

RESEARCH ARTICLE

The Effects of Asthma on Academic Achievement in a Sample of Former Head Start Children

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The ways in which a diagnosis of asthma can affect the academic achievement of students were examined in a sample of 5,711 former Head Start children, 788 of which were identified as having asthma. Results indicated statistically significant group differences in standardized reading and mathematics scores, with students with asthma performing worse than students without this diagnosis in both academic areas. In reference to reading abilities among students with asthma, indicators of socioeconomic status, gender, and level of school absences were found to be predictive of reading scores. Regarding mathematics abilities, results indicated the significant contribution of both socioeconomic status and level of school absences in predicting the math scores of students with asthma. Variables regarding the family environment did not make a significant contribution to explaining the asthma-academic achievement relationship beyond the effects of these variables.

Keywords: Asthma, Academic Achievement, Head Start

Asthma is the most prevalent respiratory chronic illness for American school-aged children, with an estimated 7.1 million children (9.6%) diagnosed with the condition (Bloom, Cohen, & Freeman, 2010). Of this group, children under the age of five are diagnosed with the condition at higher rates than any other age group (Akibani & Schoendorf, 2002). Therefore, it is important not only to address the successful management of the disease in young children but also to understand the influence of the condition on children's school outcomes.

Research suggests children with asthma are at greater risk for physical and mental health outcomes when compared to their healthy peers. These difficulties include poorer general health outcomes (Collins, Gill, Chittleborough, Martin, Taylor, & Winefield, 2008), more frequent nighttime waking and subsequent sleep deprivation from asthma symptoms (Fiese, Everhart, and Wildenger, 2009), and a higher incidence of internalizing behavior problems, including anxiety and depression (Fiese et al., 2009; Röder, Kroonenberg, & Boekaerts, 2003). Whereas studies have documented higher school absenteeism in children with asthma (Dean, Calimlim, Kindermann, Khandker, & Tinkelman, 2009; Moonie, Sterling, Figgs, & Castro, 2008; Silverstein, Mair, Katusic, Wollan, O'Connell, & Yunginger, 2001), other aspects of school functioning, particularly academic achievement, are less clear. Therefore, the current study aims to examine the academic achievement of young children with asthma, with a particular emphasis on the role that family factors, including access to resources and regular family routines, might play in potentially moderating this relationship.

ASTHMA AND ACADEMIC ACHIEVEMENT

Research regarding the effects of asthma on academic achievement is largely inconclusive. Some studies indicate children with asthma perform more poorly than their healthy peers on measures of academic functioning, particularly reading (Kohen, 2010; Liberty, Pattemore, Reid, & Tarren-Sweeney, 2010), whereas others have found that these children perform just as well or even better on measures of reading and math achievement when compared to healthy peers (Moonie et al., 2008; Moricca et al., 2012) or to children with other chronic health conditions (McNelis, Dunn, Johnson, Austin, & Perkins, 2007). Kohen (2010) suggests these discrepant findings might result from inconsistencies in both the operational definitions of asthma used (e.g., severity level, physician versus parent-reported diagnosis, etc.) and the measure(s) of academic achievement employed. For example, some studies have employed standardized achievement measures in assessing current levels of academic achievement (Liberty et al., 2010; Kohen, 2010), whereas other studies have incorporated parental reports of children's academic strengths and weaknesses (Diette, Markson, Skinner, Nguyen, Algatt-Bergstrom, & Wu, 2000). Fowler and colleagues (1992) warn that relying on parent report alone might result in identification of greater academic difficulties in students with asthma when compared to reviews of school records for these same children.

Factors Contributing to the Asthma-Academic Achievement Relationship

Disease-Related Variables. One mechanism by which asthma could adversely affect the academic achievement of children exists in the disease process itself. It is well established that many children with chronic health difficulties face challenges in academic functioning at as a result of associated cognitive deficits. In particular, many researchers have recognized an increased rate of academic problems in children with health difficulties directly impacting the central nervous system or some aspect of brain

functioning (Mukherjee, Lightfoot & Sloper, 2000; Shiu, 2001; Wodrich & Cunningham, 2008). For example, children and adolescents with epilepsy are often adversely affected academically from concomitant deleterious effects in brain regions associated with memory and learning (Wodrich & Cunningham, 2008). Although direct cognitive effects are perhaps not as apparent in students with asthma, Bender (1995) argues that neurological damage can occur in those with more severe, less-controlled forms of asthma as a result of chronic episodes of respiratory distress and subsequent cerebral hypoxia. Albeit possible, clear evidence for the existence of hypoxia-induced brain effects in children with asthma is lacking.

Other researchers have argued that a more plausible link between asthma and impaired cognitive functioning could be due to the negative side effects of asthma medications, namely inhaled corticosteroids. Side effects of long-term corticosteroid use can include mood disturbance in the form of depression, mania/hypomania, as well as increased behavior problems (e.g., agitation, aggressiveness, and oppositional behavior); all which can lead to poor academic performance at school (Cerullo, 2006; Taras & Potts-Datema, 2005). Studies examining more direct cognitive effects of inhaled corticosteroid use have found prolonged use of these medications to be associated with neurocognitive deficits related to verbal memory (Brown, Rush, & Mcewen, 1999), declarative memory (Newcomer, Craft, Hershey, Askins, & Bardgett, 1994), and attention deficits (Chen et al., 2013; Naudé & Pretorius, 2003).

