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Pediatric Asthma and Problems in Attention, Concentration, and Impulsivity:

Disruption of the Family Management System

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Abstract

Rationale—This study assesses the relationships between ADHD symptoms, specific family asthma management domains, and pediatric asthma morbidity.

Methods—Participants were 110 children with asthma and a respective parent (ages 7-17, X = 11.6 years, 25% ethnic/racial minority). Parents completed measures of asthma morbidity and report of child ADHD symptoms. Children completed measures of attention, concentration, and impulsivity. Families participated in the Family Asthma Management System Scale (FAMSS) interview to assess the effectiveness of eight features of asthma management.

Results—Parent report of ADHD symptoms and poor child performance on a computerized task of sustained visual attention were associated with asthma morbidity. Paper and pencil tasks of visual attention, and an index of auditory attention, were not related to asthma morbidity. Modest associations were found between parent report of ADHD symptoms, child performance-based indicators of attention and concentration, and features of family asthma management, although not across all measures. The family response to asthma partially mediated the relationship between ADHD symptoms and morbidity.

Conclusions—ADHD symptoms are modestly associated with difficulties in family asthma management.

Asthma is the most common childhood chronic illness, with current prevalence estimates at approximately 8% of the United States population (National Center for Health Statistics, 2002). Effective asthma management is necessary to control symptoms, maintain appropriate activity levels, and attain educational goals through consistent school attendance. Current guidelines for asthma management place considerable responsibility on the patient and family for monitoring symptoms, taking medications consistently, and avoiding triggers that initiate episodes (National Heart, Lung, and Blood Institute, 1997; 2002). Reviews of the literature, however, reveal that children with asthma and their families often have difficulty implementing treatment recommendations. For example, many children with asthma do not take preventive medications as regularly as prescribed (Bender et al., 2000; McQuaid, Kopel, Klein, & Fritz, 2003), and numerous families fail to follow environmental recommendations regarding issues such as pet ownership (Wamboldt et al., 2002) or exposure to environmental tobacco smoke (Kattan et al., 1997).

Because disease management is central to asthma outcomes, researchers have sought to identify factors that place families at risk for difficulties in asthma management. Broad factors, such as lower socioeconomic status (SES), may impede effective disease management through

multiple channels, including exposure to significant environmental triggers because of poor housing (Gruchalla et al., 2005), and limited access to quality health care (Valerio et al., 2006). Caregiver factors, such as stress (Wade et al., 1997) and maternal depression (Bartlett et al., 2001; Shalowitz, Berry, Quinn, & Wolf, 2001) have also been studied, but the mechanisms through which parental psychopathology affect disease management are not well understood.

Interestingly, despite the fact that children with asthma are at increased risk for behavioral difficulties (Goodwin, Fergusson, & Horwood, 2004; McQuaid, Kopel, & Nassau, 2001) little research has assessed whether and how child behavior problems disrupt asthma disease management processes. Children with asthma are at increased risk for internalizing problems such as anxiety and depression (e.g., Goodwin et al., 2004) and, to a lesser degree, externalizing problems (e.g., more disruptive behavioral issues such as oppositional defiant behavior or impulsivity, McQuaid et al., 2001). Furthermore, children with more severe or persistent asthma symptoms are at greater risk for behavioral difficulties, as indexed by global ratings of behavioral and emotional problems (such as oppositional behavior and depressive symptoms; Halterman et al., 2006; McQuaid et al., 2001; Wamboldt, Fritz, Mansell, McQuaid, & Klein, 1998)

Psychiatric comorbidity, or even behavioral symptoms that are below threshold for psychiatric diagnosis, may be important factors in disrupting family asthma management. The presence of comorbid behavior problems and/or reported depressive symptoms in children with asthma is associated with more frequent and prolonged hospital admissions (Kaptien, 1982), and more functional impairment due to asthma (Gustadt et al., 1989). Indeed, most of the research that has been conducted on the interface between psychiatric symptoms and asthma symptom management has emphasized depression (e.g., Bender, 2006; DiMatteo, 2000). Research in other childhood chronic diseases, however, suggests that *externalizing* problems may also be related to poor treatment adherence and impaired disease control. Specifically, research in diabetes has indicated that the presence of global externalizing problems in children may be a key factor that challenges effective and coordinated disease management. For example, Cohen and colleagues (2004) found that the presence of externalizing symptoms was related to poor glycemic control in a sample of economically disadvantaged children with type 1 diabetes. Similarly, in a study of gender differences in adherence and metabolic control in low-income children with type 1diabetes, externalizing behavior problems were associated with poor adherence and worse metabolic control, particularly for boys (Naar-King et al., 2006).

We propose that features of a specific externalizing disorder, Attention Deficit Hyperactivity Disorder (ADHD), may challenge effective pediatric asthma management in the family context. Children with ADHD have difficulties with attention, concentration, impulsivity, and self-regulation (APA, 2000). Additionally, parents of children with behavior problems such as ADHD typically report elevated levels of child-rearing stresses (Mash & Johnston, 1990).

Effective asthma management relies on timely recognition and monitoring of symptoms, consistent implementation of medication routines and strategies for trigger control, and a coordinated plan of care between family and health care provider. Family routines may serve to support consistent management behaviors (Fiese, Wamboldt, & Anbar, 2005). We propose that the difficulties in attention, concentration, and impulsivity that typically characterize ADHD pose particular problems for asthma management and, consequently, lead to increased asthma morbidity. For example, recent research indicates that children who have problems with attention and concentration may have more difficulty identifying symptoms to family members (Koinis Mitchell et al., 2004). As a result, family members may not respond to increasing symptoms of asthma in a coordinated manner, leading to treatment delays and increased risk of significant exacerbation.

