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Evaluation of a School-Based Program Targeting Pediatric Asthma Self-Management Skills in an Urban Population

Dawn J. Dore-Stites
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EVALUATION OF A SCHOOL-BASED PROGRAM TARGETING
PEDIATRIC ASTHMA SELF-MANAGEMENT SKILLS
IN AN URBAN POPULATION

by

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Western Michigan University
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EVALUATION OF A SCHOOL-BASED PROGRAM TARGETING
PEDIATRIC ASTHMA SELF-MANAGEMENT SKILLS
IN AN URBAN POPULATION

Dawn J. Dore-Stites, Ph.D.

Western Michigan University, 2007

Asthma is the most commonly diagnosed chronic disorder in childhood and is linked with several problematic outcomes including frequent school absences, increased hospitalizations and decreased quality of life. Further, urban populations struggling with low socioeconomic status are disproportionately represented in prevalence statistics and suffer from increased functional morbidity relative to other children with asthma. These findings exist in the midst of largely effective pharmacological interventions.

Asthma self-management programs (SMPs) target several behaviors linked to improved outcomes and are often used as an adjunct to medication management. SMPs have been employed using a variety of techniques and treatment targets in a wide range of settings. Data suggests that SMPs have a mild to moderate impact on functional morbidity outcomes and merit further research.

In order to facilitate efficacious interventions to those at highest risk of problematic outcomes, common barriers impinging on program attendance must be alleviated. The school setting proves to be an ideal location to deliver SMPs due to their accessibility and available resources. The current project evaluates a school-based asthma SMP delivered in an urban setting. Results reveal statistically significant increases in quality of life and child reported knowledge as well as decreased utilization

of urgent care outpatient treatment. Trends towards decreased agreement between children and caregivers on allocation of asthma management tasks reflect challenges with implementation of programs in the absence of frequent parental contact. School-based asthma SMPs afford several benefits to high-risk populations but also must reflect the need for *family* involvement in successful asthma management.

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ASTHMA OVERVIEW

Asthma, a chronic disease characterized by inflammation, hyperresponsivity and obstruction of the airways, causes a range of symptoms including coughing, wheezing, chest tightness and shortness of breath (NAEPP, 1997). It is the most commonly diagnosed chronic illness in childhood (Bender & Creer, 2002), currently affecting approximately 12% of the pediatric population in the United States (Dey, Schiller, & Tai, 2004).

Prevalence statistics are only a partial reflection of the total burden of the disease. First, asthma can result in several negative outcomes for children and their families. Children with the disease often report decreased physical activity (Lemanek, Trane, & Weiner, 1999), impaired sleep (Howenstine & Eigen, 2000) and decreased quality of life (Hallstrand, Curtis, Aitken, & Sullivan, 2003; Cohen, Franco, Motlow, Reznik, & Ozuah, 2003). As asthma is the leading cause of school absences, it can also significantly disrupt normal routines for the child and their family (deMesquita & Fiorello, 1998). Beyond consequences for individuals, children with asthma often over-utilize urgent health care resulting in increased costs for both families and the larger health care system (Milton, Whitehead, Holland, & Hamilton, 2004). These statistics occur in the midst of largely efficacious medical treatments for controlling the disease.

Secondly, statistics reveal that minority groups and individuals of a low socioeconomic background are disproportionately represented in prevalence rates (Dey et al., 2004). As an example, African-American children have increased rates of both

diagnostic prevalence (17.7%) and acute episodes (8.6%) relative to Caucasian children (Dey et al., 2004). Minority and low socioeconomic status are also predictors of a host of poor asthma-related outcomes including increased hospitalizations (Gregerson, 2000; Chen, Fisher, Bloomberg, & Strunk, 2003; Yeatts, Davis, Sotir, Herget, & Shy, 2003), general functional morbidity (Bender & Creer, 2002), school absences (Milton et al., 2004) and use of emergency room services (Yeatts et al., 2003). Several explanations exist to explain these observations including genetic predispositions to more problematic asthma (Wamboldt & Gavin, 1998), increased environmental pollutants (Wamboldt & Gavin, 1998), and disparities in access to health care (Bender & Creer, 2002). Since genetic factors do not adequately explain the increasing numbers of children diagnosed in recent years, the social factors of environmental pollutants & health care access are often used as more plausible explanations. Regardless of etiology, these statistics point to the necessity of finding better treatments which are easily accessible to high-risk populations.

Psychological and Behavioral Research in Pediatric Asthma

For most, asthma is a manageable disorder with effective pharmacological treatments. Therefore, seeing increased functional morbidity among asthmatics has led many to look at factors outside of disease status that impact outcomes. Research into the etiology, outcomes and treatment of asthma span several fields including medicine, biology, public health and psychology. Psychological research specifically addresses behavioral correlates of asthma and adjunctive treatments beyond medications.

Historically, many thought that asthma was a largely psychogenic disorder resulting from poor parental attachment (Bender & Creer, 2002). Today, this hypothesis is unsubstantiated with current research focusing on a more inclusive, and complicated, biopsychosocial model (Gregerson, 2000). Specifically, most view the etiology of asthma as purely biological in nature with psychological (e.g., depression, anxiety) and social (e.g., access to health care, familial conflict) factors playing a role in symptom presentation and/or disease outcome.

Data suggests several potential mechanisms of action behind the relationship between asthma symptom exacerbation and psychosocial variables. Some currently receiving increased research attention include overlapping physiological responses between internalizing disorders and asthma (Homnick & Pratt, 2000; Miller & Wood, 1997), decreased treatment adherence (Kaugars, Klinnert, & Bender, 2004), and impaired symptom recognition and subsequent treatment response (Howenstine & Eigen, 2000). Currently, all of the above processes have data to support their role in increased symptom presentation reflecting the many and varied risk factors impacting asthma. However, there are also many methodological limitations and some caution should be exercised in the interpretation of these results.

A parallel line of research has explored associations between psychological problems and asthma-related outcomes. Predictors of increased health care utilization and hospitalization include caregiver depression (Kaugars et al., 2004) and familial conflict (Chen et al., 2003; Kaugars et al., 2004). In addition, decreased symptom recognition is correlated with feelings of panic and fear (Homnick & Pratt, 2000) and

asthma-related mortality is associated with strong emotional reactions to separation, family conflict and patient-health care provider conflict (Kaugars et al., 2004).

Pharmacological Treatment of Asthma

Both lines of research identify relationships between disease processes/outcomes and psychosocial variables. They also guide formation of treatment targets in psychologically-based asthma treatment programs. Such programs exist as an adjunct to the largely efficacious medication management protocols. The National Asthma Education and Prevention Project (NAEPP) provide guidelines for the diagnosis and treatment of asthma symptoms based upon empirical evidence and expert opinion (Finkelstein et al., 2000). These guidelines advocate pharmacological treatments determined by disease severity as well as ongoing asthma education (NAEPP, 1997). Pharmacological treatments are classified by their contribution to the management of the disorder. The first type of medication often referred to as “quick-relief” or “rescue,” targets acute symptoms of bronchoconstriction and is used to immediately alleviate asthma symptoms of chest tightness and wheezing (NAEPP, 1997). Typically inhaled beta-agonists, (NAEPP, 1997) such drugs are adrenaline-like leading to widening of the airway passages (Lemanek et al., 1999). The NAEPP guidelines (1997) advocate the administration of these medications to all asthmatics regardless of severity classification.

The second type of medication is used for prevention of severe asthma rather than quick symptom relief (NAEPP, 1997). These medications, often referred to as “controllers,” typically target the inflammatory and hyperresponsivity symptoms rather

than act directly on the bronchial constriction. Such medications are often given to patients classified as having persistent asthma symptoms whether mild, moderate or severe (NAEPP, 1997). Such medications include orally administered medications (e.g., theophylline), leukotriene modifiers, long-term beta-agonists, and inhaled corticosteroids (NAEPP, 1997).

Behavioral and Psychosocial Asthma Treatments

Beyond pharmacological interventions, successful treatment of pediatric asthma relies on several behaviors including treatment adherence, environmental trigger reduction and symptom recognition. Psychological research has made several contributions to these areas although the literature is broad, inconsistent and suffers from several methodological problems.

A hallmark of psychologically-based asthma programs is the variability between interventions. The span of treatment targets and strategies reflect impressive diversity and include cognitive-behavioral therapy (CBT) (Redlich & Prior, 1998), family therapy (Barlow & Ellard, 2004), environmental trigger reduction (Morgan et al., 2004; Carter, Perzanowski, Raymond, & Platts-Mills, 2001; Halcken et al., 2003), relaxation training (McQuaid & Nassau, 1999), biofeedback (McQuaid & Nassau, 1999) and asthma self-management programs (SMPs) (Guevara, Wolf, Grum & Clark, 2003). As a review of all strategies is beyond the scope of this paper, focus will turn to one of the more highly researched areas, asthma SMPs.

Asthma Self-Management Programs

Asthma self-management programs are best conceptualized as package treatments targeting several intermediary behaviors that are correlated with successful asthma management with an overall goal of symptom reduction (Velsor-Friedrich, Pigott, & Loulouides, 2004). These intermediary behaviors can include those discussed earlier as well as psychological adjustment to the disorder, symptom recognition and symptom monitoring.

The Center for Disease Control (CDC) currently maintains a list of programs targeting pediatric asthma that are “potentially effective” (CDC, 2005). A review of the 35 programs specific to children reveals the common assumption that modification of crucial asthma management behaviors lead to fewer negative outcomes for an individual with asthma. However, treatment techniques, settings and participants vary widely between interventions.

Treatment Techniques

Passive distribution of information shows little impact on common markers of functional morbidity, asthma symptoms or quality of life (Barlow & Ellard, 2004). Incorporating behavioral techniques such as guided practice, reinforcement of appropriate behaviors, modeling and feedback are a necessary component of most treatments (Morgan et al., 2004). These techniques are presented in varying ways including individual instruction by health care professionals (vanEs et al., 2001; Hampel, Rudolph, Stachow, & Petermann, 2003) and peer-led education and support (Gibson, Shah, &

Mamoon, 1998; Shah et al., 2001). Recently, programs are beginning to use multimedia approaches to convey information and model techniques crucial to asthma management (Krishna et al., 2003; Bartholomew et al., 2000; Shegog et al., 2001). Examples of such programs include CD-rom based psychoeducation and practice (Bartholomew et al., 2000; Homer et al., 2000) and internet-based diaries of symptoms with provided feedback (Tinkelman & Schwartz, 2004).

Of the multimedia programs reviewed, all increased knowledge (Bartholomew et al., 2000; Homer et al., 2000; Krishna et al., 2003; Shegog et al., 2001). Two of the three that utilized measures of functional morbidity demonstrated reductions (Bartholomew et al., 2000; Krishna et al., 2003). Interestingly, one study (Homer et al., 2000) reported that changes in knowledge occurred in both the treatment and the control group indicating that computer based instruction may not impact behavior any differently than the printed materials given to the control group.

At this point, it is difficult to predict how valuable computer based instruction will be due to the relatively naïve research literature. Conceptually, unless the multimedia programs add different techniques or utilize more behavioral practice, it is likely they will be no more effective than their predecessors. However, multimedia approaches have other benefits including an associated reduction in cost due to decreased personnel needs, increased accessibility and the potential for more idiographic approaches to treatment (Homer et al., 2000; McPherson, Glazebrook, & Smyth, 2001).

Treatment Settings

Treatment settings are also varied and include the home, inpatient unit, outpatient clinic or school. A listing of treatments listed as ‘probably effective’ on the CDC website reflects the wide range of program settings. There are currently four studies set in the schools that have demonstrated probable effectiveness. This is in contrast to nine studies in the home setting and 19 in medical settings. Home-based interventions have demonstrated significant efficacy but often focus exclusively on environmental trigger reduction (Carter et al., 2001; Halken et al., 2003; Morgan et al., 2004) and are associated with increased costs and personnel requirements. As children from low socioeconomic statuses are a population at greater risk for poor asthma-related outcomes (Dey et al., 2004) and also may be impacted by reduced access to regular health care (Evans et al., 1990; McGhan et al., 2003), settings outside of outpatient clinics may have increased benefit (Bender & Creer, 2002). These factors point to several potential benefits of asthma self-management programs based in schools. First, for urban populations with a low socioeconomic status, school based programs can alleviate several of the barriers to adequate health care including access to services (McGhan et al., 2003) and the absence of a regular health care provider (Evans et al., 1990). In addition, it is usually less financially burdensome to the family since many programs are sponsored at low or no cost (McGhan et al., 2003). Schools also have physical resources and personnel necessary to implement the program as well as central organization for the sharing of resources (Evans et al., 1990). Finally, all children must go to school and providing

services in-school reduces the amount of time parents must spend outside the home (Evans et al., 1990).