It should also be emphasized that asthma-related symptoms (difficulty breathing) as well as long-term corticosteroid use can both exist as general risk factors for the development of cognitive deficits; however, little is known regarding the mechanisms by which these effects occur (Kirkham & Datta, 2006). Some have suggested that the relationship between asthma and academic achievement is perhaps best explained by individual differences among students with asthma, as has largely been borne out in the literature.

Demographic Factors. The relationship between asthma and important outcome variables, including school performance, is often moderated by individual demographic factors including gender, ethnicity, and socioeconomic status (SES). In examining these relationships, it is first necessary to understand the population of children diagnosed with asthma in the United States. Results of the most recent National Health Interview Survey conducted by the Centers for Disease Control and Prevention indicate that children with certain characteristics are differentially diagnosed with asthma in this country (Bloom et al., 2010). Regarding gender, more boys (16%) than girls (12%) receive a lifetime diagnosis of asthma. In reference to ethnicity, non-Hispanic African American children (21%) are more likely to have asthma than Hispanic children (13%) and non-Hispanic White children (12%). Finally, results of this survey denote that children from families with more limited economic resources (17%) experience higher rates of asthma than children from families who are not living in poverty (12%). It is then important to identify which, if any, of these characteristics might play a contributory role in the association between asthma and academic achievement.

Gender. Results from studies regarding the effects of gender on academic achievement are mixed. Whereas some researchers have found that boys experience

higher levels of academic success than girls (Reardon, Greenberg, Kalogrides, Shores, & Valentino, 2012) or vice versa (Mullis, Martin, Gonzalez, & Kennedy, 2003), others have argued that the gender gap related to academic achievement has radically closed over recent years (Ma, 2008). Regarding asthma, Koinis-Mitchell, Murdock, and Berz (2004) found that gender differences are apparent in the child's emotional response to the disease with girls with asthma often reporting lower perceptions of self-competence in disease management. Moreover, social-emotional difficulties such as these are recognized to place school-age children at risk for poor academic outcomes, including broader learning difficulties and school dropout (Quiroga, Janosz, Bisset, & Morin, 2013). Despite this fact, the direct role that gender might play in the association between asthma and academic achievement is less clear. Some researchers examining this relationship have controlled for the presence of basic demographic characteristics, including gender, to adequately address research questions of interest (Kohen, 2010). Others have found no relationship between gender and outcome variables related to achievement among students with asthma (Koinis-Mitchell, Adams, & Murdock, 2005).

Ethnicity. It is understood that children from diverse ethnic backgrounds, particularly those living in urban areas, are at a greater risk for asthma as well as worse asthma-related outcomes (Bloom et al., 2010). Factors accounting for this disparity have included lower medication adherence rates (Desai & Oppenheimer, 2011), different beliefs regarding medication use (Koinis-Mitchell et al., 2005), higher exposure to environmental irritants (Kattan et al., 2005), greater perceptions of community violence (Wright et al., 2004), and less access to/poorer quality of care for presenting symptoms (Ortega et al., 2002). Therefore, it is often difficult to separate the effects of minority status from such related factors. Accordingly, it is perhaps most appropriate to think of factors such as minority status and SES as broader markers for the presence of higher-risk family environments.

In a recent study of asthma-related outcomes in a sample of urban children, researchers found that the presence of a greater number of risk factors (e.g., poverty status, neighborhood disadvantage) was associated with greater asthma-related morbidity and that this relationship held for all groups regardless of ethnic background (Koinis-Mitchell et al., 2010). In contrast, this same study also demonstrated that African American and Hispanic families experienced greater functional limitations as well as higher levels of poverty resulting from asthma when compared to their non-Hispanic White counterparts, potentially pointing to a more direct effect of ethnicity (Koinis-Mitchell et al., 2010). Most studies attempt to control for ethnicity variables when examining asthma effects on academic achievement, as few have looked beyond the role of such variables as potential markers for achievement (Liberty et al., 2010). Furthermore, some still argue that any effects of minority status observed are largely still a function of related variables, namely issues of socioeconomic status (SES) (Taras & Potts-Datema, 2005).

Socioeconomic Status (SES). Research consistently demonstrates that students coming from economically disadvantaged families are at a greater risk for poorer school outcomes and that these effects are particularly apparent when the child begins school (Arnold & Doctoroff, 2003). Associated characteristics of low-SES families,

which have been demonstrated to contribute to this phenomenon, include greater parent distress resulting from economic strain, less access to educational materials (e.g., books) in the home, and less overall importance placed on education by parents (Aikens & Barbarin, 2008). As a result, children coming from lower-SES families sometimes do not achieve the same level of early academic success as those children from higher-SES families, who are more likely to have received a greater level of early academic preparedness at home (Arnold & Doctoroff, 2003).