The purpose of the present paper is to evaluate the associations among symptoms of ADHD and asthma morbidity, and to assess whether these associations are mediated through specific dimensions of family asthma management. We chose to study symptoms of ADHD, as opposed to the clinically diagnosed disorder, because we anticipated that even sub-threshold levels of ADHD symptoms might challenge asthma management within families. It was expected that symptoms of ADHD would be most strongly related to aspects of asthma management that require consistent, routine actions, such as noticing and responding to asthma symptoms and adhering to medication recommendations.

METHOD

Participants

The current study was part of a larger study investigating the role of child symptom perception in pediatric asthma. Certain results of the larger study, such as the association between symptom perception and morbidity (blinded for review), and symptom perception and family asthma management (blinded for review) have been reported elsewhere. The current study reports new results on the associations among features of ADHD, family asthma management, and asthma morbidity.

Multiple channels of recruitment were used, including flyers, physician referrals, and direct recruitment at summer camps for children with asthma. To be eligible, children had to be 7-17 years of age, and have physician-diagnosed asthma for at least six months prior to study enrollment. Children with other significant pulmonary conditions (e.g., cystic fibrosis) or with significant cognitive delays identified during screening (as defined by parent report of the child being placed in a special education classroom) were not eligible. Children with psychiatric diagnoses were not excluded.

Participants included 110 children with asthma and a primary caregiver for their asthma, most commonly the mother (92%), but occasionally the father (6%) or grandmother (2%). Seventy-four percent of caregivers were married or living with a partner, 20% were divorced/separated, 4% were single, and 2% were widowed. Children's ages ranged from 7-17 years (X = 11.6, SD = 2.3). Forty-seven percent of child participants were female. Most primary caregivers (75%) identified their child's racial/ethnic background as white, with the remainder described as African American/Black (11%), White Hispanic (6%) or Biracial (7%). The word "parent" is used below to refer to the primary asthma caregiver participating in the study.

Data were collected at three national sites (n's of 52, 23, and 35). No site differences were found in terms of child age, F (2,110) = 1.75, ns, parental occupational prestige, F (2, 102) = . 19, ns, or distribution of gender (X^2 = 4.80, ns), ethnicity (X^2= 10.84, ns), or asthma severity (X^2 = 6.64, ns).

Procedures

Written parental consent and child assent were obtained in accordance with Institutional Review Board guidelines for all three sites. Study participation involved the following three components: 1) parent completion of self-report measures, 2) child completion of a circumscribed battery of tests for symptoms of ADHD (i.e., problems in attention, concentration, and impulsivity), and 3) participation in a standard semi-structured interview to assess family asthma management. During an initial lab visit, children and parents completed self-report measures and participated in the Family Asthma Management System Scale interview (FAMSS; Klinnert, McQuaid, & Gavin, 1997; McQuaid, Walders, Kopel, Fritz, & Klinnert, 2005). All measures and methods are described in detail below.

Parent Report Measures

Demographic information—Parents completed a general demographic questionnaire that included information regarding child age, race/ethnicity, medications prescribed for the child's asthma, and parental occupation. Parent's occupational prestige (a common index of Socieoconomic Status, or SES) was classified according to the National Opinion Research Council (NORC) coding system (Nakao & Treas, 1992). This ratings system assigns a "prestige" score to each occupation, with higher scores indicating more prestigious occupations. When both parents worked, the highest rating (i.e., either the mother's or the father's) for the family parental occupation was used. Scores can range from zero to 100. The median prestige rating of families' primary occupations in the present study was 50.9. Scores ranged from 24.3 (example: maid/houseman) to 86.05 (ex: physician). The majority of the scores (within one standard deviation of the mean) ranged from 37.87 (minor technician such as surveyor's assistant) to 67.93 (optometrist).

Conners' Parent Rating Scale—The Conners' Parent Rating Scale-Revised, Short Form (CPRS-R:S), is a 27-item behavior rating scale used to assess areas of attention, conduct, cognition, hyperactivity, and global symptoms of ADHD in children aged 3-17 years old (Conners, 2000). Parents endorse how much specific behavioral features are true of their child using a 4-point Likert scale ranging from 0 (not true at all) to 3 (very much true). Raw scores are converted to *T*-scores (mean of 50 and a S.D. of 10) using norms based on child age and gender. Internal consistency reliability coefficients for Conners' Parent Rating Scale range from .67 to .95 on the subscale level; the total internal reliability coefficients for the subscales range from .73 to .94. All subscale variables of the short form were used in this study, including Oppositional, Cognitive Problems/Inattention, Hyperactivity, and ADHD (Conners, 2000).

Asthma functional morbidity—Parents completed the Asthma Functional Severity Scale (AFSS), which evaluates daily impairment related to asthma symptoms (Rosier et al., 1994). The AFSS index is a composite score calculated as a mean of morbidity items that assess episode frequency, symptom frequency between episodes, impairment intensity during an episode, and impairment intensity between episodes. A higher index score indicates greater functional morbidity. The AFSS is a validated scale, developed based on a large survey sample of over 10,000 children. Significant associations have been found between the AFSS and school absences, medication use and medical visits for asthma (Rosier et al., 1994). In this study, symptom questions were asked with reference to the past month.

