. To date, the extent to which asthma affects urban children's academic performance across multiple academic indicators (e.g., absences, grades) is not well documented.

In this report, we compare academic performance of a carefully evaluated group of urban children with asthma to their urban counterparts without asthma, and we examine ethnic differences in these associations. Based on previous results showing associations between poorer asthma control and poorer sleep quality and shorter sleep duration,¹⁶ as well as increased absences in urban children with asthma,^{11,12} we expect those in our study to experience poorer academic performance across indicators compared to their healthy peers. Given the cumulative impact that uncontrolled asthma and urban stressors can have on morbidity and daily functioning,⁷ we expect urban minority children with asthma to have the poorest academic outcomes relative to minority children without asthma. Within those with asthma, we also examine the association between asthma status (as measured by asthma control, lung function, and daily report of asthma symptoms) and academic performance measured across a four-week monitoring period, as well as ethnic differences in these associations. We expect that poorer asthma will be associated with decrements in academic performance, and that these associations will be moderated by ethnicity. Specifically, we expect the association between poorer asthma and academic performance will be more profound in the ethnic minority children, given it has been shown that morbidity¹ and exposure to urban stressors are found to be greater in this group.⁷

Methods

Data were collected within a larger five-year study, Project NAPS (Nocturnal Asthma and Performance in School), that assessed the co-occurrence of asthma, allergic rhinitis, sleep quality, and academic functioning in urban children and healthy controls across one academic year.^{3,16,22}

Participants were recruited from the four largest urban school districts in an urban Northeast U.S. city, and from hospital-based ambulatory pediatric clinics. Study eligibility criteria for the asthma participants required that: the child was between 7 and 9 years old; the

child's legal guardian was willing to participate and self-identified as Latino (Dominican or Puerto Rican), Black/African American (AA), or non-Latino White (NLW); the child attend an urban public school in one of the four targeted school districts that are identified as being high-risk for asthma prevalence and asthma-related health care utilization; and that the child had physician-diagnosed asthma or caregiver-reported asthma symptoms in the previous 12 months. Additionally, at screening, each child was initially evaluated for persistent asthma either by caregiver report of a current prescription for an asthma controller medication, and/or report of recurrent daytime or nighttime symptoms, activity limitation, rescue medication use, or 2 or more oral steroid bursts in the prior 12 months.¹⁵ Inclusion for the healthy control group were similar to those described for the asthma participants except for the need to meet the asthma-related criteria. Exclusion criteria for both groups included moderate to severe cognitive impairment as indicated by school placement; use of a stimulant medication for ADHD; another pulmonary or chronic health condition; or a diagnosed sleep disorder that would confound examination of primary hypotheses. We did not exclude sleep-disordered breathing (SDB), as this condition is highly co-morbid with asthma and we are ultimately interested in designing "real-world" interventions for these children.

Data herein were collected during the fall/ winter of each of the 4 NAPS study years. Demographic information and information regarding asthma and medication use were collected at the initial study visit. The second visit occurred at our hospital-based asthma and allergy clinic, during which study clinicians evaluated and confirmed children's asthma diagnosis and persistent severity status as well as allergy status, and confirmed asthma medication use. Given the larger study also included a focus on allergic rhinitis, the clinical evaluation included an assessment of allergic rhinitis. Immediately following this clinic visit, children and their caregiver participated in a 4-week home-based monitoring period, during which the child used a portable device twice daily to assess lung function. Participants also

completed a daily diary containing information relevant for assessment of self-reported asthma symptoms. Standardized procedures were used to orient and train families on the use of the home-based spirometer 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 electronic lung function data and to collect information on asthma and AR control. Staff implemented standard procedures to encourage protocol adherence.^{3,23}

The assessment of academic indicators occurred concurrently with asthma monitoring. After enrollment, each child's teacher was asked to complete a two-week short-term academic performance assessment which dovetailed with the last two weeks of the monitoring period. Following the clinic visit, families visited our lab and the child's academic achievement was assessed. Grades and school absences were received from each child's school for the entire academic year the child participated in the study.

Assessments were administered verbally in English or Spanish by research staff fluent in both languages and according to caregivers' preference (24% of caregivers preferred to have the interview conducted in Spanish). Standardized procedures were used for the translation of instruments.²⁴ All measures to children were implemented in English. Participants received monetary compensation for completed sessions. Study approval was obtained from the local Institutional Review Board.