Whereas many researchers have controlled for SES in examining the relationship between asthma and academic achievement, some have found that SES still plays an important role in moderating observed deleterious effects. In a synthesis of studies examining social and economic consequences of asthma, Milton and colleagues (2004) concluded that children with asthma living in lower income households are at greater risk for poorer grades in school. Another mechanism by which living in high-poverty, urban environments might adversely affect the school functioning and healthy development of children with asthma lies in the presence of poor air quality in such environments. Compromised outdoor air quality (e.g., due to traffic-related air pollution and exposure to industrial-related pollution) (Brauer, 2010) as well as poor indoor air quality as evidenced by higher concentrations of environmental toxins, including secondhand smoke in the home (Butz et al., 2011; Hullin, Caillaud, & Alessi-Maesano, 2010; Rodriguez et al., 2010), have all been shown to lead to an exacerbation of asthma symptoms among children living in such areas. Early exposure (i.e., prenatally) to airborne toxins often present in low-SES, urban environments can also have lasting effects on cognitive functioning as measured by standardized intelligence tests (Perera et al., 2009). Despite the potential negative consequences that limited economic resources and associated environmental conditions might have on the academic outcomes of students, the family environment in the form of positive parenting practices and access to neighborhood resources, have been identified as important mediators in overcoming the negative effects of poverty (Kiernan & Mensah, 2011). However, family-related variables such as these have not received much attention in examining the relationship between asthma and academic achievement.

Absences and Asthma Severity. The role that school absences play in contributing to poor school outcomes in children with chronic health problems has been studied widely. In general, the school environment offers an opportunity for students to experience both academic and personal success, to practice and master new skills, to foster a developing sense of self and growing self-efficacy, and to develop those social relationships necessary for future successful functioning at school and beyond (Shiu, 2001). Unfortunately, students experiencing chronic health difficulties are at a greater risk for school absenteeism resulting from prolonged hospitalizations, doctor visits, and an overall greater incidence of poor health days (Shiu, 2001). As a result, these students might regularly miss out on the important normative experiences that the school environment might offer in aiding healthy development. Research suggests that increased absenteeism among students is associated with negative school-related outcomes including the disruption of the learning process, strained peer relationships, and reduced involvement in physical activities, including extracurricular activities (Shiu, 2001). As children with asthma experience the highest absenteeism rate of all students with chronic

health difficulties (Doull, Williams, Freezer, & Holgate, 1996), it is important to understand how absences might adversely influence school functioning in this population.

Students with asthma, particularly those with less well-controlled forms of the disease, tend to miss more school days than healthy peers and more than peers with better-controlled asthma (Moonie et al., 2006). As reported in the literature, estimates of the difference in average days absent annually range anywhere from 1.3 (Moonie et al., 2006) to 22 (Lodha, Puranik, Kattal, & Kabra, 2003) more days missed by these students. Students with asthma miss more school days for a number of reasons that include doctors appointments, increased severity of asthma symptoms (e.g., labored breathing, fatigue), and proactive avoidance of potential contact with asthma triggers at school (Taras & Potts-Datema, 2005). Moreover, some studies have demonstrated that relationships between asthma and lower levels of school achievement are partially moderated by the incidence of more missed school days (Koinis-Mitchell et al., 2005; Moonie et al., 2008). Research suggests school absences in students with asthma are associated with multiple indicators of poor academic achievement including poorer mathematics performance (Kohen, 2010) and word reading scores (Liberty et al., 2010) as measured by standardized achievement tests.

The Family Environment. Taras and Potts-Datema (2005), in a review of studies examining the link between asthma and school-related outcomes, acknowledge that few researchers have addressed the role that other contributory factors could play in this relationship. These authors recognize that family-related factors in particular such as the home environment, level of access to community health care, and family resources have received minimal attention from asthma researchers (Taras & Potts-Datema, 2005).

Exposure to adverse sociodemographic events could place children with asthma at risk for a host of negative outcomes including low self-competence (Brooks-Gunn & Duncan, 1997), poor disease control and exacerbations of symptoms (Eggleston, Buckley, Breysse, Wills-Karp, Kleeberger, & Jaackkola, 1999), less access to quality health care (Eggleston et al., 1999), and fewer opportunities to participate in developmentally appropriate activities (Eggleston et al., 1999). Furthermore, more recent evidence indicates that family-related variables may serve an important role in moderating the effects of SES in the form of lower family income on the educational success of children living in these environments (Aikens & Barbarin, 2008). Additionally, Kazak, Simms, & Rourke (2002) have emphasized the usefulness of a systems-level framework for working with such children and their families. These authors state that in order to adequately address the needs of students with chronic health problems, schools should join all involved parties together through a culture of mutual respect, use a competence-based approach in identifying needed supports, and collaborate with the child's family and medical team together and not in isolation. Therefore, it is clear that a consideration of the family environment is certainly relevant to an examination of the school functioning of students with asthma. However, these effects are not yet clear.