Asthma Disease Severity

Asthma disease severity was collected for descriptive purposes. Two pediatric asthma specialists reviewed parental report of symptoms (using the AFSS, above), history of health care utilization, and medications prescribed. Children's disease severity was classified using NIH criteria in place at the time of data collection (National Heart Lung and Blood Institute, 1997; 2002). By using this method, 11% of the sample was classified as mild intermittent, 57% mild persistent, 26% moderate persistent, and 6% severe persistent.

Children's Attention, Concentration, and Impulsivity

A variety of different tasks were used to assess features of ADHD. These included paper and pencil tasks of *visual attention and speed* (Cancellation tasks, Trail Making Test), a computerized continuous performance task to assess *sustained visual attention and concentration* (Conners' CPT), and two brief tests of *auditory attention* (WISC-III Arithmetic and Digit Span subtests). Specific measures are described below.

Cancellation tasks—Three different cancellation tasks (letter, number, and symbol) were used to assess visual attention. Cancellation tasks are thought to measure certain features of children's attention, including visual scanning, the capacity for sustained attention, and activation and inhibition of rapid responses (Rudel, Denckla, & Broman, 1978). Children were asked to scan each paper and circle specific targets (the letters LIF, the numbers 592, a symbol of a diamond). Normative data (Rudel et al., 1978) for these tasks were used to convert total time and total errors to z-scores based on age.

Trail Making Test—Trails B, originally from the Halstead-Reitan Neuropsychological Test Battery, was used. Trails B is also thought to assess visual attention (Reitan, 1986). Children were instructed to connect alternating numbered and lettered circles (1-A-2-B, etc.). They were told to connect the circles as quickly as possible, while keeping the pencil on the paper. Errors were corrected as they occurred. Scores were based on total completion time, a common scoring method (Ernst, 1987). Times were converted to z-scores based on age norms (Reitan, 1986).

Continuous Performance Task—The Conners' Continuous Performance Test (CPT) is a computerized test designed to measure problems in attention, concentration, and task persistence in children and adults (Conners, 1995). During this task, a series of letters are flashed on a computer screen. The child is instructed to press the space bar after every letter except "X". Stimuli (target and non-target letters) are presented in variable time intervals to assess changes in response time based on presentation time. Raw scores, converted *T*-scores (mean of 50 and a S.D. of 10), and percentile scores can be derived for numerous scales. For this study, we examined three central scores, the Total score (an overall summary score), the Variability T-Score (an index of overall visual attention), and the Commissions T-Score (an index of Impulsivity). The *Conners' Continuous Performance Test Manual* (Conners, 1995) provides extensive information regarding normative data and calculation of index scores.

Wechsler Intelligence Scale for Children - Third Edition (WISC-III)—Arithmetic and Digit Span subtests from the Wechsler Intelligence Scale for Children -Third Edition (WISC-III; Wechsler, 1991) were administered to provide an assessment of short-term auditory attention. On the Arithmetic subtest, children are presented with word problems that involve mathematical calculations. They must compute the answer to the problem without paper. On the Digit Span subtest, children are orally presented with a series of numbers. Each series begins with two digits and keeps increasing in length, with two trials at each length. For the Digits Forward series, children must repeat the numbers accurately, with each set of two trials increasing the number of digits in the sequence. For the Digits Backward series, children repeat, in reverse order, the numbers that were presented to them. Arithmetic and Digit Span scaled scores (normed for age; Wechsler, 1991) were summed to create an index score of auditory attention.

Features of Asthma Management

Family Asthma Management System Scale (FAMSS) interview—The FAMSS is a semi-structured interview designed to assess the effectiveness of the family asthma management system (Klinnert et al., 1997; McQuaid et al., 2005). When administered to families with school-aged children, parents and children participate together to provide multiple perspectives regarding features of asthma management (e.g., medication adherence at home vs. during the school day). Family members are asked a series of open-ended questions (e.g., "Tell me what you do when you first notice asthma symptoms"), and also asked to provide ratings regarding certain specific content areas (e.g., "On a five-point scale from 1 = impossible to 5 = never a problem, how easy is it for you to keep track of your child's medication schedule?"). Families were asked to consider asthma symptoms and management strategies employed over the past year.

The FAMSS is rated along eight key dimensions of asthma management. These include Asthma Knowledge, Symptom Assessment, Family Response to Symptoms and Exacerbations, Child Response to Symptoms and Exacerbations, Environmental Control, Medication Adherence, Collaboration with Health Care Provider, and Balanced Integration of Asthma into Family Life (McQuaid et al., 2005). FAMSS interviews were rated using a standard manual, which provides rating instructions and a series of rating guidelines for each scale. Each scale is given a nine-point rating, from 1 (ineffective or harmful management) to 9 (highly adaptive management). A summary score, or mean of subscale items, can also be calculated. The internal consistency of this summary score has been found to be high (Cronbach's alpha = .84; McQuaid et al., 2005). The interviewer completes ratings either immediately after the interview or after a review of the audiotape. For the present study, all interviewers and raters were trained in administration and scoring through consensus meetings with two of the original authors of the interview.

All FAMSS interviews were audiotaped and rated by one of two primary interviewers who were blinded to the results of the other study assessments. A subset of audiotapes (n=38) was rated by both raters in the context of biweekly consensus meetings. The intraclass correlation, or measure of association between raters, was computed to be .84.