Measures

Demographic Information. Primary caregivers provided key demographic information (Table 1).^{16,25} Caregivers reported on children's risk for sleep disordered breathing using the Sleep-related Breathing Disorders scale of the Pediatric Sleep Questionnaire.²⁶ *Physician Query.* Child participants' primary care providers and asthma/allergy specialists (when applicable) completed a checklist detailing the date of child's last office visit, asthma and/or AR diagnosis, suspected allergy triggers, significant past medical history, and current asthma

and rhinitis treatment. This information was used to evaluate the child's asthma and allergy status.^{4,27}

Asthma Diagnosis and Classification of Asthma Severity. The clinic study visit consisted of a medical history and physical examination, allergy skin prick testing, and pulmonary function testing. Confirmation of asthma diagnosis and severity classification were made by a study clinician using standard NHLBI EPR-3 guidelines.¹⁵ Lung function measurements (FEV1, FVC, etc.) were evaluated using the Koko incentive spirometer (nSpireHealth, Longmont, CO) before and after short acting beta agonist administration.²⁸ Children's height and weight were measured, from which Body Mass Index was computed using normative data.²⁹

Allergic Rhinitis Diagnosis and Classification of Severity. AR was evaluated given its co-morbidity with allergic asthma by (1) evidence on physical examination, (2) type and frequency of parent report of AR symptoms in the past month, including an assessment of AR Control;³⁰ and (3) allergy skin prick testing (Greer Laboratories, NC) to perennial and seasonal allergens. AR severity was classified according to clinical practice guidelines.^{30,31}

Asthma and Allergy Medication Use. During the study clinic visit, the study clinician documented children's current asthma and allergy medications. Caregivers reported how often their child missed doses of daily controller medications, on a scale from 1 (misses doses all of the time) to 5 (never misses doses).³² Seventy-eight percent of caregivers reported their children were using daily asthma controller medications; 73% reported inhaled corticosteroid use. Eighteen percent reported that their children were using first generation antihistamines for AR symptoms. The average self-reported asthma medication adherence was 3.6 ($SD=1.3$, range 1-5), suggesting that most participants were moderately adherent to their prescribed medications, although given this is a self-report assessment it is likely an overestimation of children's medication adherence.

Asthma Indicators: Asthma Control. At the end of the monitoring period, families completed the Childhood Asthma Control Test (C-ACT)³³ a well-validated questionnaire of asthma-related impairment validated for children aged 4-11. Using standardized scoring procedures,³⁴ a dichotomous variable was computed using a total cut-off score of 19; those below were classified as having poor asthma control, and those above as having well-controlled asthma.

Lung Function: FEV1 Percent Predicted. Children's lung function was assessed twice daily at home, in the morning and evening, during the monitoring period using a hand-held computerized spirometer (AM2+; ERT; Yorba Lina, CA). At the beginning of each session, a research assistant (RA) oriented both the parent and child to the proper use of the device and how to perform a forced, sustained, expiration.³⁵ Participants were instructed to complete three "blows" each morning and evening prior to taking any asthma or allergy medications. The best of three blows (i.e., the highest FEV1 % predicted value) was retained for g trial. Details concerning data cleaning and reduction procedures have been published,^{23,36} including normative values used for FEV1 based on children's age.^{37,38}

Daily Diary: Asthma Symptoms. Families completed a daily diary twice daily to document the child's breathing problems during the day and evening using standard procedures.^{4,27} Diary-reported symptoms were summarized across the monitoring period by computing a proportion of monitored days during which breathing problems were noted.⁴

Academic Indicators: School Absences and Grades. School absences and grades were collected from children's final grade reports for the school year of study participation. Because grades can be reported in different metrics in various school systems, they were converted to numeric percentiles (e.g., if "4.5" was the top of the scale in one school district, and "O+" was at the top in another district, both were assigned a value of 100%).

Teacher Report of Short-term Academic Functioning. Each participant's primary classroom teacher reported on the participant's academic performance during two weeks within the monitoring period in which the child's asthma was assessed. The scale included three items with Likert-type response options assessing: work quality, percent of work completed, and carelessness with school work. Acceptable reliability has been demonstrated in prior research (Cronbach's $\alpha = .86$)³⁹ and in the current sample (Cronbach's $\alpha = .87$). Single item-total correlations ranged from .42% of schoolwork completed (a similarly low value was found in previous work)⁴⁰ to .74 (quality of school work).

*Wide Range Achievement Test-Third Edition (WRAT-4).*⁴¹ The WRAT-4 was used to evaluate academic accomplishment in reading and arithmetic and is normed for children ages 5 to 11. Psychometric properties have been reported.⁴¹

Results

Analysis Plan

Demographic, asthma, and academic outcomes were summarized for the aggregated sample and compared between groups (children with asthma versus healthy controls) using analysis of variance (continuous variables) and chi-squared tests (categorical variables). Outcome variables (academic outcomes) were assessed for normality. Bivariate correlations were used to identify potential confounders. Spearman rank order correlations were used to test for associations between demographic variables hypothesized *a priori* as potential confounders (age, gender, poverty level, sleep disordered breathing, and asthma severity) and asthma and academic outcomes. A variable was considered a confounder if it was associated both with the predictor (asthma variables) and outcome (academic variables) at a conservative $p < .10$ level, and was controlled for in subsequent analyses.¹⁶

We tested the association between group status (Asthma vs. Control) and each academic outcome using a series of generalized linear models. Models controlled for

potential confounders that were identified in preliminary analyses. Generalized linear models use a likelihood-based approach to estimation and thus make use of all available data without directly imputing missing outcomes. It should be noted that we compared our results to those of completers-only. As results did not significantly differ, we present the full model (all enrollees). Finally, ethnic differences in academic outcome were examined separately by group (Asthma, Control) using a similar modeling approach (generalized linear models). As our hypotheses regarding the associations between asthma and academic outcomes pertained to individual effects of asthma and different elements of academic function (e.g., school work, attendance), we chose to model each academic outcome separately instead of creating a composite score. The latter would not allow for identifying the effects of asthma on specific components of academic success.