Treatment Participants

Theoretically, most models looking at communication and allocation of responsibility for disease management have assumed that information is exclusively passed from caregiver to child (Evans, Clark, Levison, Levin, & Mellins, 2001). While this may represent the most developmentally appropriate pathway for younger children, the use of this model in practice presents several challenges. With the exception of home-based programs, many asthma education interventions suffer from low parental attendance due to time conflicts and family demands (Evans et al., 1990). Secondly, most asthma-education programs generally target one caregiver. However, many children have multiple caregivers and need some consistency in their care (Wade, Islam, Holden, Kruszon-Moran, & Mitchell, 1999). Finally, exclusive focus on the parent removes some responsibility from the child. As children will ultimately be wholly responsible for their own care, it is important that they have an active role in their own health protocols while balancing developmental considerations (Wade et al., 1999).

On the other end of the spectrum, some school-based programs have required little or no involvement from the caregivers (Berg, Tichacek, & Theodorakis, 2004). The creation of these programs is often driven by poor parental attendance at more traditional asthma management programs (Evans et al., 1990) or developmental considerations of adolescence (Berg et al., 2004). However, due to the many family factors that impact

symptom presentation and outcomes, it is increasingly evident that the treatment of asthma should ideally target the entire family and not just the patient (Kaugars et al., 2004). In addition, all treatment targets must necessarily occur in the home environment. Therefore, it is appropriate to provide education to caregivers at some level.

Based on this rationale, creative ways of increasing asthma management skills targeting both caregiver and child becomes crucial. An example of an intermediary approach was reported by Evans and colleagues in 2001. The study used the “Open Airways for Schools” protocol, a well established and frequently researched program currently used by the American Lung Association. Originally developed in 1977, it evolved from a traditional, outpatient asthma self-management program to the school-based, child-focused intervention used today (Spencer, Atav, Johnston, & Harrigan, 2000). The program entails child participation at 6 weekly, 40-minute sessions covering basic information about asthma, trigger identification and reduction and symptom recognition (Spencer et al., 2000). Sessions included various activities led by health educators in a group format (Evans et al., 1990). Parents attend one or two sessions covering similar topics and also receive letters communicating their child’s progress.

Evans et al. (2001) reported on the need for different strategies to encourage caregiver involvement due to the inability of many parents to attend sessions. Home-based activities were sent home with children with instructions to complete the homework with their parents. Home activities included teaching family members diaphragmatic breathing techniques, composing a letter with parents about medication dosages and schedules, interviewing the parent about asthma triggers and discussing

ways to keep the child physically active. Measures of child communication about symptoms increased from baseline indicating that children were discussing asthma issues with their parents. In addition, caregiver asthma management skills increased in the treatment group even in the absence of direct instruction. Other studies utilizing more child-directed strategies have shown similar results (Evans et al., 2001; Clark et al., 2004).

Effectiveness of Self-Management Programs

Like much of the literature on asthma, the treatment research base is complicated by a wide variety of measures, techniques and perspectives on the role of psychological factors in asthma management. In general, data suggests that educational interventions beyond passive distribution of information can decrease common markers of functional morbidity such as hospitalizations and urgent care visits when used in combination with pharmacotherapy (McIvor, 2001). Two recent meta-analyses reveal more specific data on the impact of self-management programs. Guevara and colleagues (2003) reported effect sizes on measures of lung function ($ES=0.50$), self-efficacy ($ES=0.36$), absences (-0.14) and acute health care usage (-0.21). These effect sizes reveal that self-management programs have small to moderate impacts on generally used measures of disease outcome. Barlow and Ellard (2003), using a slightly different methodology, reported that CBT-based protocols targeting self-efficacy may be promising in the treatment of asthmatics. However, they also indicate that most programs specifically target disease management and not quality of life issues. This may be an important

variable since recent research suggests that poor asthma control may be associated with decreased quality of life (Okelo et al., 2004). As this is correlational research, it is impossible to determine if targeting quality of life will enhance asthma control or if teaching better asthma control will result in increased quality of life. In addition, as some report that quality of life is more related to psychological factors rather than objective measures of disease severity (Howenstine & Eigen, 2000). Further studies will likely clarify these complicated issues. However, quality of life remains an important variable to assess and track due to its probable relationship to disease management.

The final result reported by Guevara and colleagues (2003) indicates that severe asthmatics had a stronger response to treatment relative to mild asthmatics. Throughout the treatment literature, as well as much of the literature in asthma, research is conducted on severely asthmatic patients. This has given us a wealth of information on this subset of asthmatics but has prohibited us from obtaining knowledge on the mild asthmatic. Therefore, it is unclear whether mild asthmatics do not need additional services outside of pharmacological therapies or if they are an underserved population.

Critical Review of Asthma SMPs

Identified trends in asthma SMPs discovered through meta-analyses prompt continued research interest in the interventions. However, knowledge of the significant variability between programs and methodological problems is crucial to a balanced view of the literature. Most asthma SMPs target similar domains including increased general asthma knowledge, correct inhaler techniques, environmental trigger reduction, symptom

recognition and asthma attack management. However, similarities between programs largely end with the common treatment targets.

The programs reviewed in meta-analyses demonstrate significant differences in treatment duration, intensity of instruction and use of behavioral techniques to facilitate skills acquisition. The variability of treatment “dosage,” or availability of active components to participants, significantly affects the ability to draw conclusions across interventions.

In addition, without minimizing the relevance of correlated variables and their reflection of disease burden, the overall goal of most asthma self-management programs is to decrease the frequency and/or severity of symptoms and associated functional morbidity (e.g., hospitalizations, school absences). However, SMPs tend to demonstrate larger changes in measures of knowledge and self-efficacy relative to disease outcome (Boulet, 1998; Bernard-Bonnin et al., 1995). Minimal changes in asthma-related outcomes appear to stem from two primary issues. First, research on asthma is hindered by a lack of precise, objective, easily used measures that capture changes both during and in the absence of extreme symptom exacerbation. Spirometry captures subtle changes in pulmonary function, but is costly and largely inaccessible outside of a medical setting. Peak expiratory flow readings (PEFR) using a peak flow meter (PFM) offer added convenience but questionable sensitivity (Brand et al., 1999). Therefore, from diagnosis to treatment outcomes, assessment relies heavily on self-report measures in both clinical and research settings. This is in contrast to other diseases (e.g., HIV infection, diabetes) which often use relatively simple blood tests to determine biological indicators of disease

status. The absence of parallel measures in asthma impacts the ability to conclusively understand the effect of a given intervention on pulmonary function.

Secondly, there is wide inter- and intraindividual variability within asthma. The course of the disease includes both acute and chronic components that vary widely based upon environmental and pathophysiological factors. Therefore, research in this area is impacted at several stages. During recruitment, variability can present challenges to attaining a relatively homogenous sample. Furthermore, detection of change due to treatment is often hindered by excessive variability in baseline measures, as well as post intervention measures (Bender & Creer, 2002). These factors call for unique and methodologically rigorous techniques to understand the impact of interventions on asthma symptoms and outcomes.

Current Study: Research Question and Extensions from Previous Studies

This project explored the impact of an asthma SMP on several measures of disease outcomes and correlated variables. The package intervention included computer-mediated instruction, home activities and written information for caregivers and was delivered to high-risk children in the school setting. Most asthma programs either exclude parents or make the parents the primary treatment target. This project attempted to use an intermediary approach due to barriers reported by families at elevated risk for problematic disease outcomes.

In addition to combining several cost-effective and easily implemented treatment techniques, a broader assessment battery was selected to ascertain program impact on less

studied variables including allocation of responsibility and trigger reduction behaviors.

This allows increased understanding of the benefits and limitations of the treatment on various aspects of asthma.

METHODS

Participants

A range of targeted and community-based recruitment strategies were used to solicit participants for this study. School nurses at five public schools in the metropolitan Detroit area sent letters to caregivers of students who had been identified on school-wide health surveys as having an asthma diagnosis. Letters explained the current project and indicated that the student researcher would contact them unless they opted out of participation. Because of the low return rate for annual health surveys, broader recruiting strategies were also implemented. More specifically, flyers were distributed to students in all eligible grades within the five elementary schools. The students were instructed to take the flyers home to their parents. The flyers explained the study and included a box where parents could indicate their interest in obtaining further information and also provide their contact information. Flyers that were returned to the school expressing interest in obtaining further information were transmitted to the student researcher. The researcher then contacted caregivers by phone and gave more detailed information about the study. Upon conclusion of the phone call, options for meetings were provided to discuss the project in more detail prior to the family's decision to participate.

These recruiting efforts yielded 32 participants from 25 families who met the following eligibility criteria: (1) a physician diagnosis of asthma; (2) reporting asthma symptoms at least weekly over the past three months; (3) access to regular health care;

(4) a current prescription for either long-term controller or rescue medication; and (5) at least one caregiver who spoke English. Thirty (94%) participants eventually completed the intervention.

Participants received \$5 gift cards at the end of each of four assessment sessions and a copy of the *Asthma: Quest for the Code*© computer game (to be described later) at post-treatment. The Western Michigan University Human Subjects Institutional Review Board approved all research procedures.

Measures

Assessment batteries contained a variety of physiological and self-report measures selected to capture treatment effects on both outcomes and correlated variables. Table 1 summarizes individual measures contained within each assessment period. Caregivers completed measures individually. Interviewers assisted most children with self-report measures following a standard protocol of providing an anchor point in time, introducing the scale used and working through an example.

Outcome Variables

Outcome variables included pulmonary function, symptom frequency and functional morbidity data and were assessed using both objective and subjective measures. Except as noted, administration of measures occurred at pre-, mid-, and post-treatment.

Table 1

Summary of Assessment Measure Administration

Assessment Measure	Assessment Period & Respondent							
	Pre-Treatment		Ongoing		Mid-Treatment		Post-Treatment	
	C*	CG**	C	CG	C	CG	C	CG
Background Surveys (Contact Sheet, Demographics Survey & Health History Form)		X						
ASIQ: Symptom Frequency	X	X			X	X	X	X
ASIQ: Functional Morbidity		X				X		X
Quality of Life (PAQLQ or PCQOLQ)	X	X			X	X	X	X
Asthma Responsibility Measure (ARM)	X	X			X	X	X	X
Knowledge Quizzes	X	X	X				X	X
Treatment Adherence		X		X				
Peak Expiratory Flow Readings (PEFR)			X					
Treatment Satisfaction Survey							X	X
ASIQ: Environmental Changes						X		X

Note. *C=child; **CG=caregiver.

Pulmonary Function

Peak expiratory flow rate (PEFR) was measured using Health Scan® or Personal Best® peak flow meters. Children completed three to five PEFR assessments per week under supervision of researchers at a consistently scheduled time of the school day using the same meter to control for variability between devices. A PEFR assessment session consisted of three peak flow trials as recommended by guidelines published by the

National Asthma Education and Prevention Project (NAEPP). Instructions were presented in both written and oral formats. After several sessions of consistent performance on peak flow meters, the structure of instructions shifted to simple one or two-word prompts. PEFr measures were recorded in liters per minute and the highest reading of the three trials served as the data point for that session.

Asthma Symptoms and Impact Questionnaire (ASIQ)

The ASIQ (Appendix B) was designed specifically for the current project. Assessment of three primary domains occurred through this survey including symptom frequency, functional morbidity and environmental changes. Both children and their caregivers rated the monthly frequency of symptoms for the participant. However, only caregivers reported on functional morbidity and environmental changes.

ASIQ: Symptom Frequency Domain

Each participant and their caregiver reported on the participant's monthly symptom frequency. Symptoms assessed included coughing, wheezing, gasping for breath, chest pain or tightness and waking at night due to asthma. In addition, caregivers reported on the frequency of severe asthma exacerbations over the previous month. Respondents used a 6-point Likert scale ranging from "never" to "once per day or more" to endorse symptoms. Asthma exacerbations used a 5-point scale ranging from "none" to "7 or more times."

ASIQ: Functional Morbidity Domain

Caregivers reported on the utilization of emergent health care services and school absences as part of the ASIQ. Urgent care visits, emergency department usage and hospitalizations were tracked using Likert scales ranging from “none” to “7 or more.” Caregivers reported school absence rates by writing in the number of days missed in the past month. This was done to allow caregivers to report when they may have taken their child out of school early due to asthma.

ASIQ: Environmental Changes Domain

Reduction of common asthma triggers in a child’s environment has demonstrated positive effects on asthma outcomes (Carter et al., 2001; Halken et al., 2003; Morgan et al., 2004). Therefore, assessment of changes made by parents represents an important variable to track in asthma education programs. While this domain was measured by the ASIQ, it will be discussed further under correlated variables.

Correlated Variables

Self-report measures of quality of life, allocation of responsibility, knowledge, familial communication surrounding asthma, and behavioral measures of treatment adherence were administered throughout the course of the project. Except as noted, administration of measures occurred at pre- and post-treatment.

Quality of Life

The Pediatric Caregiver Quality of Life Questionnaire (PCQOLQ) (Juniper et al., 1996a) measured the impact of a child's asthma on the caregiver's emotional functioning and activities in the previous week. Caregivers responded to 13 questions using a 7-point Likert scale where low scores reflected increased functional impairment (Juniper et al., 1996a). Beyond an overall Quality of Life Score, scores on two subscales—Emotional Functioning and Activity Limitations are also reported. All three scores are reported on the same 7-point Likert scale described above.