RESULTS

Statistical Approach

Given numerous measures of variables were available (e.g., multiple paper and pencil indices of attention, eight FAMSS subscales), we chose first to determine whether or not associations existed among the most global measures. Specifically, we first examined associations among global indices of ADHD symptoms (e.g., the CPT total score) and asthma morbidity. If associations were found between global variables and asthma morbidity, we investigated associations between specific subscales (e.g., CPT Variability T-Score, CPT Commissions T-Score) and asthma morbidity. Similarly, in assessing the relations among ADHD symptoms and family asthma management, we first determined if there were significant associations between ADHD symptoms and the global family asthma management variable. Where associations existed, we then assessed which specific features of family asthma management (e.g. medication adherence, family response to symptoms) showed the most consistent associations with symptoms of ADHD. Because of our interest in testing a novel model of the associations among features of ADHD, family asthma management, and asthma morbidity, a p-value of .05 was adopted to evaluate statistical significance.

ADHD Symptoms and Asthma Morbidity

Bivariate correlations were used to assess associations among the various indices of ADHD and concurrent asthma morbidity. Parent report of ADHD symptoms (through the CPRS-R:S) was modestly associated with increased asthma symptoms ($r = .22$, $p < .05$). Standardized scores on paper and pencil Cancellation tasks and Trails B were not significantly associated with asthma symptoms (r's = -.04 to -.16, all p's > .05), nor was performance on the WISC-III auditory attention index ($r = -.15$, $p > .05$). Poor overall performance on the CPT, representing sustained visual attention, was positively associated with asthma morbidity ($r = .29$, $p < .01$).

Given that global parent report of ADHD symptoms (CPRS-R:S) and poor overall performance on the CPT were both associated with increased asthma morbidity, we next examined associations between the specific subscales of each of these measures and asthma morbidity. All subscales of CPRS-R:S, including parent report of oppositionality ($r = .27$, $p < .01$), cognitive problems ($r = .21$, $p < .05$), and hyperactivity ($r = .29$, $p < .01$), were associated with

asthma morbidity. Additionally, specific features of performance on the CPT, including standardized scores for Commissions ($r = .23$, $p < .05$) and Variability ($r = .36$, $p < .001$) were also associated with asthma morbidity.

Symptoms of ADHD and Asthma Management

We next examined whether ADHD symptoms were associated with family asthma management, as measured through the global index of the FAMSS interview. Parent report of ADHD symptoms was negatively associated with effective family asthma management ($r = -.28$, $p < .01$). Child performance on WISC-III tasks of auditory attention was also significantly associated with higher global ratings of family asthma management ($r = .38$, $p < .001$). Child performance on the CPT (indicating more difficulties in visual attention) was negatively associated with effective asthma management ($r = -.22$, $p < .05$). Standardized scores on Cancellation tasks and Trails B were not significantly associated with effective family asthma management (r's = .05 to .17, all p's > .05).

We then evaluated associations among our global indices of ADHD (parental report, child WISC-III auditory attention, and child CPT visual attention) and specific features of family asthma management (i.e., FAMSS subscales). These correlations are presented in Table 1. Parental report of ADHD symptoms was associated with difficulties in asthma knowledge, family and child response to symptoms, medication adherence, physician collaboration, and integration of asthma into family life. Short-term auditory attention (as measured by WISC attention subscales) was positively related to asthma knowledge, knowledge of symptoms, family response to symptoms, environmental control, physician collaboration, and balanced integration of asthma into family life. Poor performance on the CPT was related to difficulties in family and child response to symptoms, and integration of asthma into family life.

Regression Models: Does Family Asthma Management serve as a Mediator?

Because associations between asthma morbidity and two separate indices of ADHD symptoms (parent report of ADHD symptoms, and a child performance based-measures of visual attention) existed, we next sought to evaluate whether this association was mediated through family asthma management. In other words, does the relationship between ADHD symptoms and asthma morbidity operate through disruptions in family asthma management? Specifically, we sought to determine whether the modest associations between ADHD and asthma morbidity were mediated through the *family response to symptoms*. We selected this subscale of the family asthma management assessment because of its consistent associations with our measures of ADHD symptoms, and its centrality to the disease management process.

We employed a series of regression models to test for mediation (Baron & Kenny, 1986), using the global variables of parent report of ADHD symptoms (CPRS-R:S ADHD symptoms index), the family response to symptoms score from the FAMSS interview, and the functional morbidity index. Testing for mediation by this method involves evaluating first if there is a statistically significant association between the predictor, parental report of ADHD symptoms, and the mediator, family response to asthma symptoms (pathway a). Second, the mediator (family response to symptoms) must be significantly associated with the outcome (asthma morbidity; pathway b). Lastly, the association between the predictor and the outcome (pathway c) must be significantly reduced when the mediator is added as a predictor.

The associations among key variables in our regression equations are shown in Figure 1, using parent report of ADHD symptoms as our predictor. As depicted in Figure 1, the predictor was negatively associated with the mediator, family response to asthma symptoms (pathway a, $r = -.26$, $p < .05$). The mediator was also negatively related to the outcome, asthma morbidity (pathway b, $r = -.40$, $p < .001$). The predictor was significantly related to the outcome (pathway

c, r = .22, p < .05). When the predictor and mediator were entered together in the same regression equation, the significance of the relationship between the predictor and outcome decreased to nonsignificance (β = .12, ns). This finding was also tested using a statistical test of mediation (Sobel, 1988), and was found to be significant (Z = 6.71, p < .01).