Next, the associations between asthma and academic outcomes were examined using a series of generalized linear models, in which each academic outcome was regressed on each asthma outcome, controlling for confounders. Models were run only among the sub-sample with asthma. Finally, we explored whether the asthma-academic associations differed by ethnicity using a series of subgroup analyses.

Following Rothman,⁴² we recognize the risk in adjusting for multiple comparisons, which may increase type II error rates at the expense of type I errors. However, to be conservative, we used Benjamini-Hochberg correction for multiple comparisons (this resulted in an adjusted significance level of 0.04). Even with our approach, the majority of results summarized maintained their significance or were borderline significant (we have indicated when this was the case). All analyses were completed using SAS 9.3; unadjusted significance was $\alpha=.05$ *a priori* for testing the primary hypotheses.

Results from Preliminary Analyses. Participants (N=395; 130 healthy control children and 265 children with asthma) were 8.30 years old on average ($SD=.86$), more than half were

male (53%) and reported living at or below the poverty threshold (67%). A full description of the sample appears in Table 1.

Bivariate correlation analysis suggested correlations between asthma severity and asthma control ($\rho=-.25, p<.001$) and FEV1 % predicted ($\rho=-0.17, p=.02$). Furthermore, asthma severity was negatively associated with quality of school work ($\rho=-0.17, p=.01$). Thus, all subsequent models of asthma and academic outcomes controlled for asthma severity.

Differences in Academic Indicators by Group Status (Asthma vs Control) and by Ethnicity and Group Status

Regression-based approaches for testing between-group differences (Asthma vs. Control) on academic indicators appear in Table 2 (aggregated over ethnicity). Regression coefficients (b) are presented and refer to unstandardized coefficients or, equivalently, adjusted mean differences between groups. Models suggest significant between-group differences in total school absences, such that children with asthma had greater number of school absences compared to healthy controls ($t=2.18, p=.03$) and indicated a nearly 3-day difference between groups (Table 2). There were no significant differences between Asthma and Control groups with respect to other academic indicators.

Table 3 presents ethnic differences in academic indicators among the sample of children with asthma. It should be noted that we chose to present both significant and non-significant effects in the Table to give a complete picture of the findings. Significant effects are presented in this section as well. The academic indicators of Latino children with asthma were poorer than NLWs in the sample across WRAT reading ($t=-3.18, p=.001$) and math scores ($t=-3.11, p=.002$), average grades ($t=-2.74, p=.01$), and teacher reported quality of work scores ($t=-2.56, p=.01$); see Table 3 for effect estimates. The only difference in academic indicators between Black and NLWs was with respect to WRAT math scores,

which were higher among NLWs ($t=-2.44$, $p=.02$, Table 3). Latino children had poorer WRAT reading scores ($t=-2.69$, $p=.01$) than Black children. Effects presented in Table 3 represent mean differences in academic scores between groups. We have chosen to present regression coefficients (rather than effect sizes) so that data can be interpreted on the scale of the original instrument. For example, there was nearly a 9-point difference between Latinos and NLW's with respect to reading scores. Reading scores in the aggregate sample had a standard deviation of 14 suggesting that differences between Latinos and NLW's were nearly one standard deviation in size. To help interpret the effects, the standard deviation of each of the academic outcomes are included in Table 3.

A similar analysis explored between-ethnic differences in academic indicators among healthy controls (Table 3). Latinos had lower WRAT math scores compared to NLWs ($t=-2.53$, $p=.01$). In addition, Black children had borderline lower quality of work scores as reported by teachers compared to NLWs ($t=-2.09$, $p=.04$). Models suggest no differences between Latino and Black participants.

Associations between Asthma and Academic Indicators

Adjusted associations between asthma and academic indicators among children with asthma appear in Table 4 (across ethnicity) and Table 5 (separately by ethnicity). Among children with asthma, *better lung function* (higher FEV1 % predicted) was associated with teacher reports of better quality school work ($t=2.31$, $p=.02$) and less careless work ($t=2.39$, $p=.02$). *Less FEV1 variability* was associated with better WRAT math scores ($t=-2.25$, $p=.03$). More *daily reported asthma symptoms* were borderline associated with teacher reports of lower percent of work completed ($t=-2.04$, $p=.04$), and significantly associated with more absences ($t=2.59$, $p=.01$). Finally, *better asthma control* was significantly associated with higher quality of work ($t=2.35$, $p=.02$) and fewer absences ($t=-2.51$, $p=.01$)

and borderline associated with more work completed ($t=2.02$, $p=.04$) and higher WRAT math scores ($t=2.03$, $p=.04$). All effect estimates appear in Table 4.