The Pediatric Asthma Quality of Life Questionnaire with Standardized Activities (PAQLQ(S)) (Juniper et al., 1996b) assessed child reported quality of life. Children responded to 23 questions using scales similar to those described in the PACQLQ. Three subscale scores (Symptom Presentation, Activity Limitation and Emotional Functioning) and an overall score are reported using similar methods as discussed above.

For both the PCQOLQ & the PAQLQ(S) a difference of 0.50 or more between scale scores across time reflects clinically significant changes. Psychometric properties indicate that the measure adequately detects such changes although sample sizes are relatively small (Juniper et al., 1996a, 1996b).

Asthma Responsibility Measure (ARM)

The National Cooperative Inner-City Asthma Study (NCICAS) Allocation of Responsibility Interview (Wade et al., 1997) measured self-report of the division of asthma-related tasks between caregiver and child. Portions of this interview were

adapted to create a self-report measure of perceptions of child and caregiver responsibility on four asthma management tasks: use of long-term controller and rescue medication, avoiding asthma triggers and stopping physical activity in the presence of increased symptoms. Using a Likert scale ranging from 1 (not at all) to 4 (most of the time), respondents rated how often they initiated asthma care across the four tasks over the previous two weeks. After rating their own behaviors, caregivers then rated their child's responsibility and children, in turn, rated their caregivers across the same time frame and same tasks. Descriptive research has demonstrated a correlation between negative asthma outcomes and disparate perception of asthma responsibility between caregivers and children (Wade et al., 1999; Walders et al., 2000). However, data are lacking on psychometric properties.

Knowledge

Quizzes published by the Starlight Starbright Foundation© measured caregiver and child knowledge of asthma. While data suggests education alone is insufficient for improved asthma care (Evans et al., 1999; Guevara et al., 2003), it is a necessary component for health programs. To track changes in asthma-related knowledge, caregivers and children completed quizzes individually. The 62 items covered the learning objectives in the treatment CD-rom that was used as a primary intervention component for this study and assessed knowledge across six domains including symptom recognition, myths, peak flow sequencing, monitoring pulmonary function,

differentiating between medication groups and lung physiology. Percentage correct on each domain served as the data point.

Treatment Adherence

Adherence to use of long-term controller medication was assessed via phone calls to caregivers throughout the study. During the phone contact, the caregiver reported either the number of pills or number of dosages (dependent upon medication prescribed) remaining as well as the date of the last refill. Scores reflect the number of administered dosages divided by number of prescribed dosages and were reported as a percentage. Because it was not feasible to actually observe the administration of a dose of medication, a dose was considered to have been “administered” if the pill had been removed from the bottle or the dosage meter had decreased. Analyses used average percentages of adherence (doses administered/doses prescribed over a given interval of time) as well as changes from pre- to post-treatment for individual participants.

ASIQ: Environmental Change

As discussed earlier, the ASIQ included a domain to track environmental changes made to decrease asthma symptoms (Appendix B). Unlike previous measures, assessment occurred at mid- and post-treatment. Caregivers first reported whether any changes occurred in the past month. For those answering ‘yes’, common changes (e.g., removing carpeting, dusting) were listed and caregivers were asked to circle activities completed. Additional space was provided for the caregiver to describe changes not

listed. Analyses used percentages of caregivers reporting changes and number of changes made.

Treatment Satisfaction

In addition to the measures discussed above, children and caregivers completed a treatment satisfaction survey (Appendix B) at post-treatment assessment. Caregivers responded to six questions using a Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). The child's measure included three questions using a scale ranging from 1 (satisfaction) to 3 (dissatisfaction). Both children and caregivers also had an opportunity to qualitatively respond to questions related to their most and least liked portions of the treatment.

Treatment Condition

The treatment consisted of three components: a computer-based educational game (*Asthma: Quest for the Code*®), home activities and caregiver information. The computer game, produced by the Starlight Starbright Children's Foundation, included eight modules covering topics important to asthma management (Table 2). Each individual module used interactive activities to highlight asthma trigger identification and provided information on one of the management topics. Activities varied between individual modules and included passive receipt of spoken and written information as well as interactive games reliant upon accurate asthma knowledge. The self-directed activities spanned from 10 to 20 minutes per session and were presented to participants

Table 2

Asthma: Quest for the Code Module Topics and Activities

Module	General Topic	Specific Activities and Lessons
Introduction	Lung Physiology	Participant takes interactive tour of lungs and learns biological basis of asthma symptoms
1	Symptom Recognition	Child identifies triggers common in kitchen and answers corresponding questions Child receives information about early warning signs and symptoms of asthma; knowledge assessed through use of game in which child categorizes signs and symptoms
2	Asthma Myths	Participant identifies triggers common in bathroom and answers corresponding questions Child answers questions posed in game show format about common asthma myths and activity limitations
3	Peak Flow Meter Usage	Participant identifies triggers common in a living area and answers corresponding questions Education provided about monitoring peak flow readings and decision model provided using green, yellow and red zones Child presented with pictures of different steps of using a peak flow meter and asked to put them in sequence
4	Appropriate Use of Long-Term and Rescue Medication	Participant identifies triggers common in a household outdoor setting and answers corresponding questions Interactive game is presented that asks child to identify when to use long-term control and rescue medication, when to monitor symptoms and when to call for emergency assistance
5	Correct Usage of Common Asthma Medication Devices	Participant identifies triggers common in a school room setting and answers corresponding questions Child presented with pictures of steps in usage of common medication devices (e.g., MDI, DPI) and asked to put them in sequence; video then plays presenting all steps as displayed by a child actor

Table 2—Continued

Module	General Topic	Specific Activities and Lessons
6	Responding to Questions from Peers	Child identifies triggers common in an urban outdoor setting Child actors role play appropriate and inappropriate responses to questions about asthma and child is asked to select correct responses
7	Effect of Asthma Medications on Lungs	Child identifies triggers common in a bedroom setting and answers corresponding questions Through an interactive game, child selects answers related to questions on how asthma medications affect lung functioning and general lung biology

individually during their school day. Modules were embedded within a larger, multi-phase game and advancement to the next level occurred contingent upon answering quiz questions correctly. Children completed one or two modules per session dependant upon progression through each section and academic schedule. At a minimum, an individual participant could complete all activities in *Asthma: Quest for the Code*® in approximately 1.25 hours. While not systematically monitored, most children utilized the CD-rom for approximately 20 minutes once per week over the course of eight to nine weeks for an approximate total time of 2.5 hours in instruction.

Four home activities (Appendix A) designed to correspond with CD-rom content and to encourage asthma-related communication between the child and caregiver composed the second treatment component. Homework used in the Open Airways for Schools (OAS) treatment program guided the design of this portion of the intervention. Table 3 lists the topics and tasks covered in home activities. Children received one home

activity upon completion of the 2nd, 4th, 6th and final computer module. The activities were designed to be brief (10–15 minutes) and completed within one week. Space for caregivers to sign worksheets upon their completion served as a means, albeit minimal, to track whether they had viewed the homework.

Table 3
Home Activity Topics

Home Activity	Target	Activity
1	Increase communication between child and caregiver about medications used to manage asthma	Child interviews parent through use of specific questions and then creates a news story about their asthma medication
2	Increase awareness of caregiver of child's early warning signs of asthma	Using an outlined format, child writes a letter to caregiver identifying their specific symptoms
3	Identification of asthma triggers in the home	Child asked to work with caregiver to identify potential triggers in the home; child specifically directed not to come in contact with triggers
4	Increased communication between caregiver and child about psychosocial aspects of asthma	Child asked to draw pictures illustrating them on a bad day with asthma; child also draws picture illustrating their feelings when they are managing their symptoms successfully

The third treatment component, caregiver guides, contained information for home caregivers to assist children with their home activities. Content from parent handouts published on the Starbright Starlight Children's Foundation® website served as the basis for the guides. Distribution of the first guide occurred after completion of pre-treatment

measures. Subsequent handouts were administered in the same time frame as home activities. With the exception of ensuring they were distributed, usage of caregiver guides was not formally tracked.

Setting and Apparatus

Pre-treatment measures were completed in a private meeting space in a range of settings including the child's school or various public buildings (e.g., community library, bookstore) selected for the convenience of the caregivers. Once pre-assessment measures were completed, contact with participants occurred in their individual schools. Caregiver contacts continued in similar settings as pre-treatment assessment.

Presentation of *Asthma: Quest for the Code*® occurred on a desk top computer in the school's media rooms. As two of the schools did not have access to reliable computers, a laptop computer housed in either the nurse's office or the library was used to present *Asthma: Quest for the Code*®. Regardless of the setting, children had access to comfortable seating during the course of the computer sessions. The monitors could be adjusted to maximize viewing ability and headphones allowed individualized volume control.

Daily peak flow readings occurred in the school nurse's office or a location selected by the nurse that provided privacy. HealthScan (©Respironics) and Personal Best (©Respironics) peak flow meters were used throughout the project. Both assess the full range of pulmonary function (60–810 L/min). Children were provided either with their own peak flow meter or used a disposable mouthpiece and shared a meter with up to

two other children. Sanitization of shared meters occurred daily. Individually used meters were sanitized once per week. Children used the same meter at each session to control for inter-device variability

Procedure

Initial Contacts and Informed Consent

Table 4 outlines the procedures of the project. After initial phone contact, the first meeting occurred with the caregiver(s), child(ren) and student investigator. The protocol for this initial meeting included: (a) explaining the study and the requirements for participation, (b) answering questions and addressing concerns about the study, (c) providing the option to participate in the study and, for those wishing to participate, and (d) completing informed consent documents.

For those parents and participants who signed the consent/assent documents, the administration of the pre-treatment measures occurred immediately or at another scheduled meeting. Children and caregivers responded to measures individually.

School-Based Assessment and Intervention Sessions: Participant Contact

After the initial contact, all assessment and intervention activities for participants occurred in their schools. Unless otherwise stipulated, the first author and trained undergraduate assistants served as the primary contact for participants. Pulmonary function, measured by frequent peak flow readings, occurred between three and five

Table 4

Summary of Contacts with Participants

Contact	Goal	Measures	Handouts
1	Address questions & concerns from caregiver and child regarding the project If child and caregiver agree to participate, complete informed consent and assent	Pre-treatment assessment measures	Caregiver Guide 1
2	Complete baseline peak flow readings		
3	Computer modules: Introduction & 1	Ongoing peak flow readings	Home Activity 1 Caregiver Guide 2
4	Computer modules: 2 & 3	Ongoing peak flow readings	Home Activity 2 Caregiver Guide 3
5	Mid-Treatment Assessment	Mid-treatment assessment measures	
6	Computer modules: 4 & 5	Ongoing peak flow readings	Home Activity 3 Caregiver Guide 4
7	Computer modules: 6 & 7	Ongoing peak flow readings	Home Activity 4 Caregiver Guide 5
8	Post-Treatment Assessment	Post-treatment assessment measures	Computer game Certificate

times per week dependent upon scheduling. Exposure to the computer game was presented approximately one time per week

Scheduling and Collecting Baseline Peak Flow

Through collaboration with the teacher, times were selected for peak flow readings and computer sessions that presented minimal disruptions to the child's

academic day. A minimum of four baseline peak flow readings were collected prior to starting the treatment condition. To alleviate social consequences of being called out of class publicly, children met the researchers at the school nurse's office or at an alternatively predetermined location. Exceptions were made for children who expressed preferences for meeting the researcher at their classroom.

Implementation of Intervention

The computer training sessions occurred subsequent to collection of baseline peak flow readings. Children met the researcher at a predetermined location within the school and returned to their normal school day activities after completion of the computer-based game. A similar sequence was followed with subsequent modules. Children were allowed to complete two modules per session if they could do so within the 20-minute time allocated to be away from normal school activities

Upon the completion of two modules, the child was given a home activity (Appendix A) and corresponding caregiver guide. Home activities included due dates to ensure that they were returned prior to the next computer session. Peak flow readings continued to be collected during the time home activities were outstanding and prompts were provided to students if they did not return home activities. Mid-treatment measures were distributed to children upon completion of four computer modules and two home activities (see Table 4). Post-treatment assessment measures were administered immediately upon return of the final home activity or within a week of the final computer session. Upon completion of the final computer module and post-treatment assessment

measures, children were provided with certificates of completion and a copy of the computer game.

Design and Analysis of Data

Design

There is wide variability both within and between asthma patients (Bender & Creer, 2002). This variability prompts a need for large numbers of participants to achieve adequate statistical power. Due to financial and logistical limitations, the numerous participants needed could not be recruited. Therefore, to understand the impact of treatment on the largest number of students possible, a one group pre-test, post-test design was selected.