A similar series of regression models was conducted using the child performance on the CPT as our key predictor (Figure 2). In this set of models, we assessed whether family response to symptoms mediated the association between child sustained attention (CPT total) and asthma morbidity. The predictor was also negatively associated with the mediator (pathway a, r = -.27, p < .01). As in the previous series of regressions, the mediator was significantly associated with the outcome (pathway b, r = -.40, p < .001). The predictor was also significantly related to the outcome (pathway c, r = .29, p < .01). When the predictor and the mediator were entered together into the same regression equation, the significance of the mediator decreased, although remained significant (β = .19, p < .05), indicating partial mediation. This effect was also evaluated using a statistical test of mediation (Sobel, 1988), and found to be significant, Z = 6.19, p < .01.

DISCUSSION

Although much of the extant literature regarding psychiatric comorbidity and asthma outcomes has emphasized the role of internalizing disorders (i.e., depression and anxiety), recent evidence and clinical observation suggest that externalizing disorders may complicate chronic disease management (Naar-King et al., 2006), and that symptoms of ADHD, specifically, may disrupt asthma management processes (Koinis Mitchell et al., 2004). Findings of the present study demonstrate modest associations between features of ADHD (as measured by parent report and child CPT task) and an index of asthma morbidity, suggesting that the presence of problems in attention, concentration, and impulsivity may also be related to disease outcomes. Of note, however, not all measures of attention and concentration were related to asthma morbidity. This suggests that further research with larger samples may be needed to elucidate which features of ADHD are most problematic for asthma management.

Analyses revealed associations between a variety of measures of attention, concentration, and report of ADHD symptoms and features of family asthma management. Results were most consistent in terms of asthma management behaviors that require coordinated and complex actions, such as child and family response to the occurrence of asthma symptoms. Interestingly, interviewer ratings of balanced integration of asthma into family life, which measures the extent to which asthma routines have been readily adapted by the family and developmental expectations have not been disrupted, were also consistently related to symptoms of ADHD. These findings suggest that it may be quite challenging for families with children who have both a chronic health condition (asthma) and difficulties in attention, concentration, and impulsivity to manage both conditions successfully.

We evaluated whether the association between features of ADHD and asthma symptoms operates through the family response to symptoms. Results indicated that the link between features of ADHD and asthma morbidity is partially mediated by family responses to asthma exacerbations. It should be noted that statistical tests of mediation performed on cross-sectional variables may not reflect causation. One reasonable interpretation, however, is that the presence of difficulties in organization and sustained attention, which are characteristic of ADHD, may interfere with responding to asthma symptoms in a coordinated fashion, resulting in increased asthma morbidity. Alternatively, given ADHD is associated with lower socioeconomic status (SES) (Rieppi et al., 2002), and low SES is related to increased difficulties in asthma management (McQuaid et al., 2005), it is possible that families of low SES face more contextual and economic stresses (e.g., more difficulty accessing health care or utilizing the health care

system), which may challenge effective asthma control. A third possibility is that parental factors, such as the parent's own problems in concentration (or even diagnosis of ADHD) may be related to both difficulties in family asthma management and child symptoms of ADHD.

Fiese and Everhart (2006) note that general features of the family climate, such as family cohesion, may have important effects on adherence to chronic illness regimens. As an example, family routines have been shown to have positive associations with medication adherence (Fiese et al., 2005). Future research could address the specific contributions of overall family organization, parental resources, parental psychopathology, and child behavioral symptoms to family asthma management and subsequent disease morbidity.

A number of methodological limitations bear mention. We did not collect extensive information regarding family composition, income, insurance status, or use of medication for psychiatric disorders (ADHD or others). Our asthma severity assessment was conducted with medication information obtained by parental report, not chart review. We further acknowledge that our assessment of asthma morbidity would have been strengthened by a multimodal approach to asthma outcomes, including pulmonary function variables and health care utilization.

It should also be noted that the association between ADHD symptoms and asthma morbidity found in the present study is modest, and not consistent across measurements. For example, child performance on paper and pencil measures of visual attention and tracking (i.e., Cancellation and Trails tasks) were not associated with our index of asthma morbidity, nor was our task of short-term auditory attention (as measured by subscales of the WISC-III). It is possible that these measures are less sensitive to variations in ADHD symptomatology, or that different features of ADHD are more or less deleterious for asthma management. Although our findings are modest, it is important to notes that there are many factors that relate to asthma morbidity, including allergic status, underlying pathophysiology, presence of environmental triggers, and many others. This study provides one window through which asthma symptoms can be affected by psychiatric features, and the pathways through which psychiatric features may influence disease outcomes within the context of the family.

Findings from the present study illustrate how behavioral symptoms (specifically, features of ADHD) may be related to pediatric chronic disease management. Primary care providers should be attuned to the presence of child behavior difficulties in their patients with asthma, and build appropriate supports into place. Strategies from working with children who have problems in attention and concentration may be applied in the context of asthma management. Specifically, as we would break down an academic task, such as homework completion, into smaller parts for someone with ADHD, we may need to operationalize specific behavioral steps to manage asthma episodes and adhere to medication regimens. This could include providing concrete, simplified action plans, streamlining medication regimens for asthma, and including regular "check-ins" for how well tasks of asthma management are being executed. Strategies need to be age-appropriate in nature. Modifications for a 7 year old child would be very different then those for a 16-year old. For example, younger children may need more concrete, specific reminders about the need to take medications consistently or avoid triggers, while older children may need to be integrated into the asthma management process in a way that increases their sense of control and autonomy. Health care providers can also identify family strengths and supports that could be used to provide additional oversight of asthma management tasks in the family context to help children manage their asthma more consistently and effectively. Lastly, a greater emphasis is needed on the development of theory-based family interventions to address asthma management in order to benefit families with complex medical and psychosocial issues (Celano, 2006; McQuaid et al., 2005).