Finally, there were significant associations between asthma and academic indicators, stratified by ethnicity (Table 5). *Among Latinos*, better lung function was associated with less careless schoolwork ($t=2.38$, $p=.02$), as well as higher WRAT math ($t=2.73$, $p=.01$) and reading scores ($t=2.98$, $p=.003$). Furthermore, *higher FEV variability* was associated with worse WRAT math ($t=-2.20$, $p=.02$), and reading scores ($t=-2.19$, $p=.03$).

Among Black children, more daily reported symptoms were associated with more school absences ($t=2.50$, $p=.01$). Finally, *better asthma control* was associated higher WRAT math scores ($t=2.52$, $p=.01$) and fewer school absences ($t=-2.96$, $p=.01$).

Among NLW children, there were borderline associations between *better lung function* (FEV1) and better quality of work ($t=2.15$, $p=.04$). Furthermore, *more daily reported symptoms* were significantly associated with worse quality of work ($t=-2.63$, $p=.01$), worse WRAT math scores ($t=-2.22$, $p=.03$) and more school absences ($t=2.57$, $p=.01$). Finally, *better asthma control* was associated with better quality of work ($b=2.33$, $p=.03$) (Table 5).

Discussion

In a carefully evaluated sample of urban children with persistent asthma, this study examined associations among a range of asthma and academic indicators. The current study is an in-depth investigation of the extent to which asthma may impact urban children's academic performance through both objective and subjective measurements. A demographically matched control group of children with no asthma allows for examination of academic indicators between the two groups, and the extent to which asthma status may challenge optimal academic performance. Ethnic differences in outcomes between children with and without asthma were also examined to inform future tailored interventions that can be implemented in medical and/or academic settings.

Regarding differences in academic outcomes by asthma status in our sample, as expected, the number of school absences across the academic year of participation in the study was higher in children with asthma than their no-asthma peers. When children are symptomatic, caregivers may elect to keep them at home, in case urgent care or visits to the healthcare provider are warranted. Nocturnal asthma has also been related to poorer sleep quality.³ When children miss sleep due to asthma, caregivers also may elect to keep the child home.^{11,12} We have shown that caregivers' fear of their child's asthma symptoms may contribute to decisions to keep the child home from school.⁴³ Strategies to reduce absences may include identifying children with asthma who miss school more often, so that the school nurse and/or child's primary teacher can encourage the family to see the child's primary care provider.⁴⁴ Educating caregivers on the risk for absences related to poor asthma control can be useful to promote consistent learning in this group. Educational strategies for caregivers can include a review of when best to communicate with the school nurse regarding the child's asthma status (e.g., in the morning), how to communicate (e.g., by phone) and what information to share (e.g., symptom frequency, history of urgent care visits, treatment plan).⁴⁴ Low levels of medication adherence, increased environmental exposures, and urban stress present additional challenges to optimal preventative asthma management behaviors in this group.⁷ Still, given that guidelines for optimal management of asthma in school⁴⁴ are challenging to implement consistently in urban schools, reviewing strategies to reduce absenteeism with caregivers, school nurses, and school staff through asthma management educational training is clearly needed.

More pronounced differences in academic outcomes were found by ethnicity within the asthma and healthy control groups, the most robust being within the asthma group. For example, Latinos and Black children with asthma had poorer academic outcomes than their

298 NLW counterparts, with Latino children having the poorest outcomes across a range of
299 indicators.

300 Results suggest that asthma status can exacerbate ethnicity-based disparities in
301 academic outcomes in urban minority children with asthma. Latino children with asthma
302 appear to have the highest risk for poor academic performance. Our prior work has shown
303 that urban Latino children with asthma face urban stressors *and* unique cultural-related
304 stressors (e.g., acculturative stress,⁴⁵ higher levels of fear of asthma,⁴⁶ poorer symptom
305 perception,²³ lower medication adherence,⁴⁷ greater concerns regarding medications⁴⁸ that
306 may put them at risk for poor academic performance. Future work should identify
307 contributing factors to poor school performance among specific groups of children with
308 asthma, as these stressors and poor sleep may be areas to target in future interventions.

309 Our results also suggest that asthma may impact children's academic performance.
310 For example, better lung function was related to better quality school work and less careless
311 work by teacher report. Further, the more lung function varied for children across the
312 monitoring period, the poorer their WRAT math scores were. More frequent symptom reports
313 by children and caregivers were related to less work completed and more school absences.
314 Finally, better asthma appeared to be important for a number of academic indicators,
315 including higher levels of teacher-reported quality of school work and a higher percent of
316 work completed, higher WRAT math scores, and fewer absences. These results suggest the
317 important role of asthma management for children's academic performance. Although each
318 asthma indicator was related to several academic outcomes, asthma control was associated
319 with the most academic outcomes. Asthma control, a marker of morbidity, can be useful to
320 identify children who may be at risk for problems with school performance.