Family Resources and Family Routines. Two aspects of the home environment that appear to be integral to children's development, including the

promotion of positive educational outcomes, are access to community resources and the existence of regular family routines. First, families living in higher-quality environments often have greater opportunities to provide their children with potentially enriching community experiences that can aid in healthy development (e.g., parks, youth programs, libraries, well-performing schools) (Leventhal & Brooks-Gunn, 2005). Furthermore, studies have shown that less access to such resources is associated with a range of variables often identified as correlates of poor school functioning, namely high poverty rates (Leventhal & Brooks-Gunn, 2000), negative parenting practices (Simons et al., 2002), and a diminished sense of community organization and cohesion (Sampson, Raudenbush, & Earls, 1997). Furthermore, greater access to community resources is often associated with potentially moderating environmental variables including better air quality and access to health care (Eggleston et al., 1999).

The presence of family routines in daily activities such as mealtimes, nighttime curfews, and homework is also accepted as an integral element to promoting a sense of cohesion in the family, while also serving a protective role in the health and well-being of children (Roche & Ghazarian, 2012). Although consistent family routines can have great effects on encouraging healthy child development, particularly social development, studies have demonstrated that such routines are not as prevalent in families living in poorer neighborhoods. Characteristics of low SES neighborhoods that might contribute to a lack of consistent family routines include less social organization and economic constraints (e.g., parents working long hours to support the family; Leventhal & Brooks-Gunn, 2005). It is therefore apparent how aspects of more advantageous home environments in the form of higher access to community resources and the existence of family routines might play a role in contributing to the positive educational outcomes of students. However, the role of such variables in moderating this relationship among students with asthma is not clear.

THE CURRENT STUDY

The purpose of the current study was to better understand the mechanisms by which asthma can affect the academic achievement of children with this disease. Although past studies have begun to explore the role of potentially intervening variables in this relationship, much of this focus has been on identifying common covariates of low achievement in isolation, including school absences (Moonie et al., 2006; Moonie et al., 2008), disease severity and associated limitations (Kohen, 2010; Moonie et al., 2006), and other demographic variables, namely SES (Liberty et al., 2010). In contrast, studies have not examined the contributory role that other variables might play above and beyond these effects. Therefore, in addition to examining potential covariates including gender, ethnicity, SES (in the form of household income), and number of school absences, the focus of the current investigation was also on exploring whether aspects of the family environment, including access to resources and family routines might further represent an important aspect of this relationship. Additionally, few studies have examined the asthma-academic achievement relationship at the national level as most previous research has focused on aspects of this relationship in more localized samples. As such, the current study extends an understanding of potential asthma effects in

examining this issue in a nationwide sample of students formerly enrolled in the federal Head Start program. The following research questions were posed:

1. Do students with asthma exhibit different academic profiles than those without asthma as measured by standardized tests of academic achievement?
2. Among students with asthma, are levels of academic achievement contingent upon student and family characteristics including gender, ethnicity, SES in the form of household income, number of school absences, and disease severity?
3. Do family-related variables also help to account for the level of academic achievement experienced by students with asthma? That is, do those families of children with asthma who report greater access to resources and more regular family routines tend to have higher achieving children?

First, it was hypothesized that students with and without asthma would perform similarly on measures of reading and math achievement as most past research fails to support the existence of asthma-specific learning difficulties (Bender, 1995).

Regarding potential moderators of the asthma-academic achievement relationship in this study, it was first hypothesized that basic demographic variables, particularly gender and ethnicity, would not contribute significantly to the variance in academic achievement scores among students with asthma. In addition, as results of previous studies have demonstrated that differential academic functioning is often attributed to differences in SES among individuals (Taras & Potts-Datema, 2005), it was similarly expected that academic achievement outcomes among students with asthma will be moderated by differences in household income. It was also hypothesized that differences in academic achievement among students with asthma would be partially moderated by indicators of asthma severity and level of school absences. That is, some more recent studies have demonstrated that individuals experiencing more severe forms of the disease and resulting higher levels of school absences have lower levels of school achievement (Moonie et al., 2008). Finally, regarding family-related variables, it was hypothesized that those families of children with asthma reporting greater access to resources and the presence of regular family routines will have children with higher levels of academic achievement. These results were expected given the potential positive effects that such variables can have on fostering successful academic outcomes for all students. In identifying those factors that do and do not significantly contribute to the academic achievement of students with asthma, the conversation can then shift to identifying effective means of intervening with this group with the ultimate goal of improving academic outcomes.

METHOD

Procedures

Study participants were drawn from the National Head Start/Public School Early Childhood Transition Demonstration Study (Ramey et al., 2000) conducted from 1991 to

1999. The study was completed to provide information regarding the nationwide implementation of the Head Start program and to provide data regarding the impact of the program on children, families, communities, and schools as children transitioned into the first four years of public school. More than 7,500 former Head Start children and families were enrolled in the national study. Outcome data were collected from families, teachers, school administrators, and children annually from kindergarten to third grade. Data collection occurred in the Fall and Spring of children's kindergarten year and then in the Spring of first, second, and third grade. Data collected included information regarding basic demographic information, family and community characteristics, child health, school climate, and individual child attributes, including measures of academic functioning. Although the original data were collected in the 1990s, asthma diagnosis is a relatively robust measure and along with a common standardized achievement measure, we believe that the findings from this study are relevant today.