REFERENCES

American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR). APA; Arlington, VA: 2000.

Baron RB, Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology 1986;51:1173–1182. [PubMed: 3806354]

Bartlett SJ, Kolodner K, Butz AM, Eggleston P, Malveaux F, Rand C. Maternal depressive symptoms and emergency department use among inner-city children with asthma. Archives of Pediatric and Adolescent Medicine 2001;155:347–353.

Bender B, Wamboldt FS, O'Connor SL, Rand C, Szefler S, Milgrom H, et al. Measurement of children's asthma medication adherence by self report, mother report, canister weight, and Doser CT. Annals of Allergy, Asthma, & Immunology 2000;85:416–421.

Bender BG. Risk taking, depression, adherence, and symptom control in adolescents and young adults with asthma. American Journal of Resipiratory and Critical Care Medicine 2006;173:953–957.

Celano MP. Family processes in pediatric asthma. Current Opinion in Pediatrics 2006;18:539–544. [PubMed: 16969169]

Conners, C. Conners' Continuous Performance Test Manual. Multi-Health Systems Inc.; 1995.

Conners, C. Conners' Rating Scales- Revised, Technical Manual. Multi-Health Systems Inc.; 2000.

DiMatteo, M. Practitioner-family-patient communication in pediatric adherence: implications for research and clinical practice. In: Drotar, D., editor. Promoting adherence to medical treatment in chronic childhood illness. Lawrence Erlbaum Associates; Mahwah, New Jersey: 2000. p. 237-258.

Ernst J, Warner MH, Townes BD, Peel JH, Preston M. Age group differences on neuropsychological battery performance in a neuropsychiatric population: an international descriptive study with replications. Archives of Clinical Neuropsychology 1987;2:1–12. [PubMed: 14589567]

Fiese BH, Everhart RS. Medical adherence and childhood chronic illness: family daily management skills and emotional climate as emerging contributors. Current Opinions in Pediatrics 2006;18:551–7.

Fiese BH, Wamboldt FS, Anbar RD. Family asthma management routines: connections to medical adherence and quality of life. Journal of Pediatrics 2005;146:171–6. [PubMed: 15689901]

Goodwin RD, Fegusson DM, Horwood LJ. Asthma and depressive and anxiety disorders among young persons in the community. Psychological Medicine 2004;34:1465–1474. [PubMed: 15724877]

Gruchalla RS, Pongracic J, Plaut M, Evans R 3rd, Visness CM, Walter M, Crain EF, Kattan M, Morgan WJ, Steinbach S, Stout J, Malindzak G, Smartt E, Mitchell H. Inner City Asthma Study: relationships amongst sensitivity, allergen exposure, and asthma morbidity. Journal of Allergy & Clinical Immunology 2005;115:478–485. [PubMed: 15753892]

Gustadt LB, Gillette JW, Mrazek DA, Fukuhara JT, LaBrecque JF, Strunk RC. Determinants of school performance in children with chronic asthma. American Journal of Disease of Childhood 1989;143:471–475.

Halterman J, Conn K, Forbes-Jones E, Fagnano M, Hightower A, SZilagyi P. Behavior problems among inner-city children with asthma: Findings from a community-based sample. Pediatrics 2006;117:192–199.

Kaptien AA. Psychological correlates of length of hospitalization and rehospitalization in patients with acute, severe asthma. Social Science and Medicine 1982;16:725–729. [PubMed: 7089607]

Kattan M, Mitchell H, Eggleston P, Gergen P, Crain E, Redline S, et al. the National Cooperative Inner-City Asthma Study. Characteristics of inner-city children with asthma. Pediatric Pulmonology 1997;24:253–262. [PubMed: 9368259]

Klinnert MD, McQuaid EL, Gavin L. Assessing the Family Management System. Journal of Asthma 1997;34:77–88. [PubMed: 9033443]

Koinis Mitchell, D.; McQuaid, EL.; Nassau, J.; Kopel, S.; Seifer, R.; Klein, R.; Wamboldt, M.; Fritz, G. Symptom Perception in Children with Asthma: Psychological and Cognitive Factors; Paper presented at the International Society for the Advancement of Respiratory Physiology; Princeton New Jersey. 2004;

Koinis Mitchell D, Murdock KM, McQuaid EM. Risk and resilience in urban children with asthma. Children's Health Care 2004;33:275–298.

Mash EJ, Johnston C. Determinants of parenting stress: Illustrations from families of hyperactive children and families of physically abused children. Journal of Clinical Child Psychology 1990;19:313–328.