321 More associations between asthma indicators and a range of academic outcomes were
322 observed in the Latino group of children, followed by the NLW group of children. Latino

children's lung function variables were related to their achievement scores and teacher reported impressions of the quality of their work. A range of asthma indicators (lung function, control, symptom reports) related to several academic indicators in the NLW group of children. In the Black group of children, only symptom reports were related to more absences and less work completed, by teacher report. Overall, there was not a single academic indicator that seemed to be affected by poorer asthma status more often in the overall asthma sample or in the specific ethnic groups. However, children's grades were not associated with asthma activity in the group of children with asthma, whereas teacher reported academic indicators, school absences, and achievement scores were each associated with more asthma activity.

Several limitations of the current study should be noted. We examined academic performance and asthma through objective approaches (e.g., lung function via AM2+); however, the design did not capture potential bi-directional relationships in real time. This cross-sectional design may pose limitations for inferring directional or causal associations. We used means across monitoring periods for variables collected daily, such as the asthma variables. Furthermore, academic variables were collected at the end of the semester rather than during the specific time of an asthma event and included both objective and subjective measures of academic function. Likewise, other health or behavioral agents, such as sleep quality, as well as other psychosocial factors (e.g., family functioning, caregiver stress) may have impacted academic or asthma variables. Further, allergic rhinitis is highly co-morbid in urban children with asthma and may impact sleep quality,²² which can also affect academic outcomes.¹² In addition, seasonality, infectious triggers, and allergy status, can contribute to AR and asthma symptoms and academic functioning, and should be considered in future research with urban children. Further, exposure to environmental triggers in the home, school, and neighborhood environment can exacerbate symptoms, and possibly contribute to

academic outcomes. Future research should assess the mediating role of specific behavioral, environmental, and health processes on asthma and academic functioning in larger samples of urban children.

Poor asthma control can affect children's daily functioning. Children's optimal school performance, a key factor in their future learning and academic trajectory, is at stake. Asthma management education for students, caregivers, and school staff is needed to provide clear asthma response plans for students experiencing symptoms at school.⁴³ School staff are instrumental in identifying children with asthma who may be absent more often or exhibit signs of poor asthma control and referring them to the school nurse for follow up. Increased communication between caregivers, teachers, and school nurses about the asthma care of children can ensure students' asthma response plan in school is clear and that they have available rescue medications at school.⁴⁴ Although asthma control is modifiable, urban schools are faced with barriers (e.g., often one school nurse teacher per hundreds of school children, difficulties obtaining prescriptions for rescue inhalers and student's asthma action plans from caregivers), that may limit optimal asthma management at school; interventions designed to increase parent-provider-school partnerships should be encouraged to address these barriers.

References:

1. Centers for Disease Control and Prevention. National Center for Health Statistics. Asthma Prevalence, Health Care Use and Mortality: United States, 2003-05. 2007; <http://www.cdc.gov/nchs/products/pubs/pubd/hestats/ashtma03-05/asthma03-05.htm>. Accessed June 06, 2008.
2. Boergers J, Koinis-Mitchell D. Sleep and culture in children with medical conditions. *Journal of Pediatric Psychology*. 2010;35(9):915-926.
3. Koinis-Mitchell D, Kopel SJ, Boergers J, et al. Good sleep health in urban children with asthma: A risk and resilience approach. *Journal of Pediatric Psychology*. 2015;40(9):888-903.
4. Koinis-Mitchell D, Kopel SJ, Boergers J, et al. Asthma, allergic rhinitis, and sleep problems in urban children. *Journal of Clinical Sleep Medicine*. 2015;11(2):101-110.
5. Morgan WJ, Crain EF, Gruchalla RS, et al. Results of a home-based environmental intervention among urban children with asthma. *New England Journal of Medicine*. 2004;351(11):1068-1080.
6. Garrison MM, Lozano P, Christakis DA. Controller medication use and sleep problems in pediatric asthma: A longitudinal case-crossover analysis. *Archives of Pediatrics and Adolescent Medicine*. 2011;165(9):826-830.
7. Koinis-Mitchell D, McQuaid EL, Seifer R, et al. Multiple urban and asthma-related risks and their association with asthma morbidity in children. *Journal of Pediatric Psychology*. 2007;32(5):582-595.
8. 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. *Archives of Pediatric Adolescent Medicine*. 2000;154(9):923-928.

9. Horner CC, Mauger D, Strunk RC, et al. Most nocturnal asthma symptoms occur outside of exacerbations and associate with morbidity. *Journal of Allergy and Clinical Immunology*. 2011;128(5):977-982
10. Moonie SA, Sterling DA, Figgs L, Castro M. Asthma status and severity affects missed school days. *Journal of School Health*. 2006;76(1):18-24.
11. Basch CE. Asthma and the achievement gap among urban minority youth. *Journal of School Health*. 2011;81(10):606-613.
12. Reynolds KC, Boergers J, Kopel SJ, Koinis-Mitchell D. Multiple Comorbid Conditions, Sleep Quality and Duration, and Academic Performance in Urban Children With Asthma. *Journal of Pediatric Psychology*. 2018.
13. Summary health statistics for US children; National Health interview survey, 2011. 2012. http://www.cdc.gov/nchs/data/series/sr_10/sr10_255.pdf.
14. Rhode Island Department of Health. *The burden of asthma in Rhode Island 2014* <http://www.health.ri.gov/publications/burdendocuments/2014Asthma.pdf>2014.
15. National Heart Lung and Blood Institute. Guidelines for the diagnosis and management of asthma. In. Bethesda, MD: National Institutes of Health; 2007.
16. Koinis-Mitchell D, Kopel SJ, Seifer R, et al. Asthma-related lung function, sleep quality, and sleep duration in urban children. *Sleep Health*. 2017.
17. Hsu J, Qin X, Beavers SF, Mirabelli MC. Asthma-related school absenteeism, morbidity, and modifiable factors. *American Journal of Preventive Medicine*. 2016;51(1):23-32.
18. Taras H, Potts-Datema W. Childhood asthma and student performance at school. *Journal of School Health*. 2005;75(8):296-312.