Analysis of data occurred via three distinct pathways. First, basic descriptive summary scores (e.g., mean, standard deviation) occurred on all measures. Secondly, due to the small number of participants and resulting violations of parametric test assumptions, nonparametric analyses were used to compare pre- to post-treatment differences in all measures except the ARM. Specific tests selected included the Wilcoxon and McNemar analyses which are sensitive to data collected from dependent samples. In the case of the ARM, kappa statistics analyzed level of agreement between respondents. Some scales were dichotomized to facilitate analyses. If conducted, descriptions are provided in greater detail in the results section. While multiple comparisons warrant the use of a Bonferroni correction, alpha was set at the traditional level of 0.5 due to the pilot nature of the project.

Finally, effect sizes (Cohen's *d*) were calculated for several measures within the current project including school absences, symptom frequency (asthma exacerbations, night awakenings, coughing, wheezing, gasping and chest tightness), urgent medical care usage (outpatient, ED and hospitalizations) and caregiver and child knowledge. Selection of measures analyzed occurred subsequent to a systematic review of the existing treatment outcome literature which identified common metrics used in multiple studies. Papers were identified from two sources: a recent meta-analysis by Guevara and colleagues (2003) and the Centers for Disease Control bibliography (retrieved from: <http://www.cdc.gov/asthma/interventions/bibliography.htm>). Criteria for inclusion in effect size analyses included: (1) targeting a pediatric (birth to 18) population; (2) availability of pre- and post-treatment group means, sample sizes and standard deviations; and (3) inclusion of parallel measures used in the current project. Of the 137 pediatric asthma treatment outcome papers identified by the CDC and Guevara sources, effect sizes were calculated for 27 (20.0%) studies. Several papers described pediatric asthma programs, but were not used primarily due to absence of necessary data (n=92; 67.0%), lack of parallel measures (n=14; 10.0%) or use of a different design (n=4; 3.0%). Appendix C lists papers analyzed for each domain.

RESULTS

Sample Characteristics

Recruitment and Pre-Treatment Assessment

Recruitment yielded 32 participants from 25 families. Thirty participants ($M = 9.1$ years, $SD = 1.75$ years) completed pre-treatment assessment. Two children were unable to complete pre-treatment self-report measures due to age ($n=1$) or cognitive deficits ($n=1$) but were retained in the study. These participants completed peak flow readings and caregivers completed their portion of the assessment battery.

Treatment Data

Of the 32 recruited, 30 children (93.75%) completed all modules in the computer game and were given four home activities. One child did not complete treatment due to frequent absences resulting from disciplinary suspensions and early departures. One additional participant withdrew in the first phases of the intervention without providing a rationale for their withdrawal.

Duration of treatment spanned from the caregiver signing the informed consent document through final peak flow readings. Children averaged 96.87 days in treatment ($SD=14.50$) and were available for 73.88% of peak flow reading times ($SD=16.48\%$). Ninety percent of participants finished 50% of home activities or more with 46.7% completing all four home activities.

Post-Treatment Assessment and Completer Characteristics

At post-treatment, 23 of the 30 children who completed the intervention (76.67%) had pre- and post-treatment self-report and caregiver data. Three additional children (10.0%) completed self-report measures only and two children (6.67%) had caregiver reports in the absence of self-report measures. Incomplete post-treatment measures (from either the child or caregiver) resulted from age (n=1), cognitive deficits (n=1), caregiver refusal to provide information (n=2), homelessness (n=1) or inability to locate (n=2).

For measures in which both child and caregiver reports are needed for analysis (e.g., Asthma Responsibility Measure), analyses used data from those participants with both caregiver and self-reports. For other measures that are largely independent, the number of child and caregiver reports will differ. Each analysis specified the number of respondents as variations also occurred due to omission of individual items within the larger assessment battery.

The two participants lacking both self-report and caregiver post-treatment assessment data did not differ from remaining participants on pre-treatment demographic variables including health care access. One of the two reported significantly increased symptom presentation, decreased caregiver quality of life and severely compromised peak expiratory flow readings (PEFR) throughout the intervention. This family described significant economic barriers resulting in homelessness at the end of the project. Due to the absence of post-treatment data, the information obtained from the two participants

during pre-treatment assessment as well as PEF data, are excluded from analyses yielding a maximum final subject pool of 28.

Characteristics of Participants in Final Data Set

Demographics

Most participants in the final data set were male (64.3%; n=18) and enrolled in grades 3 through 5 (78.6%; n=22). Thirty-nine percent of the sample was African-American (n=11), 28.6% were Caucasian (n=8), 14.3% were Hispanic (n=4) and 17.9% was biracial (n=5). Most families reported earnings the previous tax year in two categories: less than \$20,000 (34.6%; n=9) or between \$21,000 and \$40,000 (53.8%; n=14). Caregivers of two participants did not disclose income information.

Asthma History

The average number of years since diagnosis was 6.65 years (SD=3.35) with the majority of participants diagnosed in early childhood (M=2.54 years, SD=3.18 years). Caregivers endorsed year-round symptoms for 88.9% of the children. All participants had prescriptions for rescue medication (e.g., albuterol) and 71.4% also had prescriptions for long-term controller medications. Controller prescriptions varied with the majority (32.1%) reporting leukotriene modifiers as their primary asthma medication. Other medications reported included inhaled corticosteroids (25.0%) or a combination of leukotriene modifiers and an inhaled corticosteroid (14.3%). Approximately half of the sample (44.4%) was diagnosed with another medical or psychological condition in

addition to asthma. The presence of one smoker in the home was noted for 42.9% of the participants. Many of the parents reported smoking outside the presence of their child. However, 10.7% indicated using tobacco while their child was in the home and 28.6% admitted smoking while in the car with the child.

Lifetime utilization of health care services due to asthma was common with 39.3% of the sample reporting previous overnight hospital stays and 64.3% reporting previous visits to the emergency department (ED). Of children with reported usage of emergent care, 15.6% reported three or more hospitalizations and 40.6% reported three or more ED visits over their lifetimes. Over one-third (35.8%) of the children had five or more absences due to their asthma in the previous school year.

Many caregivers reported health care inconsistent with established guidelines. Only 11.1% reported having an action plan for their child's asthma and 14.8% indicated possession of a peak flow meter. Most families (96%) reported no previous asthma education. Caregivers reported refilling rescue inhalers frequently with 28.6% needing refills one time per month and an additional 39.3% requiring refills once every two months. Only 28.6% of participants reported refills less than every 6 months—a recommended benchmark indicating appropriate control of symptoms (Millard, 2003). Approximately two-thirds of children had inhalers at school (67.9%).

Treatment Data: Asthma Outcomes

Pulmonary Function

All participants provided peak expiratory flow rate (PEFR) assessments throughout the project. Analysis occurred with data from 27 participants (90%). Outside of the two children lacking post-treatment assessment, one additional child was not measured for height. The absence of this measurement does not allow calculation of predicted PEFR. PEFR from the first 10 (labeled “early treatment”) and last 10 sessions (“late treatment”) were used in analyses. The percentage of predicted expiratory flow based upon established norms are summarized in Table 5 for both early and late PEFR sessions.

Table 5

Peak Expiratory Flow Readings (PEFR): Percentage of Predicted Levels
Early and Late in Treatment

	Early Treatment (n=27)	Late Treatment (n=27)
Mean (SD)	85.56 (15.88)	89.34 (17.80)
Range	56.64–112.50	58.20–119.48

Participants averaged 85.56% of their predicted PEFR in early sessions with a slight increase to 89.34% in later sessions. Wide individual variability between participants was present with percentages ranging from 56.64% to 112.50% in early sessions and 58.20% to 119.48% in later treatment. Change from pre- to post-treatment

of percentage of predicted PEFR was also calculated and averaged 3.78% (SD: 7.40%).

Again, wide variability was observed with values ranging from -10.30% to 22.01%.

Nineteen (63.3%) participants demonstrated an increase in PEFR averaging a gain of 7.12% (SD: 6.02%). The remaining eight (26.67%) exhibited a mean decrease of 4.17% (SD: 2.73%).

Asthma Symptoms and Impact Questionnaire: Symptom Frequency Domain

Respondents rated the frequency of asthma symptoms over the previous month using a 6-point Likert scale ranging from “once per day or more” to “never.” To facilitate analyses, responses were divided into two categories: “weekly or more frequent symptoms” or “two to three times monthly or less.” Tables 6 and 7 present the percentage of respondents endorsing weekly or more frequent symptoms.

Table 6

Child ASIQ Self-Report of Monthly Symptom Frequency

Symptom	Pre: Percentage Weekly Symptoms	Post: Percentage Weekly Symptoms	Statistical Significance
Coughing (n=26)	76.9	46.2	$p=0.039^*$
Wheezing (n=26)	38.5	34.6	$p=1.000$
Gasping (n=26)	38.5	19.2	$p=0.180$
Chest Tightness (n=26)	38.5	23.1	$p=0.219$
Awaking at Night (n=26)	38.5	26.9	$p=0.250$

Table 7

Caregiver ASIQ Responses on Monthly Symptom Frequency of Participants

Symptom	Pre: Percentage Weekly Symptoms	Post: Percentage Weekly Symptoms	Statistical Significance
Coughing (n=25)	76.0	52.0	$p=0.109$
Wheezing (n=23)	52.2	40.0	$p=0.727$
Gasping (n=25)	40.0	28.0	$p=0.375$
Chest Tightness (n=22)	37.5	26.1	$p=0.250$
Awaking at Night (n=24)	36.0	25.0	$p=0.375$

McNemar analyses were used to determine statistically significant differences between pre- and post-treatment. While the percentage of respondents endorsing frequency of symptoms as weekly or more decreased across all indicators, statistically significant changes were only observed on child report of coughing frequency. Sixty-eight percent of caregivers reported their child experiencing asthma exacerbations in the month prior to pre-treatment. At post-treatment, the percentage had decreased to 56% although the difference was not statistically significant ($p=0.739$).

Asthma Symptoms and Impact Questionnaire: Functional Morbidity Domain

Caregivers reported on frequency of health care utilization and school absences in the previous month. Similar to the symptom frequency domain, the original Likert scale was dichotomized into two categories: “occurrence” or “no occurrence.” Table 8 reports the percentage of caregivers endorsing the presence of specific events.

Table 8
Caregiver ASIQ Reports of Functional Morbidity

Outcome	Pre: Percentage Reporting Occurrence	Post: Percentage Reporting Occurrence	Statistical Significance
School Absence (n=25)	33.3	21.7	$p=0.231$
Urgent Care Visit (n=25)	40.0	16.0	$p=0.034^*$
ED Visit (n=25)	12.0	8.0	$p=0.655$
Hospitalization (n=25)	4.0	4.0	$p=1.000$

Note. *statistically significant at $\alpha=0.05$.

McNemar analyses revealed statistically significant decreases in monthly urgent care visits from pre- to post-treatment ($p=0.034$). Caregivers also reported decreased usage of emergency department services and school absences although neither was at statistically significant levels. Hospitalization rates remained the same from pre- to post-treatment.

Treatment Data: Correlated Variables

Child Quality of Life (PAQLQ)

PAQLQ scores are summarized in Table 9. The mean PAQLQ Overall score changed within this time period from 4.48 to 5.37 ($p=0.000$). Approximately 62% of children reported changes in the positive direction of 0.05 or greater reflecting clinically significant differences (Juniper et al., 1996b). Of the three subscale scores, the

Table 9

Pediatric Asthma Quality of Life Questionnaire (PAQLQ) Results

PACQLQ Score	Pre: Mean (SD)	Post: Mean (SD)	Difference	Children reporting positive change of ≥ 0.05 (%)
Overall (n=26)	4.48 (1.45)	5.37 (1.43)	0.89*	61.54
Activity Limitation (n=26)	4.67 (1.52)	5.53 (1.28)	0.86*	46.15
Emotional Functioning (n=26)	4.46 (1.68)	5.40 (1.59)	0.94*	57.69
Symptoms (n=26)	4.34 (1.49)	5.15 (1.75)	0.81*	65.38

Note. *statistically significant at $\alpha=0.05$.

Emotional Functioning domain reflected the greatest change ($p=0.000$). Wilcoxon analyses revealed statistically significant changes from pre- to post-treatment in the Activity Limitation subscale ($p=0.015$) and Symptoms subscale ($p=0.002$) were also observed.

Parental Quality of Life (PACQLQ)

PACQLQ scores are summarized in Table 10. Twenty-five caregivers completed the PACQLQ at pre- and post-treatment. The mean PACQLQ Overall score changed within this time period from 5.35 to 6.03 ($p=0.007$). Forty-eight percent of caregivers reported changes greater than 0.05 in the overall score between pre- and post-treatment. This benchmark has been established as reflecting clinically significant changes (Juniper et al., 1996a). Wilcoxon procedures analyzed differences from pre- to post-treatment. Both the Activity Limitation and Emotional Functioning subscale scores revealed

Table 10

Pediatric Asthma Caregiver Quality of Life Questionnaire (PACQLQ) Results

PACQLQ Score	Pre: Mean (SD)	Post: Mean (SD)	Difference	Caregivers reporting positive change of ≥ 0.05 (%)
Overall (n=25)	5.35 (1.25)	6.03 (1.05)	0.68*	48.0
Activity Limitation (n=25)	5.12 (1.70)	6.27 (0.83)	1.15*	64.0
Emotional Functioning (n=25)	5.43 (1.26)	5.91 (1.25)	0.48*	40.0

Note. *statistically significant at $\alpha=0.05$.

statistically significant changes at the $\alpha=0.05$ level. The Activity Limitation subscale demonstrated greater changes ($p=0.003$) relative to the Emotional Functioning subscale ($p=0.024$).