McQuaid EL, Koinis Mitchell D, Walders N, Nassau J, Kopel S, Klein R, et al. Pediatric Asthma Morbidity: The importance of symptom perception and family response to symptoms. Journal of Pediatric Psychology 2007;32:167–177. [PubMed: 16717140]

McQuaid EL, Kopel SJ, Klein RB, Fritz GK. Medication adherence in pediatric asthma: Reasoning, responsibility, and behavior. Journal of Pediatric Psychology 2003;28:323–333. [PubMed: 12808009]

McQuaid EL, Kopel SJ, Nassau JH. Behavioral adjustment in children with asthma: A meta-analysis. Journal of Developmental and Behavioral Pediatrics 2001;22:430–439. [PubMed: 11773808]

McQuaid E, Walders N, Kopel S, Fritz G, Klinnert M. Pediatric asthma management in the family context: The family asthma management system scale. Journal of Pediatric Psychology 2005;30:492–502. [PubMed: 16055487]

Naar-King S, Idalski A, Ellis D, Frey M, Templin T, Cunningham PB, et al. Gender differences in adherence and metabolic control in urban youth with poorly controlled type 1 diabetes: The mediating role of mental health symptoms. Journal of Pediatric Psychology 2006;31:793–802. [PubMed: 16322274]

Nakao K, Treas J. The 1989 Socioeconomic Index of Occupations: Construction from the 1989 Occupational Prestige Scores. GSS Methodological Report 1992;74

National Center for Health Statistics. Current estimates from the National Health Interview Survey, 2002. Vital and Health Statistics 2002;10:221.

National Heart Lung and Blood Institute. Guidelines for the Diagnosis and Management of Asthma. National Institutes of Health; Bethesda, MD: 1997. (No. NIH Publication NO 97-4051)

National Heart Lung and Blood Institute. Asthma statistics, Data fact sheet. National Institute of Health; Bethesda, MD: 2002.

Reitan, R. Theoretical and methodological bases of the Halstead-Reitan Neuropsychiatric Test Battery. In: Grant, I.; Adams, K., editors. Neuropsychological Assessment of Neuropsychiatric Disorders. Oxford University; New York: 1986. p. 3-30.

Rieppi R, Greenhill L, Ford R, Chuang S, Wu MD, Mark, Abikoff H, et al. Socioeconomic Status as a Moderator of ADHD Treatment Outcomes. Journal of the American Academy of Child and Adolescent Psychiatry 2002;41:269–277. [PubMed: 11886021]

Rosier MJ, Bishop J, Nolan T, Robertson CF, Carlin JB, Phelan PD. Measurement of functional severity of asthma in children. American Journal of Respiratory and Critical Care Medicine 1994;149:1434–1441. [PubMed: 8004295]

Rudel RG, Denckla MB, Broman M. Rapid silent response to repeated target symbols by dyslexic and nondyslexic children. Brain and Language 1978;6:52–62. [PubMed: 698784]

Sobel, ME. Direct and indirect effects in linear structural equation models. In: Long, JS., editor. Common problems/proper solutions. Sage; Beverly Hills, CA: 1988. p. 46-64.

Shalowitz MU, Berry CA, Quinn KA, Wolf RL. The relationship of life stressors and maternal depression to pediatric asthma morbidity in subspecialty practice. Ambulatory Pediatrics 2001;1:185–193. [PubMed: 11888399]

Valerio M, Cabana M, White D, Heidmann D, Brown R, Bratton S. Understanding of asthma management: Medicaid parents' perspectives. Chest 2006;129:594–601. [PubMed: 16537856]

Wade S, Weil C, Holden G, Mitchell H, Evans R 3rd, Kruszon-Moran D, et al. National Cooperative Inner-City Asthma Study. Psychosocial characteristics of inner-city children with asthma: a description of the NCICAS psychosocial protocol. Pediatric Pulmonology 1997;24:263–276. [PubMed: 9368260]

Wamboldt F, Ho J, Milgrom H, Wamboldt M, Sanders B, Szefler S, et al. Prevalence and correlates of household exposures to tobacco smoker and pets in children with asthma. The Journal of Pediatrics 2002;141:109–115. [PubMed: 12091860]

Wamboldt M, Fritz GK, Mansell A, McQuaid EL, Klein RB. Relationship of asthma severity and psychological problems in children. Journal of the American Academy of Child and Adolescent Psychiatry 1998;37:943–950. [PubMed: 9735613]

Wechsler, D. Wechsler Intelligence Scale for Children-Revised. Psychological Corporation; New York: 1991.