Participants

For the purposes of the current study, data from a group of former Head Start children enrolled in the National Head Start/Public School Early Childhood Transition/Demonstration Study (Ramey et al., 2000) whose parents/caregivers completed the question of whether or not they had received a doctor's diagnosis of asthma were examined ($N = 5711$). Of this group, 788 were identified by their parents as having an asthma diagnosis (14% of the sample). Specifically, caregivers were asked if a doctor has told them that their child had asthma. If the parent responded yes, three follow-up questions were posed that include the age at which the diagnosis was made, if the child still has the condition, and if the child ever received treatment for the condition. Although the asthma diagnosis was not pulled from medical records, there is reasonable certainty of the presence of the condition from these parental report data given consistency of responding on this question across years of the study. Data on covariates (e.g., gender, ethnicity, SES) were inspected within the sample of students with asthma to determine the role that each might play in the asthma-academic achievement relationship. To adequately address research questions, outcome data from the end of the third grade school year were examined. This third-grade subset of data was chosen as it is thought that a greater variety in outcome variables, namely academic achievement variables, is more likely to be observed as students reach later grades in school.

Of those children enrolled in the study, 45% were White, 32% were African American, 13% were Hispanic/Latino, 2% were Asian, and a further 7% were identified as American Indian, Eskimo/Alaskan Native, or Other ethnicities. 52% were male and 48% were female. Respondents to surveys were mostly mothers (87%). Other respondents included fathers (6%), grandmothers (4%), and other relatives (3%), which included stepparents, siblings, grandfathers, and foster parents. Regarding socioeconomic status, 4,499 respondents (79%) reported a monthly family income below the federal poverty line, whereas 989 respondents (18%) reported an income above this level.

Measures

Demographic/Family Background Measures.

Family Background Interview. Parents/caregivers were interviewed regarding basic family characteristics and child demographics on the Family Background Interview, a structured interview developed by the authors of the National Head Start/Public School Early Childhood Transition Study. Information collected in this interview and used in this study included the child's gender, race/ethnicity, number of school absences, and monthly family income.

Your Child's Health and Safety Survey. Parents/caregivers also reported information regarding children's current health status as well as any past history of health difficulties in response to interview items created by researchers of the original study. Two items from this interview were inspected for the purposes of informing the current investigation. First, the item, "Would you say your child's health, in general, is excellent, very good, good, fair, or poor?", referred to as "Child Health" was examined as an indicator of children's current health as well as a potential marker for asthma severity. The second item, referred to as "Asthma Status" asked parents/caregivers if they were ever told by a doctor that their child had asthma and was used to differentiate between the two groups of interest (i.e., students with and without asthma) in the current study.

Measures of Family Characteristics.

Family Resource Scale. The Family Resource Scale (Leet & Dunst, 1985) provides a measure of families' level of access to resources within their community and is based on those resources that have been identified as integral to the support and wellbeing of families (Dunst & Leet, 1987). That is, the scale consists of 30 items addressing level of access to health/necessities, growth/support, physical shelter, nutrition/protection, communication/employment, intrafamily support, income, and childcare (Leet & Dunst, 1985).

Psychometric properties of the Family Resource Scale have been deemed adequate (Dunst & Leet, 1987). Regarding internal consistency, coefficient alpha as measured by the average correlation among all 30 items included in the scale is .97 (Dunst & Leet, 1987). Validity evidence for the Family Resource Sale exists in the identified factor structure of the measure and the alignment of this structure with well-established conceptions of family supports and needs (Bronfenbrenner, 1979; Maslow, 1954). Criterion-related validity also exists for the measure in the prediction of scores on other measures of both health and well-being (i.e., Health and Well-Being Index) and parental commitment to providing for their children (i.e., Personal Allocation Scale) from Family Resource Scale total scores (Dunst & Leet, 1987). Four of the subscales have also been found to correlate highly with other measures of well-being and parental commitment to child-based interventions (Dunst & Leet, 1987).

Family Routines Inventory. The Family Routines Inventory (Boyce, Jensen, James, & Peacock, 1983) was also completed by parents/caregivers and served as a further measure of current family functioning. This 28-item measure serves as an indication of predictability/routinization in the family's daily life (Boyce et al., 1983).

The measure operates under the assumption that family routines are observable events involving multiple family members and that these events occur at predictable intervals (Boyce et al., 1983). Domains of family routines are assessed ($n = 10$): workday, weekend and leisure time, children's routines, parents' routines, bedtime, meals, extended family, leaving and homecoming, disciplinary routines, and household chores (Boyce et al., 1983). For each family activity (e.g., whole family eats dinner together), participants were asked to rate how often that activity occurs per week on a 4 point scale ranging from occurs "almost never" to occurs "every day." The scale yields an overall frequency score serving as an indication of the level to which the family engages in regular routines.

Psychometric properties of the Family Routines Inventory were acceptable. That is, the 30-day test-retest reliability coefficient for the overall frequency score was .79. (Jensen, James, Boyce, & Hartnett, 1983). Moreover, the overall frequency score was positively correlated with family cohesion, family organization, and family control and negatively correlated with family conflict as measured by the Family Environment Scale, another scale measuring family functioning with known acceptable psychometric properties (Jensen et al., 1983).

Standardized Measure of Academic Achievement.