Asthma Responsibility Measure (ARM)

Data analyzed from this measure included child and caregiver perceptions on responsibilities for four asthma-management tasks in the preceding two weeks. Twenty-three child/caregiver dyads completed this measure although not all dyads completed all questions. As an example, only those children prescribed long-term controller medications were asked to respond to perceived responsibility on that specific task. High scores reflect increased responsibility and range from 1 (“not at all” responsible) to 4 (responsible for tasks “most of the time”). Descriptive statistics of perceptions of child responsibility are summarized in Table 11.

Table 11

Descriptive Statistics of Child and Caregiver Responses
on ARM of Child Responsibility

Asthma Management Task	Caregiver		Child	
	Pre-Treatment Mean (SD)	Post-Treatment Mean (SD)	Pre-Treatment Mean (SD)	Post-Treatment Mean (SD)
Use of long-term controller medications	2.71 (1.33)	2.76 (1.35)	2.50 (1.03)	2.81 (1.17)
Decision when to use rescue medications	3.00 (1.04)	3.05 (1.05)	3.22 (0.90)	2.67 (1.11)
Avoidance of asthma triggers	2.61 (1.16)	3.22 (1.04)	2.82 (1.26)	2.65 (1.30)
Cessation of physical activity when symptoms arise	2.56 (0.99)	2.73 (1.24)	2.61 (1.12)	2.70 (1.15)

At pre-treatment, caregiver ratings on child responsibility ranged from 2.56 (cessation of physical activity) to 3.00 (decision when to use rescue medication). Children endorsed mean ratings ranging from 2.50 (long-term medication usage) to 3.22 (decision to use rescue inhalers). At post-treatment, caregiver ratings on child responsibility increased across all tasks ranging from 2.73 (cessation of physical activity) to 3.22 (avoidance of asthma triggers). Children's ratings of self-responsibility decreased in two tasks (use of rescue medications and avoidance of triggers) with increased mean ratings in the remaining activities.

To analyze agreement between child and caregiver responses, kappa statistics were calculated. The original 4-point Likert scale was reorganized into a dichotomy. Endorsement of high frequency was described as "mostly responsible" and low frequency responses as "rarely responsible." Table 12 summarizes the data.

Table 12

Caregiver and Child ARM Responses: Response Patterns and Kappa Statistics

Asthma Management Task	Is the child more frequently responsible for the listed task?									
	Kappa Statistic		Both No (n)		Child Yes CG No (n)		Child No CG Yes (n)		Both Yes (n)	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
Use of long-term controller medications	0.55	0.32	4	2	2	2	1	2	7	9
Decision when to use rescue medications	0.40	0.11	3	3	3	3	2	5	15	8
Avoidance of asthma triggers	0.33	0.07	5	3	3	3	4	7	10	10
Cessation of physical activity when symptoms arise	0.12	-0.05	5	3	5	5	5	6	8	8

At pre-treatment, statistically significant levels of agreement on child responsibility were observed in two areas of asthma management: use of long-term controller ($k=0.553$; $p=0.036$) and rescue ($k=0.404$; $p=0.051$) medications. At post-treatment, no statistically significant results were observed and kappa statistics decreased across all four tasks reflecting decreased agreement between child and caregiver perceptions of child responsibility. Of the four possible patterns, two reflect disagreement between caregiver and child responses. These two categories, child responding they are primarily responsible while their caregiver responds that they are not and vice versa, are presented in the Table 12. Potential for “over allocation” of responsibility is increased when the child responds that they are frequently responsible for a given task and caregivers respond that the child is not. On the other hand, potential

for “under-allocation” could occur if the child endorses minimal responsibility and the caregiver responds that the child is primarily responsible. No changes were observed on any task from pre- to post-treatment within the “over-allocation” pattern. Changes were observed on every task within the “under-allocation” trend.

Knowledge

Twenty caregivers and 23 children completed both pre- and post-treatment measures of knowledge. Results are summarized in Tables 13 and 14. Wilcoxon analyses revealed statistically significant differences between pre- and post-test administration were observed on 5 of the 6 domains for children.

Table 13

Children’s Asthma Knowledge Scores: Mean Percentage Correct

Knowledge Domain	Pre: Mean (SD)	Post: Mean (SD)	Difference
Symptom Recognition	47.52 (12.11)	55.90 (13.90)	8.38*
Asthma Myths	74.27 (17.88)	86.29 (16.14)	12.02*
Use of PFM ^a	40.87 (37.41)	69.57 (24.02)	28.70*
Monitoring PFR ^b	88.36 (14.77)	93.25 (8.86)	4.89*
Asthma Medications	45.17 (24.76)	71.01 (18.16)	25.84*
Lung Physiology	55.98 (24.08)	63.82 (24.22)	7.84

Note. ^aPFM=peak flow meter. ^bPFR=peak flow readings.

*statistically significant at $\alpha=0.05$.

Table 14

Caregiver's Asthma Knowledge Scores: Mean Percentage Correct

Knowledge Domain	Pre: Mean (SD)	Post: Mean (SD)	Difference
Symptom Recognition	72.14 (18.23)	74.00 (15.44)	1.86
Asthma Myths	90.93 (10.52)	90.59 (9.12)	-0.34
Use of PFM ^a	49.00 (33.39)	72.00 (31.39)	23.00*
Monitoring PFR ^b	88.50 (23.90)	95.79 (7.78)	7.29
Asthma Medications	63.00 (35.26)	60.00 (34.34)	-3.00
Lung Physiology	86.88 (15.43)	88.13 (18.35)	1.25

Note. ^aPFM=peak flow meter. ^bPFR=peak flow readings.

*statistically significant at $\alpha=0.05$.

Caregivers reported scores of 80% or greater in three domains of knowledge at both pre- and post-treatment: recognition of asthma myths, monitoring peak flow readings and lung physiology. Four of the domains yielded changes of 5% or less from pre- to post-treatment. The portion of the quiz that assessed knowledge about use of peak flow meters illustrated the greatest change from pre- to post-treatment (23.00%) and was the only statistically significant change determined by Wilcoxon analyses.

Treatment Adherence

Of the 20 children using long-term controller medication, reliable data was obtained from 8 (40.0%). Failing to obtain data resulted from unreliable communication with families (n=5), sharing medication or having two or more devices (n=5), relocation of the family (n=1) or being taken off of long-term controller medication in the midst of

the study (n=1). Seven of the eight children reported increased adherence over the course of the study. Of the 8 children with complete data, the average percentage of time adherent with medication at pre-treatment was 48.16% (SD=21.2). At post-treatment, the average percentage of time adherent was 63.93% (SD=25.14). Change from pre- to post-treatment was calculated for each child resulting in an average change in adherence of 15.77% (SD=12.99).

Environmental Changes

From pre- to mid-treatment, seven families reported making environmental changes recommended by medical experts to improve asthma control. These changes ranged from improved cleaning techniques to removal of carpet in the home. Of these 7 families, 6 made three or more changes. From mid- to post-treatment, 52.0% of families (n=13) reported making one to six changes. Changes made were similar between administration times.

Treatment Satisfaction

Caregivers of 24 participants completed the treatment satisfaction survey. Caregivers reported mean treatment satisfaction scores between 1 (strongly agree) and 2 (agree) on all six questions presented. Means and descriptive statistics of caregiver satisfaction are presented in Table 15. Twenty-five children reported similar elevated rates (Table 16) of satisfaction with mean ratings near 1 (satisfied).

Table 15

Caregiver Treatment Satisfaction Ratings: Means and Standard Deviations

Question	Mean	Standard Deviation
Time spent was worthwhile	1.42	0.93
Expectations were met	1.42	0.88
Belief that project helped child manage asthma	1.25	0.85
Belief that project helped caregiver learn about asthma	1.42	0.93
Overall satisfaction	1.33	0.87

Table 16

Child Treatment Satisfaction Ratings: Means and Standard Deviations

Question	Mean	Standard Deviation
Liked the time spent on this project	1.12	0.33
Learned a lot about asthma	1.08	0.28
Overall satisfaction	1.04	0.20

Effect Size Comparisons

Cohen's d , a standardized mean difference, provided an estimate of effect size for pre- and post-treatment changes in intervention groups of the selected studies (listed in Appendix F). Positive values reflect changes in the predicted direction. Table 17 provides effect size ranges from the selected studies and d values from the current study for comparison. Using conventional Cohen guidelines for interpretation of effect sizes, small effect sizes were observed for decreased absences ($d=0.32$), asthma attack

Table 17

Effect Sizes (Cohen's *d*) From Literature and Current Study

Domain	Number of papers analyzed	Range of effect sizes	Current project effect size
Absences	9	0.11–4.01 ^a	0.32
Asthma attacks	4	0.12–0.50	0.18
ED visits	5	0.53–1.99 ^b	0.21
Hospitalizations	4	0.00–1.85 ^c	0.13
Caregiver knowledge	6	0.56–1.63	Range from –0.03 (asthma myths) to 0.71 (sequence of peak flow meter use)
Child knowledge	7	–0.14–1.73 ^d	Range from 0.32 (lung physiology) to 1.19 (use of different asthma medications)
Night awakenings	2	–0.02–0.45	Caregiver report: 0.25 Child report: 0.28
Symptom frequency	6	0.10–0.82	Range from 0.26 (child report of chest tightness) to 0.71 (child report of coughing)
Urgent care visits	7	0.06–1.07 ^e	0.54
Frequency of wheezing	2	0.53–0.60	0.26 (child report) 0.31 (caregiver report)

Note. ^aOne study yielded an ES of 4.01; all other studies in this domain ranged from 0.11 to 0.70.

^bTwo studies yielded ES of 1.66 and 1.99; other three ranged from 0.53 to 0.66. ^cOne study yielded an ES of 1.85; other three studies ranged from 0.00 to 0.48. ^dSix of 7 studies analyzed in this domain ranged from 0.80 to 1.73. ^eOne study reported an ES of 1.07; others ranged from 0.06 to 0.78.

frequency ($d=0.18$), emergency department visits ($d=0.21$), hospitalizations ($d=0.13$), night awakenings (caregiver: $d=0.25$; child: $d=0.28$) and frequency of wheezing (child: $d=0.26$; caregiver: $d=0.31$). Decreased usage of urgent care visits yielded a medium effect size ($d=0.54$). Caregiver knowledge effect sizes ranged from -0.03 to 0.71 depending upon domain assessed. Child knowledge exhibited a wider range and spanned from 0.32 to 1.19 . Symptoms also varied ranging from 0.26 (child report of chest tightness) to 0.71 (child report of coughing).

Figure 1 represents the current project's effect size data plotted within the range of effect size data from published studies. The graph differs from Table 17 in two aspects. First, means of effect sizes from the current project were calculated if there were several effect sizes within a given domain (e.g., child or caregiver knowledge). Secondly, outlying effect size data from published research was removed. The specific data points removed can be viewed as notes under Table 17.

Both Figure 1 and Table 17 capture the project's effect sizes that fall within the ranges defined by upper and lower effect sizes from the literature. Emergency department visits, mean child knowledge and frequency of wheezing fall below published effect sizes. All other domains fall within ranges expected in the literature.