19. Moonie S, Sterling DA, Figgs LW, Castro M. The relationship between school absence, academic performance, and asthma status. *Journal of School Health*. 2008;78(3):140-148.
20. Kattan M, Stearns SC, Crain EF, et al. Cost-effectiveness of a home-based environmental intervention for inner-city children with asthma. *Journal of clinical Immunology*. 2005;116(5):1058-1063.
21. McQuaid EL, Everhart RS, Seifer R, et al. Medication adherence among Latino and non-Latino white children with asthma. *Pediatrics*. 2012;129(6):e1404-e1410.
22. Esteban CA, Everhart RS, Kopel SJ, Klein RB, Koinis-Mitchell D. Allergic sensitization and objective measures of sleep in urban school-aged children with asthma. *Annals of Allergy and Asthma Immunology*. 2017;119(3):238-245.
23. Fritz GK, McQuaid EL, Kopel SJ, et al. Ethnic differences in perception of lung function: A factor in pediatric asthma disparities? *American Journal of Respiratory and Critical Care Medicine* 2010;182(1):12-18.
24. Canino G, Bravo M. The adaptation and testing of diagnostic and outcome measures for cross-cultural research. *International Review of Psychiatry*. 1994;6(4):281-286.
25. U.S. Department of Health and Human Services. *The 2005 HHS Poverty Guidelines*. Washington, DC: U.S. Department of Health and Human Services;2005.
26. Redline S, Tishler PV, Hans MG, Tosteson TD, Strohl KP, Spry K. Racial differences in sleep-disordered breathing in African-Americans and Caucasians. *American Journal of Respiratory and Critical Care Medicine*. 1997;155(1):186-192.
27. Esteban CA, Klein RB, Kopel SJ, et al. Underdiagnosed and undertreated allergic rhinitis in urban school-aged children with asthma. *Pediatric Allergy, Immunology, and Pulmonology*. 2014;27(2):75-81.

28. American Thoracic Society, European Thoracic Society. ATS/ERS recommendations for standardized procedures for online and offline measurement of exhaled lower respiratory nitric oxide and nasal nitric oxide. *American Journal of Respiratory and Critical Care Medicine*. 2005;171:912-930.
29. Centers for Disease Control and Prevention. Body Mass Index: About BMI for children and teens.
http://www.cdc.gov/nccdphp/dnpa/bmi/childrens_BMI/about_childrens_BMI.htm.
30. Bender BG, Milgrom H. Comparison of the effects of fluticasone propionate aqueous nasal spray and loratadine on daytime alertness and performance in children with seasonal allergic rhinitis. *Annals of Allergy, Asthma & Immunology*. 2004;92(3):344-349.
31. Bousquet J, Khaltaev N, Cruz AA, et al. Allergic Rhinitis and its Impact on Asthma (ARIA) 2008 *Allergy*. 2008;63 Suppl 86:8-160.
32. McQuaid EL, Walders N, Kopel SJ, Fritz GK, Klennert MD. Pediatric asthma management in the family context: the Family Asthma Management System Scale. *Journal of Pediatric Psychology*. 2005;30(6):492-502.
33. Schatz M, Sorkness CA, Li JT, et al. Asthma Control Test: reliability, validity, and responsiveness in patients not previously followed by asthma specialists. *Journal of Allergy and Clinical Immunology*. 2006;117(3):549-556.
34. Nathan RA, Sorkness CA, Kosinski M, et al. Development of the Asthma Control Test: A survey for assessing asthma control. *Journal of Allergy and Clinical Immunology*. 2004;113(1):59-65.
35. Okupa AY, Sorkness CA, Mauger DT, Jackson DJ, Lemanske RF, Jr. Daily diaries vs retrospective questionnaires to assess asthma control and therapeutic responses in