Woodcock-Johnson Psychoeducational Battery - Revised. The Woodcock-Johnson Psychoeducational Battery – Revised (WJ-R) (Woodcock & Johnson, 1990) consists of a set of tests assessing a variety of academic and cognitive skills. Those tests measuring reading and math skills were administered to all children enrolled in the original study at the end of the third grade school year as these skills are regarded to be integral to children's academic success.

The reading cluster of the WJ-R administered to participants included 2 subtests: Letter-Word Identification, requiring the child to identify and read a series of letters and words presented to them and Passage Comprehension, a task examining the child's ability to understand and identify missing words and pictures from a series of passages when given context clues. Internal consistency reliabilities for these two subtests were .96 for letter-word identification and .95 for passage comprehension (Woodcock & Mather, 1990). The Mathematics cluster administered to participants was comprised of a Calculation subtest, which required the child to solve a series of increasingly complex mathematical computations and an Applied Problems subtest, in which the child had to determine the correct procedure for solving problems, identify necessary information, and provide a solution. Reported internal consistency reliabilities for these two subtests were .93 for Calculation and .84 for Applied Problems. Sampling and re-norming procedures for the WJ-R have been judged to meet high standards as its technical adequacy is well supported (Cummings, 1995).

RESULTS

Regarding sample characteristics of students with ($n = 788$) and without asthma ($n = 4923$), demographic variables were examined across groups. Of students with an asthma

diagnosis, 59% were male and 41% were female. Of students without asthma, 51% were male whereas 49% were female. In reference to ethnicity, sample characteristics were fairly similar between groups (44% Caucasian, 37% African American, 12% Hispanic, and 7% other ethnicities among students with asthma; 45% Caucasian, 32% African American, 14% Hispanic, and 9% other ethnicities among students without an asthma diagnosis). Regarding SES, characteristics were again comparable between groups with 82% and 84% of families of students with and without asthma, respectively reporting an income below the federal poverty line. Of note, missing data was present across surveys and respondents. In such cases, listwise deletion was employed before running statistical analyses.

To address the question of whether students with asthma exhibit different academic profiles than students without asthma, t-tests were conducted examining mean differences between groups across reading and math composites on the WJ-R. Results of this analysis are presented in Table 1 below.

TABLE 1
Results of T tests examining differences in reading and math scores between students with and without asthma

| WJ-R Composite | <i>t</i> | <i>df</i> | <i>Sig. (2 tailed)</i> | <i>Mean Difference</i> |
|----------------|----------|-----------|------------------------|------------------------|
| Reading | 3.878 | 3724 | .000** | 3.12 |
| Mathematics | 2.001 | 3721 | .045* | 1.77 |

Note. * $p < .05$, ** $p < .01$

Regarding reading abilities, a significant difference was observed between reading scores on the WJ-R for students without asthma ($M = 97.98$, $SD = 16.47$) and students with an asthma diagnosis ($M = 94.86$, $SD = 18.35$); $t(3724) = 3.88$, $p = .00$. In reference to mathematics abilities, there was also a significant difference between the mathematics scores on the WJ-R between students without asthma ($M = 100.68$, $SD = 18.15$) and students with asthma ($M = 98.91$, $SD = 20.09$); $t(3721) = 2.00$, $p = .045$. The effect sizes for both these analyses ($d = .18$ and $.09$, respectively) were found to fall below Cohen's (1988) convention for a small effect ($d = .20$).

The remaining research questions were addressed by examining the sample of students with an asthma diagnosis only ($n = 788$) using hierarchical multiple regression. To examine the potential role of demographic factors, school absences and asthma severity, as well as the unique contribution of family-related variables to the academic achievement of students with asthma, variables that might explain this relationship were entered in three steps. In step one, academic achievement (WJ-R) scores were the dependent variables and demographic variables (e.g., gender, race/ethnicity and SES) were the independent variables. In step two, Child Health and school absences were entered into the step one equation. Finally, family-related variables in the form of family routines and access to resources including health services/necessities were entered to determine their contribution to a model of asthma and academic achievement. This process of analysis was completed in examining the contributory relationship of these

variables on both reading and mathematics abilities. Before the hierarchical multiple regression analysis was performed, variables were tested for collinearity. Results of the variance inflation factor (all less than 2.0), and collinearity tolerance (all greater than .89) suggest that the estimated β 's are well established in the following regression models.

In examining relationships between study variables, post hoc analyses revealed several findings relevant to an interpretation of study results. First, differences were evident in the number of school absences experienced by students with asthma from different ethnic groups [$F_{(3, 522)} = 5.88, p < .01$] with African American and Native American students missing an average of 3.4 and 7.4 more days of school, respectively than Caucasian students with asthma. SES in the form of monthly income was also found to be related to the Child Health variable [$t(755) = 2.19, p = .03$] with families with monthly incomes above the federal poverty line on average also reporting better overall health in their children. The remaining observed significant relationships between study variables were related to the level of access to health/necessities and family routines variables, which were significantly related to one another [$r(711) = .31, p < .01$]. First, both variables were related to SES in the form of monthly income with those families reporting monthly incomes above the poverty line reporting greater access to community resources [$t(731) = 7.17, p < .01$] and a higher level of family routines [$t(708) = 3.55, p < .01$]. Finally, both variables were also related to the Child Health variable with families who rated their children as healthier indicating greater access to community health/necessities ($F_{(4, 755)} = 9.54, p < .01$) and a higher level of family routines ($F_{(4, 730)} = 3.11, p < .01$).