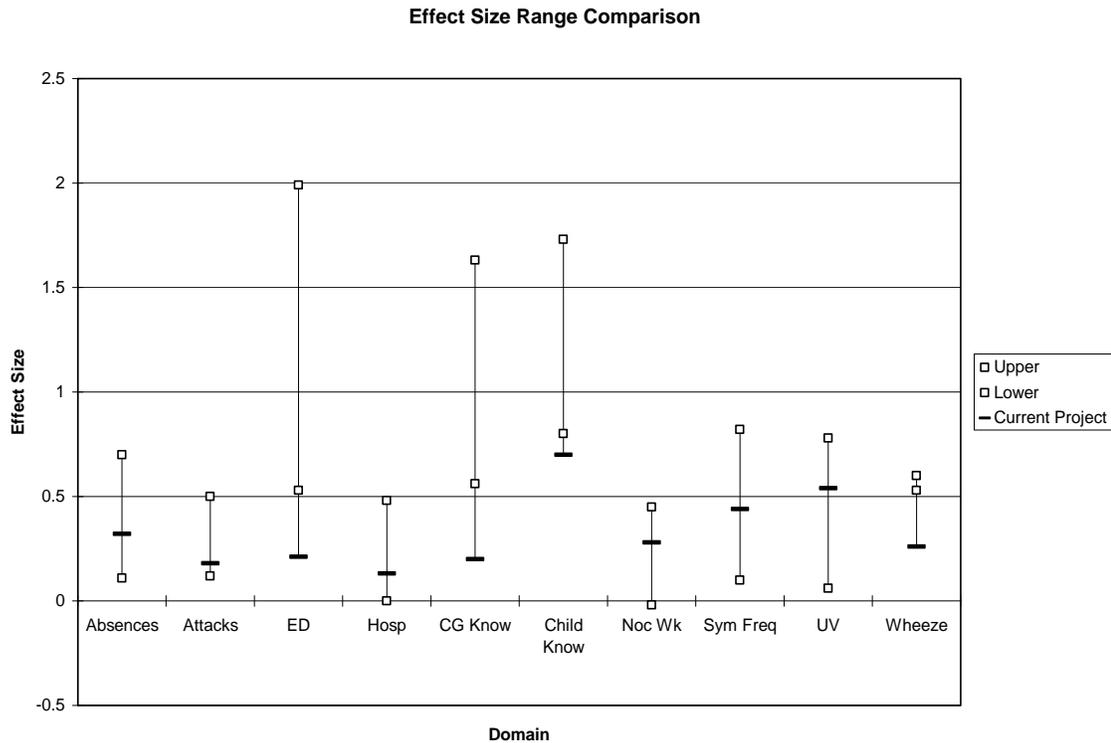


Figure 1. Comparison of Published Effect Sizes and Effect Sizes of Current Project.

DISCUSSION

This project demonstrates the feasibility of a cost-effective, school-based illness management program targeting urban children diagnosed with asthma. Treatment components included computer aided instruction, written materials for caregivers and home activities. Multimethod assessment strategies tracked changes from pre- to post-treatment on behavioral and clinical outcome variables. Of the original recruitment sample, 94% (n=30) completed the intervention.

Several individual, familial and systems factors impact asthma-related outcomes (McQuaid et al., 2007). Therefore, understanding the impact of treatment necessitates broad assessment strategies across several domains including knowledge, behavioral changes, psychosocial impact and physiological/clinical variables.

Changes in Knowledge

Acquisition of knowledge about asthma is a necessary but insufficient component of treatment programs (Evans et al., 1999; Guevara et al., 2003). In this project, children demonstrated increased asthma-related knowledge in contrast to the lack of change observed in caregivers. Failure to demonstrate change in caregiver knowledge could indicate the inadequacy of homework components to facilitate communication around asthma topics within the family. Alternatively, many caregivers demonstrated significant knowledge at baseline. Therefore, the measure may have been limited due to potential ceiling effects.

Differences between the child knowledge ESs from the current study and previous work may be explained by reviewing the papers used for ES calculations. These studies reflect the extensive range of strategies common in the asthma literature and such variability may impact the ability to compare one intervention to another. As this project primarily used computer-mediated instructional techniques, review focused upon the other treatments utilizing similar educational methods. This allowed identification of other factors that may impact acquisition of knowledge while holding the specific technique constant.

Three studies (Krishna et al., 2003; Rubin et al., 1986; Shames et al., 2004) reported use of computer-based strategies with ES ranging from 1.10 to 1.57. These three studies varied from the current project as they included parents (Krishna et al., 2003; Rubin et al., 1986), increased time in instruction (Rubin et al., 1986) or mandated visits to an asthma/allergy specialist (Shames et al., 2004). Relative to the correlation between the access to specialty health care and increased knowledge, there are stronger relationships between the former two variables and gains in asthma-related information. Therefore, while this intervention produced statistically significant increases in child knowledge, the changes may be bolstered through increased time and/or adult involvement during this treatment component.

Behavioral Changes

Simply transferring asthma-related knowledge does not impact functional morbidity (Evans et al., 1999). It is crucial to target skills acquisition of intermediate

behaviors to reduce problematic disease outcomes (Bernard-Bonnin, Stachenko, Bonin, Charette, & Rousseau, 1995). Successful asthma management requires several skills including proper utilization of inhaled medication, environmental control strategies and symptom monitoring (Weinstein, 1998). In this study, treatment adherence rates and self-reported trigger reduction strategies exhibited promising trends. However, the two factors are impacted by incomplete data sets and should be interpreted with caution.

Treatment adherence to controller medication is an especially viable behavioral target. As described in the results section, several barriers occurred to collection of treatment adherence data. The resulting eight participants who contributed information may not accurately represent the population as a whole due to their availability to provide information. Therefore, the full impact of this intervention on more behavioral targets necessitates further exploration with more precise measures before conclusions can be drawn.

Psychosocial Impact

Two psychosocial variables, quality of life (QOL) and allocation of responsibility, demonstrated changes across the duration of the treatment. QOL increased significantly across respondents and domains reflecting decreases in self-reported burden due to asthma. As QOL measures track the impact of an illness on multiple areas (e.g., physical, emotional, social), changes may result from multiple causes (Drotar, 2004).

Hypothetically, the setting of the intervention may have largely contributed to QOL increases. First, many of the children opted to complete PFR and use the computer game

at similar times as other participants in their school. Data on the impact of peer social support and asthma-related variables is lacking (Kaugars et al., 2004). However, it is possible that seeing other children with the same disease may have removed any stigma they may have felt resulting in increased QOL.

Secondly, and also related to the setting, school nurses and participants maintained frequent contact due to PFR conducted several times throughout the week. The increased time allowed nurses to track changes in asthma related symptoms and facilitated increased communication with parents. Previous research supports the relationship between improved asthma care and nurse's knowledge of a child's baseline pulmonary function (Persaud et al., 1996). Additional asthma-related assistance for children and their caregivers may decrease the perceived burden of the disease and yield increased QOL scores.

School based programs offer unique opportunities to deliver interventions that are easily accessible (Evans et al., 1990) and cost-effective (McGhan et al., 2003) especially to higher risk populations that may have limited access to health care (Evans et al., 1990). This project reflected many of the benefits of school-based programs including minimizing parental scheduling obligations. However, it also highlights the problems with limited parental contact. Of specific interest is the decreased agreement between child and caregiver ratings of child responsibility. Such disagreement has been noted previously with increased agreement found on tasks that are more likely to occur in the home (e.g., use of long-term controller medications; Wade et al., 1999). The current project exhibits parallel findings. However, the pattern demonstrating the most change,

under allocation of responsibility to the child, may reflect changes in the child's expectations of contact with an adult when asthma symptoms increase—a management strategy championed in the intervention. Due to the repetition of this message, children may have shifted perception of their personal responsibility and expected greater direction from caregivers. However, in the absence of frequent contact between researchers and caregivers, parents did not shift their perception of responsibility resulting in increased potential for inadequate asthma management. As most intervention work in this area has not measured or reported perceived responsibility for asthma-related tasks within the family, it is unclear whether this finding represents a normal shift. Descriptive research demonstrates that overestimation of child responsibility by the caregiver is correlated with increased non-adherence and resulting poor asthma-related outcomes (Walders et al., 2000). Therefore, it remains an area of concern.

Data suggests a positive correlation between parental monitoring and improved disease outcome (Ellis et al., 2007). Perceptions related to allocation of responsibility may impact parental monitoring as well as treatment adherence (Wade et al., 1999). As an example, if a parent perceived their child as primarily responsible for taking their daily medication, there is a possibility that they will not monitor the child as closely. Walders et al. (2000) advocated for development of written allocation plans that would clearly identify which family member is responsible for specific tasks. Phone calls or internet-based strategies could be designed to facilitate completion of management plans. Inclusion of such techniques would respect the many barriers caregivers report to

attendance of asthma programs while still providing information on family allocation of responsibility.

Several lines of research suggest that familial processes contribute to asthma-related outcomes (McQuaid et al., 2007). Yet, variables related to family management of asthma are rarely described in self-management program research. In this study, failing to measure family factor changes would have prevented identification of a potentially problematic trend in allocation of responsibility. This, coupled with the relative importance of family factors, speaks to the need for increased assessment of these variables.

Physiological/Clinical Variables

Without minimizing the importance of correlated variables and their reflection of disease burden, the overall goal of most asthma self-management programs is to decrease the frequency or severity of symptoms as well as associated measures of functional morbidity. Despite a small sample size, changes in several physiological and clinical variables were noted. Across respondents, decreased frequency of several pediatric asthma symptoms was reported. Urgent care visits and school absences followed similar trends. ES calculated on the frequency of symptoms and functional morbidity measures compared favorably with ES from other studies on similar variables. These changes reflect potential benefits derived from participation in the program. However, a couple of observations necessitate further exploration prior to arriving at such a conclusion.

First, decreased frequency of symptoms is not consistent with the minimal changes observed in mean PEFr. Assuming a linear relationship between the two variables, peak expiratory flow should increase in the face of improved symptom profiles. Unfortunately, the weak correlation between PEFr and subjective symptom reporting is often reported in the literature (Harver & Katkin, 1998; Kotses, Harver, & Humphries, 2006) making interpretation of results challenging. Therefore, to determine whether this intervention impacted physiological indicators of asthma, determination of which measure is likely more reflective of the clinical presentation of the participants becomes necessary.

PEFr is a simple, objective measure of pulmonary function. However, its clinical (Kotses et al., 2006; Wensley & Silverman, 2004) and research (Barnes, 2000) utility sparks considerable debate. Inconsistent correlations between PEFr and more precise measures of lung function (e.g., FEV₁) raise questions related to the validity of the procedure (Eid et al., 2000). More germane to the current project, PEFr may also fail to demonstrate improvements in the presence of decreased symptoms (Brand et al., 1999). While no one questions that PEFr measure some aspect of pulmonary function, questions surrounding its lack of sensitivity should be considered when interpreting results.

Measurement of self-reported symptoms also suffers from significant methodological problems including reliance upon recall and impaired symptom recognition. However, confidence that symptoms truly decreased is bolstered by two observations. First, symptom frequency declined regardless of respondent with both

child and caregiver reporting decreased symptoms in individual assessment sessions. While not impossible, it is less probable that this consistency would be observed if symptoms were underreported. Secondly, associated functional morbidity variables also decreased. As discussed later, other explanations for the associated decrease in urgent care visits also exist. However, taken together, these data suggest that observed decreases in symptoms occurred over the duration of the project and are likely the result of variables outside of tendencies to underreport symptoms.

Attributing the decreased frequency of asthma symptoms to treatment components is challenging due to the design of the study. Asthma symptoms are notorious for seasonal changes (Evans et al., 1999). Few studies report data identifying patterns in asthma symptoms across time. However, in one multi-site study with over 1000 participants, data tracking seasonal changes noted symptom decreases for both intervention and control groups throughout the winter and early spring months (Evans et al., 1999). This time span maps on to the current project and thus makes it difficult to detect and interpret changes that might result from the intervention itself. Therefore, the absence of a control group in this study precludes conclusive determination of the impact of the treatment on symptom changes.

Beyond symptom decreases, several measures of functional morbidity exhibited decreases. Of specific interest is the decreased frequency of urgent care visits. Explanations for this trend range from the positive to the more ominous. Decreased utilization may have resulted from decreased symptom presentation associated with seasonal fluctuations in asthma. Alternatively, decreased use of urgent care services may

be the direct result of treatment components including increased access to school nurses and frequent asthma related information. These components may decrease urgent outpatient care appointments in one of two ways. First, there may be decrease in symptoms. However, as discussed earlier, it is challenging to determine if this intervention prompted decreased symptoms. Secondly, children may be continuing to experience mild asthma exacerbations but they are able to manage them earlier and more successfully in the home. The minimal change in reported frequency of asthma exacerbations lends support to the latter hypothesis.

A third, more problematic hypothesis, is that caregivers and children raised the threshold for acknowledging existing symptoms and managed severe and/or frequent exacerbations in the home rather than appropriately accessing urgent care services. Such a finding would significantly damper recommendations of future use of this intervention. Assuming children and their caregivers demonstrated increased latency to respond to symptoms appropriately, if children suffered asthma exacerbation and did not access urgent outpatient care, elevated rates of emergency department (ED) visits and hospitalizations may be observed. Support for the intervention prompting delay of appropriate medical care is less plausible in the absence of this pattern of health care utilization.

Limitations and Strengths of the Current Project

This study has several limitations which merit attention. First, the design of the study did not include use of a control group. The addition of a no intervention control

group would allow some separation of the contribution of seasonal changes to the observed changes in the intervention group. Secondly, the present sample included few participants resulting in low statistical power. Such small sample sizes are problematic across asthma research and it is a particularly challenging problem due to the variability of the disease course both between and within participants. Attempts to minimize these limitations included placing all children in the treatment condition, tracking change in variables over time and comparing project ES to magnitudes of change reported in previously published research. However, a greater number of participants and inclusion of a control group condition would lend stronger support to findings.