- asthma clinical trials: is participant burden worth the effort? *Chest*. 2013;143(4):993-999.
36. Koinis-Mitchell D, McQuaid EL, Seifer R, et al. Symptom perception in children with asthma: Cognitive and psychological factors. *Health Psychology*. 2009;28(2):226-237.
37. Wang X, Dockery DW, Wypij D, Fay ME, Ferris BG, Jr. Pulmonary function between 6 and 18 years of age. *Pediatric Pulmonology*. 1993;15(2):75-88.
38. Hankinson JL, Odencratz JR, Fedan KB. Spirometric reference values from a sample of the general U.S. population. *American Journal of Respiratory and Critical Care Medicine*. 1999;159(1):179-187.
39. Fallone G, Acebo C, Seifer R, Carskadon MA. Experimental restriction of sleep opportunity in children: effects on teacher ratings. *Sleep*. 2005;28(12):1561-1567.
40. Fallone G, Acebo C, Seifer R, Carskadon M. Experimental restriction of sleep opportunity in children: Effects on teacher ratings. *Sleep*. 2005;28(12):1561-1567.
41. Jastak S, Wilkinson G. The Wide Range Achievement Test-Revised: Administration Manual. In. Wilmington, DE: Jastak Associates, Inc.; 1984.
42. Rothman KJ. No adjustments are needed for multiple comparisons. *Epidemiology*. 1990;43-46.
43. Koinis-Mitchell D, McQuaid E, Fritz G, et al. Culturally and contextually tailored asthma self-management for urban, Latino middle school students: The Rhode Island-Puerto Rico ASMAS program. In. *Presented at the American Thoracic Society Annual conference*. Washington, DC2017.
44. National Asthma Education and Prevention Program. *Expert Panel Report 3: Guidelines for the diagnosis and management of asthma*. Bethesda MD: US Department of Health and Human Services, National Institutes of Health;2007.

45. Koinis-Mitchell D, McQuaid EL, Kopel SJ, et al. Cultural-related, contextual, and asthma-specific risks associated with asthma morbidity in urban children. *Journal of Clinical Psychology in Medical Settings*. 2010;17(1):38-48.
46. Koinis-Mitchell D, Kopel SJ, Esteban C, et al. Asthma status and physical activity in urban children. American Thoracic Society; 2017; Washington DC.
47. McQuaid EL, Kopel SJ, Klein RB, Fritz GK. Medication adherence in pediatric asthma: Reasoning, responsibility, and behavior. *Journal of Pediatric Psychology*. 2003;28(5):323-333.
48. McQuaid EL, Vasquez J, Canino G, et al. Beliefs and barriers to medication use in parents of Latino children with asthma. *Pediatric Pulmonology*. 2009;44(9):892-898.

Table 1

Participant characteristics: Full sample and by ethnic group

	Sample	Latino	Black/African American	Non-Latino white	Ethnic group differences	Effect sizes [†]
N (%)	395	182 (46%)	132 (33%)	81 (21%)	---	---
Age ,M(SD)	8.3 (0.86)	8.3(0.9)	8.3(0.8)	8.2(0.8)	F<1.0	.01
Gender, % Male	209 (53)	100(55%)	74(56%)	35(43%)	$\chi^2=3.9$	.10
At/below poverty threshold (%) ^a	248 (67)	140(81%)	81(65%)	27(38%)	$\chi^2=43.8***$	.34
Number of children in home, M(SD)	2.71 (1.27)	2.78(1.19)	2.72(1.52)	2.53(.96)	F=1.05	.01
Number of adults in home M(SD)	1.81 (0.81)	1.78(.81)	1.79(.88)	1.91(.67)	F<1.0	.004
ASTHMA CLINICAL CHARACTERISTICS						
SDB, % High Risk	134(38)	63(39)	51(43)	20(27)	$\chi^2=5.2$	.07
On Controller	186(81)	94(80)	64(83)	28(76)	$\chi^2=.89$	.06
Asthma Medication (%)						
AR Not well/Poorly Controlled (%)	98 (37)	54 (39)	34 (40)	9 (23)	F=1.5	.01

*p<.05; **p<.01; ***p<.001

M denotes mean (standard deviation) presented

[†]ANOVA effect sizes are partial omega squared (ω^2p); chi square effect sizes are Cramer's Phi (c)^a Significant group differences were between NLW and Latino ethnic groups

Table 2.

Adjusted effects of asthma vs healthy control group on mean academic outcome

	Asthma vs. Control
Quality of school work	-0.12(.13)
Percent of work completed	-0.26(.15)
Careless/Hasty school work	-0.35(.20)
Total school absences*	2.65(1.22)
Math standard score	0.58(1.60)
Reading standard score	-0.48(1.69)
Mean 1st quarter or trimester grades	-0.68(1.32)

*Estimates are unstandardized regression coefficients (standard errors). Negative effects denote cases where mean academic outcome in Asthma group was lower than mean outcomes in Control. Models controlled for asthma severity.

Table 3.

Mean comparisons of academic outcomes and ethnic comparisons among asthma group and healthy controls.