Reading Achievement

In reference to reading scores, the results of step one indicated that the variance accounted for (R^2) with the first three independent variables (gender, race/ethnicity, and SES) equaled .05 (adjusted $R^2 = .05$), which was significantly different from zero ($F_{(3, 379)} = 3.08, p < .01$). Gender ($\beta = .16, p < .01$) and SES ($\beta = .15, p < .01$) represented significant predictors of reading achievement for students with asthma in this step, with boys and students from those families with monthly incomes above the federal poverty level exhibiting higher reading scores. In step two, after adding Child Health and school absences into the regression equation, the change in variance accounted for (ΔR^2) was equal to .24, which was significantly different from zero ($F_{(5, 377)} = 6.30, p < .01$). In this step, number of school absences was the only significant predictor adding to the model ($\beta = -.16, p < .01$), indicating those students with asthma experiencing less days missed from school demonstrated higher reading scores. In step three, family-related variables including level of family routines and access to resources in the form of health services/necessities were entered into the equation. The change in variance accounted for (ΔR^2) by this final step was .003, which was also significantly different from zero ($F_{(7, 375)} = 4.63, p < .01$). It should be noted that neither variable in isolation entered in step three served as a significant predictor in the full model of reading achievement for students with asthma. Together, all predictors in the final model accounted for 8% of the variance in reading achievement scores for students with asthma. The standardized (B) and unstandardized (β) regression coefficients for variables in the full model are reported in

Table 2 below.

TABLE 2
Summary of hierarchical regression predicting reading achievement in students with asthma

| Step 1 | | | | .05* |
|-----------------|-------|------|-------|-------|
| Race/Ethnicity | -1.00 | .78 | .78 | |
| SES | 5.84 | 2.50 | .12* | |
| Gender | 6.04 | 1.89 | .16* | |
| Step 2 | | | | .24* |
| Child Health | -.23 | .99 | -.01 | |
| School Absences | -.33 | .11 | -.16* | |
| Step 3 | | | | .003* |
| Resources | .10 | .11 | .05 | |
| Family Routines | -.05 | .10 | -.03 | |

Note. * $p < .01$

Mathematics Achievement

Regarding mathematics scores, the results of step one demonstrated that the variance accounted for (R^2) with the first three independent variables (gender, race/ethnicity, and SES) was equal to .03 (adjusted $R^2 = .02$), which was significantly different from zero ($F_{(3, 379)} = 3.30, p = .02$). Only SES ($\beta = .16, p < .01$) served as a significant predictor of math achievement for students with asthma in this step. As with reading results, the trend observed here was for students with families reporting monthly incomes above the federal poverty level to have higher math achievement. After adding Child Health and school absence variables in step two, the change in variance accounted for (ΔR^2) was equal to .22, which was significantly different from zero ($F_{(5, 377)} = 3.74, p < .01$). In this step, number of days absent was again the only significant predictor adding to the model of math achievement ($\beta = -.15, p < .01$), indicating students with asthma who are, on average, absent for fewer days during the year are more likely to have higher math achievement. In step three, when family-related variables were entered into the regression equation, the change in variance accounted for (ΔR^2) by this final step was .001. This final model was again significantly different from zero in predicting math scores for students with asthma ($F_{(7, 375)} = 2.70, p < .01$). Similar to results observed regarding the last step of asthma-reading achievement prediction, neither of the family-related variables taken in isolation served as a significant independent variable in explaining math achievement. All predictors in this final model accounted for 4.8% of the variance in mathematics achievement scores for students with asthma. The standardized (B) and unstandardized (β) regression coefficients for variables in the full model are reported in Table 3 below.

TABLE 3
Summary of hierarchical regression predicting math achievement in students with asthma

| Variable | <i>B</i> | <i>SE B</i> | β | ΔR^2 |
|-----------------|----------|-------------|---------|--------------|
| Step 1 | | | | .02* |
| Race/Ethnicity | .25 | .88 | .02 | |
| SES | 7.01 | 2.81 | .13* | |
| Gender | 1.76 | 2.12 | .04 | |
| Step 2 | | | | .22* |
| Child Health | .25 | 1.11 | .01 | |
| School Absences | -.35 | .12 | -.15* | |
| Step 3 | | | | .001* |
| Resources | -.00 | .12 | -.00 | |
| Family Routines | .06 | .11 | .03 | |

Note. * $p < .01$

DISCUSSION

The purpose of the current study was to determine what variables are most relevant in contributing to the academic achievement of students with asthma. More specifically, in addition to determining whether students with asthma exhibit different academic profiles than students without asthma, the main focus was on identifying factors contributing to differential academic success among children with asthma. First, it was hypothesized that differences observed in academic achievement scores between students with and without asthma would not be statistically significant. Regarding basic demographic variables, it was expected that gender and race/ethnicity would not serve as significant explanatory variables in the asthma-academic achievement relationship, whereas a further demographic variable, SES would. Third, it was hypothesized that indicators of both asthma severity and level of school absences would also serve as moderators in this relationship. Finally, it was believed that those families of students with asthma reporting higher levels of regular family routines as well as greater access to community resources in the form of health care and necessities would also have higher achieving children. Hypotheses were partially supported.