Thirdly, this study relied heavily upon self-report of symptom frequency across broad spans of time. Recall over an extended time frame may decrease the precision and accuracy of information. Such measures are the standard in the literature but extensions of the research may benefit from incorporating symptom recall over smaller time increments. As an example, use of questions from brief screening measures has demonstrated adequate discrimination of asthma control (Lenoir et al., 2006; Ahmed et al., 2007). The questions primarily surround excessive inhaler use, night awakenings and school absences due to asthma (e.g., 30 Second Asthma Test). Rather than rely on extended recall, children could be asked during a daily peak flow reading whether they experienced the outcomes the day prior to meeting. While not a replacement for objective indices of lung function, tracking self-reported changes over time using more frequent self report measures may provide a more accurate measure of symptom control. In addition, as subjective perception of symptoms (e.g., coughing, wheezing) is often in

disagreement with objective measures (Rietveld et al., 1997), measuring behavioral events related to disease management may also increase precision of reporting.

While computer game usage was monitored objectively, other treatment components suffered from a lack of true treatment integrity measures primarily due to logistical barriers. This leads to questions about the amount of exposure to other elements, specifically home activities and written information, occurred in the home. Most caregivers signed their child's home activities. However, the signature did not necessarily reflect active participation by the parent. In addition, no measures were used to track whether the parents used the written information guides. Increased treatment integrity would be a valuable extension for future research with this treatment.

Finally, clinical observations of interactions surrounding peak flow readings lead to questions surrounding whether the peak flow assessments functioned solely as a dependent variable or whether the interaction assumed some treatment functions. Recall that participants were assessed multiple times per week and these assessments were often characterized by students describing their asthma symptoms and researchers questioning the students about their health. While brief, over the course of the study, the peak flow assessments could have provided additional instruction and social support for preventative and management efforts on the part of the participants. In cases where extreme changes in symptoms were noted, calls were placed to parents by school nurses to discuss their child's asthma care. While clinically necessary, these factors may have prompted a shift of the peak flow readings from a true dependent measure to a part of the

intervention. Therefore, implementing the project in a school setting without the use of peak flow readings may yield different results.

The primary strength of this study lies in its placement within the school setting. From a scientific standpoint, conducting research outside of the lab invites a host of problematic threats to internal validity. However, it also affords researchers with the ability to understand the transportability of a given intervention. This project demonstrated the feasibility of a school-based program that is cost-effective, easily accessible and successful at decreasing some problematic asthma outcomes.

Clinical Implications and Directions for Future Research

Caution should be exercised in the interpretation of the data in light of the internal validity issues outlined above. However, trends towards increased adherence, statistically significant findings on some correlated variables and high reported satisfaction with treatment promote the importance of further research with this intervention package. First and foremost, future studies should include larger sample sizes, utilize a comparison group and include appropriate measures of treatment integrity. These changes would especially facilitate interpretation of changes in symptoms. Secondly, use of objective indices of treatment adherence (e.g., prescription records, electronic meters) and more precise methods of self-report may alleviate some concerns related to measurement of change. While not often conducted in other studies, continued assessment of multiple areas of asthma management is warranted in order to understand the domains which may change as a result of the intervention.

Due to the trend in familial allocation of responsibility, incorporating increased parental involvement while respecting barriers present in high-risk populations is a crucial extension of the current work. Finally, clinical observations of benefits attained through peak flow monitoring sessions merit further exploration. Data comparing children receiving peak flow monitoring plus support versus those elements and the computer game may be especially informative as it would foster greater understanding of how to allocate asthma-related resources within a school setting.

Identification of treatments that have an empirical base and are readily available to professionals in the field is crucial to reducing problematic disease outcomes (Krutzscher et al., 1987). This project demonstrates trends toward improvements in variables correlated with asthma outcomes in a naturalistic setting. Promoting programs within the school setting offers unique benefits for those at increased risk for poor outcomes while reflecting an integrated system of care. However, the trend towards under-allocation of asthma responsibilities points to the need to find creative methods of educating the *family* about asthma—not just the child. Continuing research in this area will provide further insight into decreasing the negative impact asthma can have on a child and their family.

Appendix A
Home Activities

TV Superstar

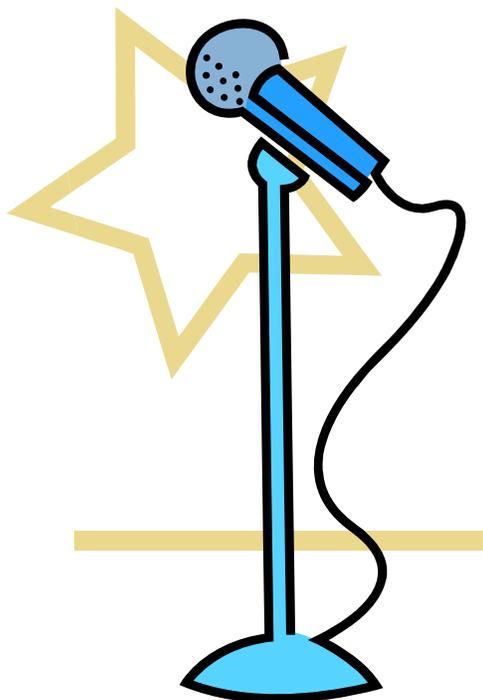
Home Activity 1

**F A C T**

Family Asthma Control Team

Congratulations! You have already learned a lot about asthma and now it is time to help those important people in your life learn, too. This is also a good time to show them how smart you are about asthma!

Remember, just do your best and we can talk about the homework when you bring it back for your next session. If you run into questions, call Dawn at (248) 340.0935 or bring it back to school and ask for some help.



TV Reporter Superstar!

Interview your adult asthma helper by asking them the following questions. Be sure you write down their answers!

1. What asthma medications do I have to take?
2. How often do I need to take them?
3. What are ways to help me remember to take medicines?
4. Who should I tell if I run out of medicine?

Next, write up a news story using your answers. For example, my news story would read something like:

“Good evening ladies and gentlemen. This is Dorky Dore reporting for TV WHEEZE. I am with Sally Super talking about asthma. I have learned that I take one medication every day and one only when I need to. The medicine that I take every day is called a controller and I will leave it by my toothbrush so I remember to take it every day. If I run out, I need to tell Sally”.

Now I know you can do better than I can. Try it out and you can show us your skills at the next meeting!

MY NEWS STORY!

Caregiver Signature: _____ Date: _____

The Early Bird

Home Activity 2



F A C T

Family Asthma Control Team

Sometimes it can be hard for our adult asthma helpers to understand when we are having problems with our asthma. Fill out the following letter and talk with your asthma helpers about your early warning signs.

Dear _____

Asthma has a lot of early warning signs. I know that I should be on alert when I have (circle the ones that fit you):

Itchy skin Watery Eyes Scratchy throat

Headache Sneezing Stomachache

Runny nose Tiredness Weakness

When I am having an asthma attack, I may wheeze and I find it hard to breathe. I learned that I should:

- ✓ Tell an adult
- ✓ Take my quick relief medicine

I will keep my quick relief (rescue) medicine in this place all of the time so I know where it is:

Love,

Caregiver Signature: _____ Date: _____

Super Sleuth

Home Activity 3



F A C T

Family Asthma Control Team

Playing Detective

You already learned about a lot of the things that can make your asthma act up. Now you get to play detective!

Talk with your adult asthma helper and look around your house. List 4 asthma triggers that you find. ***Just look for them—do not come in contact with them since they may make your asthma worse.*** Working with your adult asthma helper, come up with ways to get rid of them.

Asthma Trigger	What I Can Do About It
Example: cat hair on my bed	I can keep the cat out of my room or off my bed.
1.	
2.	
3.	
4.	

Caregiver Signature: _____ Date: _____

Feelings About Asthma

Home Activity 4

**F A C T**

Family Asthma Control Team

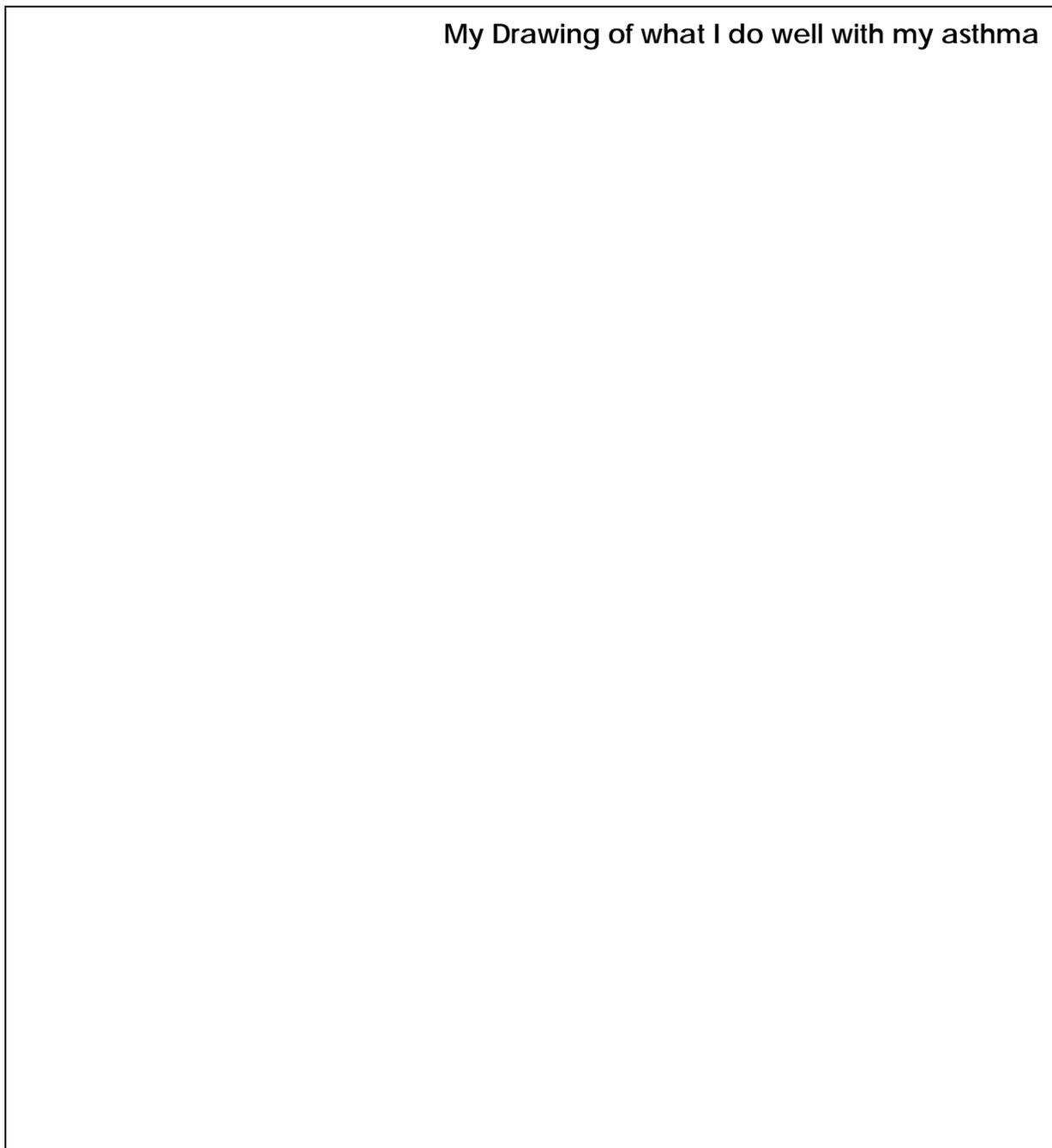
Sometimes kids with asthma get mad or sad because of their breathing problems. We want to be sure you let your asthma helpers know how you feel about having asthma.

In this activity, we want you to draw two pictures. In the first picture, show how you feel on a bad day with asthma. In the second picture, draw what you like most about yourself and how you handle your asthma.

After you are done with your drawing, show your asthma helpers the picture. Be sure to answer any questions they may have and bring your drawings with you next time you see Dawn.

My Drawing of a Bad Day with Asthma

My Drawing of what I do well with my asthma



Caregiver Signature: _____ Date: _____

Appendix B
Selected Measures

Subject Number: _____

Health History Form



Family Asthma Control Team

Health Care

1. Does your child have a regular doctor or go to the same clinic for health care? Yes
No

If yes, what is the name of the doctor or clinic?

About how long ago did you last see the doctor?

When is your next appointment?

2. Does your child have insurance? Yes
No
3. Has your child **ever** had to stay overnight or longer in a hospital because of their asthma? Yes
No

If yes, how many times? 1 2 3 4 More
 than 4

If yes, how old were they when they were last hospitalized? _____

Medications

8. Please list all of your child's medication below (include medication that is not used for asthma too).

Medication	Dosage	How often?