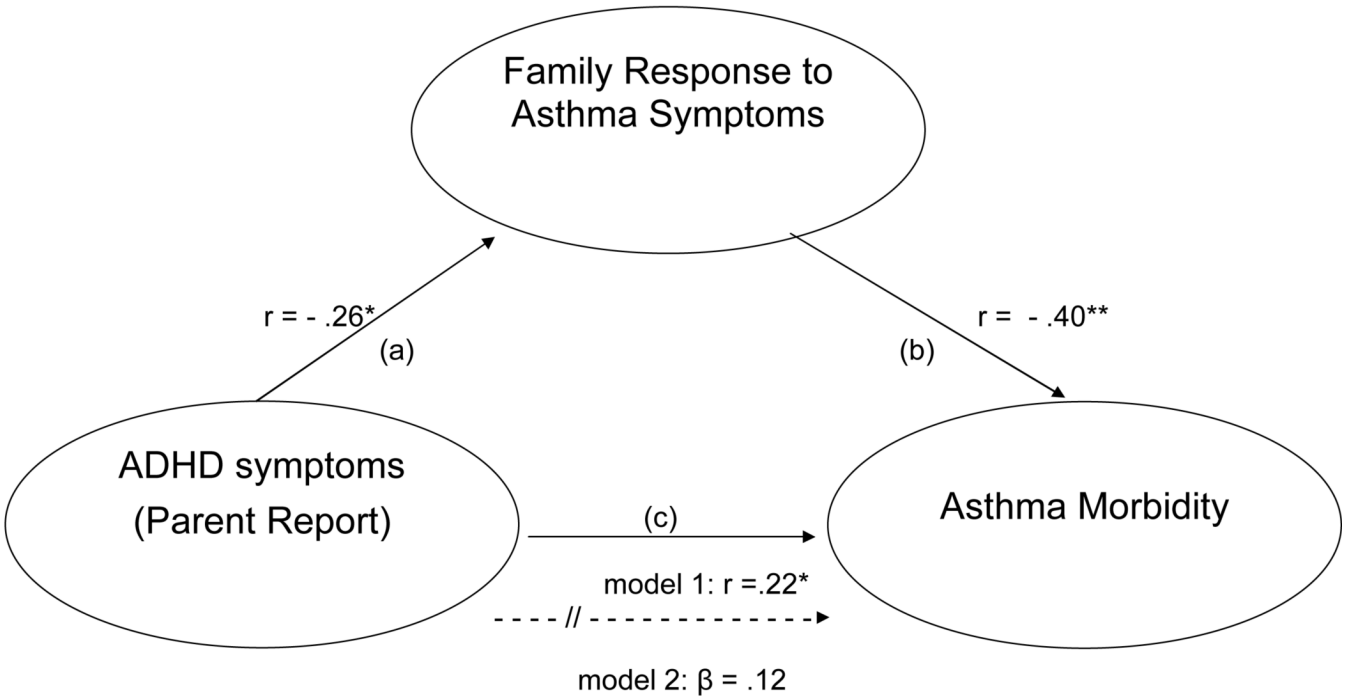

Figure 1.

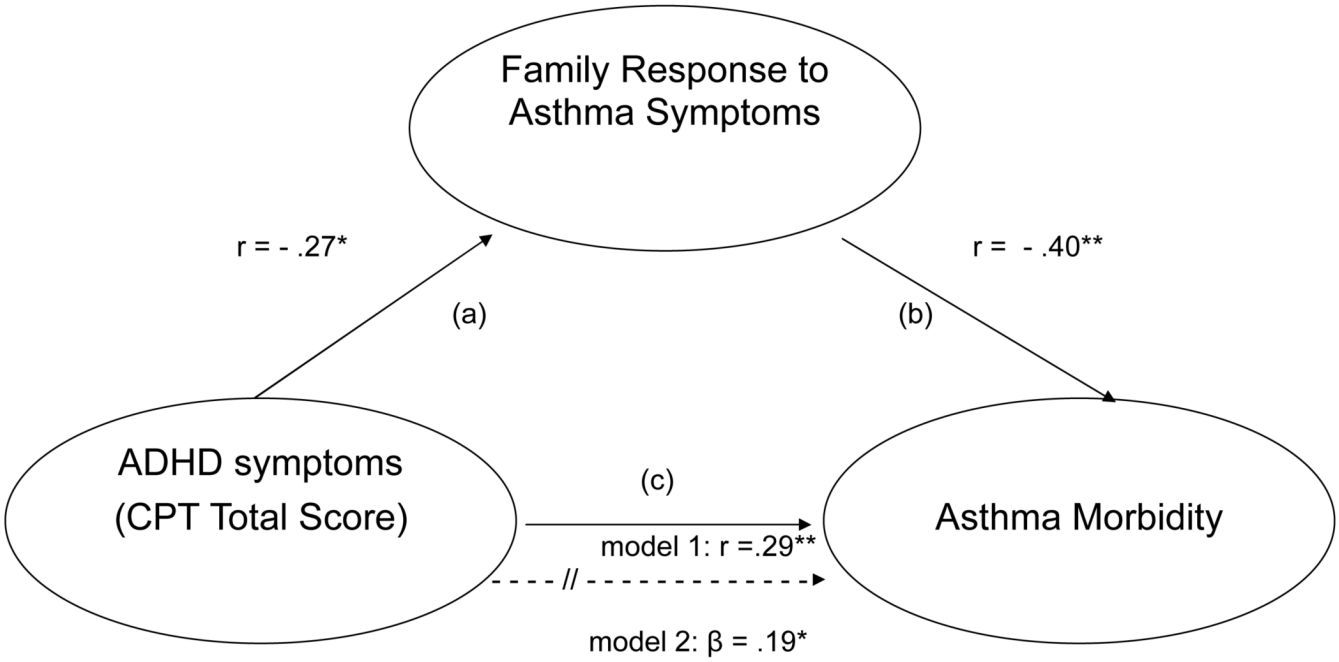

Figure 2.

Table 1

Correlations Between Global Measures of ADHD and Features of Family Asthma Management

	Asthma Knowledge	Symptom Assessment	Family Response	Child Response	Environmental Control	Medication Adherence	Physician Collaboration	Balanced Integration
Parent Report of ADHD Symptomsa (CPRS-R:S)	-.20*	-.03	-.26**	-.25*	-.03	-.25*	-.31**	-.25**
Short term Auditory Attention (WISC-III)	.28**	.28**	.35**	.15	.30**	.18	.22*	.32**
Sustained Visual Attention (CPT-Total)	-.13	-.07	-.27**	-.33**	-.01	-.08	-.16	-.23*

*p<.05

**p<.01