	Latino vs. Black	Latino vs. NLW	Black vs. NLW
Asthma Group			
Quality of work (SD=1)	-0.12(0.17)	-0.54(0.21)*	-0.42(0.23)
Percent of work completed (SD=1)	-0.05(0.21)	-0.42(0.26)	-0.37(0.28)
Careless/Hasty school work (SD=1)	0.19(0.19)	-.07(.23)	-0.26(0.25)
Total school absences (SD=8)	3.33(1.76)	3.53(2.13)	0.21(2.30)
Math standard score (SD=13)	-1.46(2.15)	-8.69(2.80)*	-7.24(2.96)*
Reading standard score (SD=14)	-5.99(2.23)*	-9.21(2.89)*	-3.23(3.06)
Mean 1st quarter or trimester grades (SD=7)	-4.18(1.80)*	-5.93(2.16)*	-1.75(2.32)
Healthy Controls			
Quality of work (SD=1)	0.05(0.23)	-0.43(.24)	-0.48(0.23)
Percent of work completed (SD=1)	-0.07(0.26)	-0.33(0.27)	-0.26(0.26)
Careless/Hasty school work (SD=1)	-0.25(0.26)	-0.13(0.27)	0.12(0.26)
Total school absences (SD=8)	-0.29(2.13)	-0.85(2.07)	-0.56(2.11)
Math standard score (SD=13)	-4.59(3.01)	-8.01(3.17)*	-3.42(2.96)
Reading standard score (SD=14)	-3.47(3.32)	-6.21(3.48)	-2.74(3.26)
Mean 1st quarter or trimester grades (SD=7)	-0.60(2.63)	-3.11(2.60)	-2.51(2.53)

*Significant after adjusting for multiple comparisons.

Estimates are unstandardized regression coefficients(SE)

SD indicates standard deviation in aggregate sample and can be used to interpret effect size.

Table 4.

Association between asthma and academic outcomes among asthma group

	FEV1 % Predicted	FEV1 Variability	Diary Reported Symptoms	Asthma Control
Quality of work (SD=1)	.01(.006)*	-.004(.01)	-.59(.43)	.05(.02)*
Percent of work completed (SD=1)	.01(.008)	-.01(.01)	-1.05(.52)	.05(.03)
Careless/Hasty school work (SD=1)	.02(.01)*	-.002(.01)	-.57(.46)	.04(.02)
Total school absences (SD=8)	.05(.07)	-.02(.13)	12.89(4.98)*	-.52(.21)*
Math standard score (SD=13)	.15(.08)	-.34(.16)*	-.24(5.64)	.54(.26)
Reading standard score (SD=14)	.15(.09)	-.27(.17)	-.14(5.79)	.11(.28)
Mean 1st quarter or trimester grades (SD=7)	.07(.07)	.003(.13)	1.21(5.50)	.07(.23)

*Significant after adjusting for multiple comparisons.

Estimates are unstandardized regression coefficients(SE) from models comparing each predictor (column) to each outcome (row) adjusting for asthma severity

SD indicates standard deviation in aggregate sample and can be used to interpret effect size.

Table 5.

Association between asthma and academic outcomes by ethnicity within asthma Group

	FEV1 % Predicted	FEV1 Variability	Diary Reported Symptoms	Asthma Control
Latino				
Quality of work	.02(.02)	-.004(.02)	-.33(.64)	.02(.04)
Percent of work completed	.01(.01)	-.01(.02)	-1.15(.77)	.01(.05)
Careless/Hasty school work	.02(.01)*	-.01(.02)	-.32(.65)	-.03(.04)
Total school absences	.11(.09)	-.08(.15)	2.06(7.02)	.06(.32)
Math standard score	.28(.10)*	-.52(.24)*	3.79(7.58)	-.14(.44)
Reading standard score	.36(.12)*	-.51(.23)*	5.00(8.19)	-.36(.49)
Mean 1st quarter or trimester grades	.07(.11)	-.09(.17)	-2.13(8.22)	-.07(.40)
Black/African American				
Quality of work	.01(.01)	.002(.02)	-.04(.70)	.05(.03)
Percent of work completed	.02(.01)	-.0004(.03)	-.84(.99)	.86(.04)*
Careless/Hasty school work	.01(.01)	.02(.02)	-.32(.89)	.06(.03)
Total school absences	.23(.15)	-.03(.24)	14.31(9.51)*	-.90(.30)*
Math standard score	-.11(.15)	-.20(.25)	10.62(10.32)	.90(.36)*
Reading standard score	-.18(.14)	.10(.24)	-3.09(9.75)	.47(.35)
Mean 1st quarter or trimester grades	-.01(.16)	.56(.25)	16.48(11.77)	.30(.35)
Non-Latino White				
Quality of work	.03(.01)	-.08(.04)	-2.18(.83)*	.10(.04)*
Percent of work completed	.02(.01)	-.06(.05)	-1.25(.94)	.06(.05)
Careless/Hasty school work	.01(.01)	-.06(.05)	-1.48(1.01)	.09(.05)
Total school absences	-.11(.16)	.21(.57)	29.69(11.56)*	-1.04(.60)
Math standard score	.27(.21)	-1.33(.59)	27.97(12.59)*	1.08(.65)
Reading standard score	.11(.21)	-.53(.63)	-12.71(13.12)	.54(.67)
Mean 1st quarter or trimester grades	.14(.07)	-.69(.39)	-2.68(8.06)	.31(.38)

*Significant after adjusting for multiple comparisons.

Estimates are unstandardized regression coefficients from models comparing each predictor (column) to each outcome (row) adjusting for asthma severity within each ethnicity group.