**Researcher: Please mark rescue inhaler (R) and controller (C)

9. How does your child take their asthma medication?
 Nebulizer Inhaler (puffer) Spacer

None of the above

10. How often do you need to refill your child's prescriptions for their rescue inhaler?

Once per month Once every couple of months

Once every 6 months Less than once every 6 months

11. Does your child have trouble remembering to take their medications? Yes No

12. Does your child bring their rescue inhaler to school? Yes No

13. Has your child been diagnosed with anything besides asthma? Yes No

14. If yes, what else?

15. Is it difficult for your family to pay for your child's asthma medications? Yes No

16. Does anyone in your home smoke? Yes
No

17. If there are smokers in the home, do they smoke in the same area that the child is in? Yes
No

18. Do people smoke in the car when your child is a passenger? Yes
No

19. Do any of the following make your child have an asthma attack or make their symptoms worse?

Infections (colds or bronchitis)	Pollen	Mold
House dust mites	Animals	Vacations
Smoke hard	Cold air	Exercise or playing
Strong odors	Crying	Laughing hard
Shouting or yelling weather	Aspirin	Changes in

20. Have you or your child ever gone to an asthma education program before?

Yes No

21. If yes, please describe the program.

Where did the program take place?

Who led the program?

What did you and your child do at the program (e.g. played a computer game; listened to lectures)?

Subject Number: _____

Demographic Form



Family Asthma Control Team

1. Child's age: _____ 2. Grade in school: _____
3. How old was your child when you were first told they had asthma?
4. Child's Ethnicity: African American Caucasian
 Hispanic American Asian American
 Native American Biracial/Mixed
 Other: _____
5. Is English the primary language in your home? Yes No
 If no, what is the primary language? _____
6. Do you work outside of the home? Yes No
 Occupation: _____
7. Are you currently receiving services through WIC or Medicaid?
 Yes No
8. Are you: Single Married Divorced
 Widowed Living with partner Other
9. Are both of the child's biological parents in the home?
 Yes No
 If no, does the child see their other parent frequently? Yes No
10. Does your child receive special education services? Yes No

11. During the last tax year, what was your family's income?

Below \$20,000

Between \$21,000-\$40,000

Between \$40,000-\$60,000

Above \$60,000

Subject Number: _____

Caregiver: Treatment Satisfaction Survey

F A C T



Family Asthma Control Team

For each of the following questions, please respond using this scale:

1 _____ 2 _____ 3 _____ 4 _____ 5 _____
 Strongly agree Agree No opinion Disagree Strongly disagree

1. The time spent on this project was worthwhile.

1 2 3 4 5

2. My expectations about this project were met.

1 2 3 4 5

3. I believe that this project helped my child manage their asthma.

1 2 3 4 5

5. I believe that this project helped me learn more about asthma.

1 2 3 4 5

6. Overall, I am glad I participated with my child in this project.

1 2 3 4 5

7. What did you like best about this project?

8. What did you like least?

9. Do you have any last questions about the project?

Subject Number: _____ T C

F A C T**Child: Treatment
Satisfaction Survey****Family Asthma Control Team**

For each of the following questions, please mark your answers.

1. I liked the time I spent on this project.

1 _____ 2 _____ 3
  

2. I learned a lot about my asthma since I started this project.

1 _____ 2 _____ 3
  

3. Overall, I am glad I joined this project.

1 _____ 2 _____ 3
  

What did you like best about this project?

What did you not like?

Do you have any last questions about the project?

Subject Number: _____

MID POST FolUp

Asthma Symptoms & Impact



Family Asthma Control Team

My Child's Asthma

1. *In the last month*, how often has your child had the following symptoms?

Symptom	Once per day (or more)	3 to 5 times per week	1 time per week	2 to 3 times per month	Once per month	Never
Coughing						
Wheezing						
Gasping for breath						
Chest tightness						
Runny nose or watery eyes						
Having a lot of mucus (phlegm, 'snot')						
Waking up in night due to asthma symptoms						
Other symptoms (please list)						

Asthma Attacks

3. *In the last month*, how often has your child had an asthma attack (severe shortness of breath, using rescue inhaler)?

None 1-2 times 3-4 times 5-6 times 7 or more

Consequences

4. *In the last month*, how many times was your child absent because of asthma? _____

5. In the *last month*, how many times did you have to miss work because of your child's asthma?

6. *In the last month*, how many times have you had to go to see the doctor at an unscheduled time due to your child's asthma?

None 1-2 times 3-4 times 5-6 times 7 or more

7. *In the last month*, how many times have you had to go to the ER because of your child's asthma?

None 1-2 times 3-4 times 5-6 times 7 or more

8. *In the last month*, how many times has your child been hospitalized due to asthma?

None 1-2 times 3-4 times

Subject Number: _____	MID	POST	FoUp
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Environmental Triggers

In the last month, have you made any changes to your home to reduce triggers for asthma?

Yes

No

No need to

If yes, what have you done?

Put mattress cover/pillow covers on child's bed

Used roach traps

Cleaned bathroom of mold

Stopped smoking around child home

Removed pet hair from

Used air filter/vacuum filter

Other: (write below)

Subject Number: _____	Mid	Post	FoUp
-----------------------	-----	------	------

F A C T

Asthma Symptoms & Impact
Child Report



Family Asthma Control Team

In the last month, how often have you felt the following symptoms?

Symptom	Once per day (or more)	3 to 5 times per week	1 time per week	2 to 3 times per month	Once per month	Never
Coughing						
Wheezing						
Gasping for breath						
Chest tightness						
Runny nose or watery eyes						
Having a lot of mucus (phlegm, 'snot')						
Waking up in night due to asthma symptoms						
Other symptoms (please list)						

Appendix C

References: Studies Used in Effect Size Analyses

School Absences

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Appendix D
Additional Figures

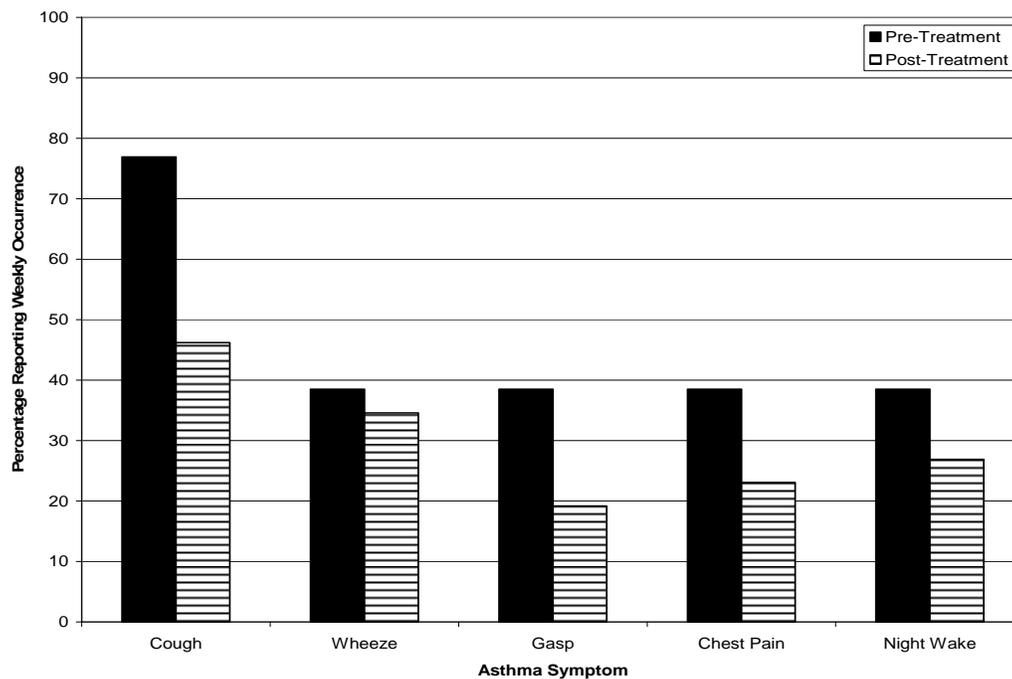


Figure D1. Child-reported monthly symptom frequency: Percent reporting weekly occurrence pre- and post-treatment.

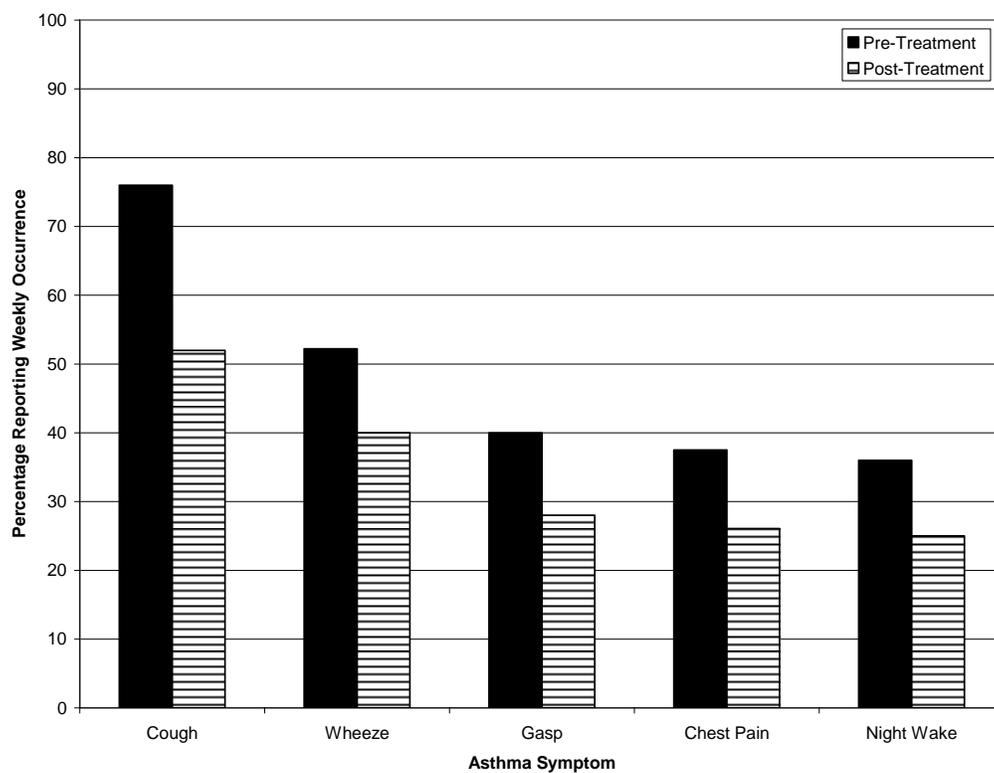


Figure D2. Caregiver-reported frequency of child monthly symptoms: Percent reporting weekly occurrence pre- and post-treatment.

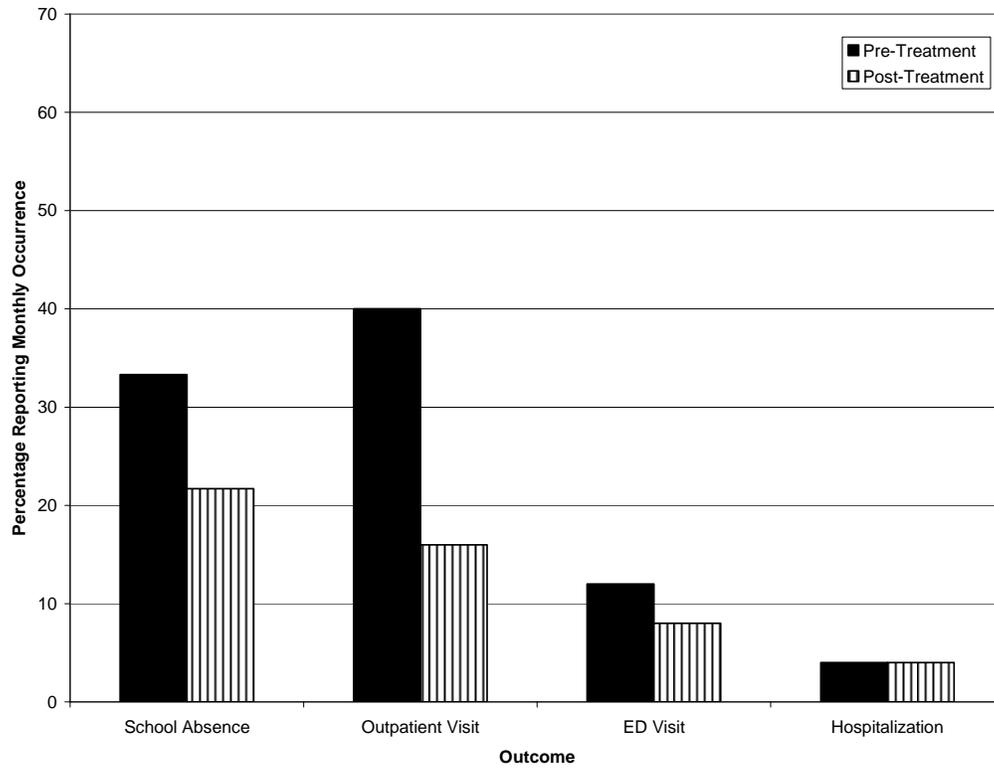


Figure D3. Functional morbidity outcomes: Percentage of respondents indicating occurrence in previous month at pre- and post-treatment.

Appendix E

Approval Letter from Human Subjects Institutional Review Board (HSIRB)

Human Subjects Institutional Review Board approval letter is on file in the Graduate College.

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