First, regarding academic achievement scores of students with and without an asthma diagnosis, results demonstrated that statistically significant differences exist in both math and reading outcomes for these two groups. That is, on average, students with asthma were found to have lower math and reading abilities at the end of third grade as measured by the WJ-R. Although contrary to hypotheses, these results are partially consistent with some past findings that, when compared to healthy peers, students with asthma perform worse on measures of standardized reading abilities (Liberty et al., 2010). However, it must also be noted that although observed differences in this study were statistically significant, effects were found to be small.

In examining the school functioning of students with asthma, it was then important to determine those factors that play a role in determining why some students

with asthma perform worse than healthy peers on measures of reading and math abilities, whereas others do not. First, in reference to the role of demographic variables, it was found that whereas race/ethnicity did not explain a significant proportion of variance in academic outcomes, SES and gender did serve as significant predictors in this relationship. These findings are consistent with expectations as well as previous research results pointing to the significant role that various indicators of SES (i.e., access to educational opportunities, enriching community experiences) can play in promoting the academic success of all students (Aikens & Barbarin, 2008). The finding that significant gender effects are apparent in predicting reading scores of students with asthma, with boys performing better in this area, might be indicative of previous research showing that girls with asthma tend to struggle more in their emotional response to the disease, which can then affect their performance at school (Koinis-Mitchell et al., 2004). However, the fact that similar gender effects were not evidenced in predicting math scores among students with asthma also appears to support increased parity between the genders in school achievement as has been the trend in more recent years.

Regarding the role of the associated variables of disease severity and school absences in predicting academic achievement in students with asthma, hypotheses were again partially supported. That is, students with asthma experiencing a greater number of absences during the school year tended to perform more poorly on measures of both reading and math achievement. This result is perhaps not surprising given that students who experience more time away from school often miss out on quality instructional time and presentation of foundational concepts promoting greater school success (Kohen, 2010; Liberty et al., 2010). The finding that students with asthma from minority ethnic backgrounds (i.e., African American, Native American) tend to miss more days on average than their Caucasian counterparts might portray that these students could be particularly vulnerable to the detrimental effects of time away from school.

Finally, hypotheses were partially supported when examining the role of family-related variables in predicting the academic achievement of students with asthma. That is, although the full model including these variables was statistically significant in predicting both math and reading scores, neither level of family routines nor access to community resources in isolation helped to explain the variance in these scores above and beyond the influence of SES, gender and school absences. It could be that there was not enough variability in participants' scores on these measures to detect these effects given the population studied (i.e., students formerly enrolled in the Head Start program). It might also be that many family-related variables such as these are already captured to a certain degree in a broad definition of SES. That is, families of children with asthma from lower SES backgrounds might experience fewer routines in daily living at home as well as lower access to health care and necessities, which in turn can affect the academic performance of their children. Indeed, when examining the relationships among these variables, all were found to highly correlated with one another.

CONCLUSION

This study helped to identify those factors that play a contributory role in the academic achievement of students with asthma. Further, in examining this relationship in a

nationwide sample of former Head Start students, a group already at a greater risk for a range of adverse school outcomes, it is hoped that results might help point to those variables most relevant in leading to more positive outcomes in Head Start students with asthma. Findings first suggest that although differences can be observed in the reading and math abilities of students with asthma and their healthy peers, these abilities are not largely discrepant. Moreover, when examining achievement among students with asthma, results of the current study point to the importance of examining other factors beyond solely an asthma diagnosis in determining disease effects. Despite the importance of these findings, several limitations to the current study exist.

First, study participants consisted of children formerly enrolled in the federal Head Start program. It is less clear whether these same results would be found in other student populations. Another limitation exists in that further information regarding students' asthma conditions beyond the presence of an asthma diagnosis was not examined. Although a rating of overall child health was taken as an indicator of asthma severity among participants, other aspects of asthma including level of control over current asthma symptoms and medication use, factors that could also play a role in the asthma-academic achievement relationship was not collected. Future studies further examining this relationship might benefit from taking such variables into account.

Although limitations exist, this study adds to the growing body of knowledge regarding how chronic health conditions including asthma can affect the ultimate school success of children. In addition, this is one of the first studies to examine such effects in former Head Start children, a population already vulnerable to negative school outcomes. The results of the current study suggest that variables including SES, school absences, and gender all contribute to an explanation of academic achievement in this group. The fact that family-related variables were not significant in contributing to the prediction of achievement scores among students with asthma might portray that such variables are already captured in a consideration of SES and thus do not contribute to an explanation of further unique variance to the model. However, this determination is beyond the scope of the current study. Of note, these are all variables that have been shown to contribute to overall school success in the general school population as a whole, suggesting that students with asthma are perhaps not so different. In recognizing the role of such variables, future research should turn to examining potentially efficacious interventions for ensuring the educational success of all students with asthma.

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