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The impact of family asthma management on biology: a longitudinal investigation of youth with asthma

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Abstract This study examined longitudinal associations of asthma management-related beliefs and behaviors with changes in asthma-relevant biological markers in a sample of 43 children with asthma. Children (M age = 12.4, 75% male) and parents were interviewed about asthma management beliefs and behaviors. Asthma outcomes included lung function (FEV_1%), eosinophil counts, and daily cortisol measured at two time points, 18 months apart. Children with a less sophisticated disease belief (termed the "no symptoms, no asthma" belief) displayed eosinophil counts that increased over time, controlling for baseline levels. Poorer family asthma management was associated with increasing eosinophil counts over time. Poorer child asthma management was associated with cortisol output that declined over time. Further, families who reported poorer collaboration with their physician had children who displayed worsening lung function over time. These findings suggest that interventions aimed at teaching families better asthma management approaches and more accurate disease beliefs may have the potential to alter biological profiles in children with asthma.

Keywords Family asthma management · Longitudinal · Biological outcomes

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Introduction

Asthma is the most common chronic illness in youth, and is a leading cause of school absenteeism and a major cause of hospitalizations in Canada (Asthma Society of Canada 2005) and the United States (Akinbami 2006; DeFrances et al. 2007), with an associated annual cost of $3.2 billion to treat youth under the age of 18 in the United States (Weiss et al. 2000). Reasons for asthma exacerbation are numerous, and include physical, environmental and psychological factors. With respect to psychosocial contributors to asthma exacerbations and symptoms, one important area of research is on the role of asthma management and beliefs. This research has shown that within the family, better asthma management and certain asthma beliefs can have an impact on childhood asthma. However, the bulk of research in this area has focused on clinical outcomes such as healthcare utilization, while the specific biological mechanisms through which asthma management and beliefs come to impact asthma outcomes have been largely neglected. Thus, the current study sought to elucidate some of the biological mechanisms through which family beliefs about and management of one's illness, are related to asthma biological outcomes over time in a sample of children with asthma. This endeavor is important for developing plausible mechanistic models of how it is that psychological factors such as beliefs can have clinical manifestations in terms of disease outcomes. In order to persuasively argue that psychological beliefs can affect the manifestation of disease, researchers need evidence that these beliefs can also affect the biological markers that contribute to the pathophysiology of that disease.

Previous research has linked both asthma management techniques and asthma-related beliefs to morbidity outcomes in children with asthma. Asthma management refers

broadly to both preventive and rescue strategies implemented by families to improve symptoms in children with asthma. For example at-home behaviors, such as washing bedsheets regularly in hot water, have been shown to be related to decreased rates of hospitalizations and emergency room (ER) visits (Lieu et al. 1997). In addition, medical management behaviors, such as having a written action plan, have been associated with fewer return emergency room (ER) visits and hospitalizations (Sockrider et al. 2006; Lieu et al. 1997). Other researchers have used extensive interviews about family asthma management, and have documented that management dimensions such as better integration of asthma into the family's daily life, a more collaborative relationship with physicians, and more timely responses to symptoms are associated with decreased asthma morbidity in children (McQuaid et al. 2005).

Finally, a number of intervention studies have found that patient education and interventions to improve in-clinic and at-home behaviors are effective both for changing physician and patient asthma management behaviors as well as improving activity limitations, peak flow readings, and the likelihood of ER visits (Shegog et al. 2006; Guendelman et al. 2002).

In addition to research on asthma management, research on asthma-related beliefs has found that beliefs are related to both management behaviors, as well as clinical outcomes (Walker et al. 2009). Much of the work in this area with families of children with asthma has documented beliefs about behavioral outcomes such as treatment adherence. For example, parental fear and overconcern about medications have been linked to poor adherence in children (Conn et al. 2005; Chan and DeBruyne 2000), and recent findings from Conn and colleagues (2007) suggest that the balance between parents' positive and negative beliefs about medication use (that is, the balance between necessity and concern beliefs regarding their child's asthma medications) impacts medication adherence in children, such that a higher rating of necessity rather than concern, predicted better adherence. Other research has examined beliefs about the chronicity of asthma, and in a sample of inner-city adults, Halm and colleagues (2006) identified an acute disease belief termed the "no symptoms, no asthma" belief. Individuals who held this belief reported that they had asthma only when symptomatic, rather than believing that asthma is a chronic illness that is always present. This belief was found to be associated with lower adherence to inhaled corticosteroids (ICS) when asymptomatic. Finally, other studies have provided support for the notion that child and parent self-efficacy beliefs as well as parental beliefs about the helpfulness of asthma management behaviors, have been linked to clinical outcomes, such as fewer symptoms among children with asthma, fewer days of wheezing, better health status, as well as fewer days of school missed (Bursch et al. 1999; Wade et al. 2000; Grus et al. 2001).

All of the above studies have focused on the links between asthma management and beliefs with clinical outcomes in asthma. However, many of them have been cross-sectional. As such, directionality (that is, whether beliefs affect asthma outcomes, or whether asthma morbidity affects beliefs) is uncertain. Further, much research has also focused on either children or parents, and has not incorporated both family members in assessing asthma management practices. Finally, very little research has explored how these beliefs and management practices might alter biological processes to explain associations with clinical outcomes.

With respect to asthma, the relevant biological processes center around inflammation. For example, immune cells such as eosinophils get recruited to the airways and activated during asthma exacerbations. Activated eosinophils in turn produce histamine and leukotrienes, leading to the symptom profile associated with asthma (airway constriction and mucus production). In contrast, the hormone cortisol is implicated in the dampening or cessation of this inflammatory response by signaling immune cells to cease inflammatory processes. Thus, in this study, we tested whether asthma beliefs and management practices could be linked to biological processes relevant to asthma, including eosinophil counts and cortisol, as well as to measures of pulmonary function.

In a preliminary cross-sectional study by our team, using a brief beliefs and management interview, we demonstrated that inflammatory profiles were linked to asthma beliefs and management behaviors in a sample of children with asthma (Walker et al. 2009). In the present study, we tested these associations more stringently by (1) using a more extensive and well-established family asthma management interview (the Family Asthma Management System Scale; FAMSS, McQuaid et al. 2005), we (2) examined whether family asthma management and beliefs could predict longitudinal changes over time in biological measures in a sample of children with asthma. Though the relationships we studied are complex and iterative, an important first step in establishing causality is to document temporal precedence of asthma management variables predicting biological changes over time. We hypothesized that children from families with poorer asthma management strategies, as well as those children who held the "no symptoms, no asthma" acute disease belief, would show increases in inflammatory profiles, decreases in cortisol output, and poorer pulmonary function over an 18 month period.

Methods

Participants

This sample consisted of 43 children with asthma between the ages of 9 and 18 years living in Vancouver, B.C., Canada. Each child participated with one parent. Families were recruited via asthma and allergy clinics, newspaper ads, school newsletters, and community flyers. Eligibility criteria included child age, physician diagnosis of asthma, no other chronic illnesses, proficiency in English, and not on any prescription medications other than asthma medications. Study visits were postponed if children were sick on the day of their scheduled appointment. Ethical approval was granted by the Behavioral Research Ethics Board of the University of British Columbia.

Measures

The Family Asthma Management System Scale

Children and parents were interviewed together about asthma management beliefs and behaviors, using the Family Asthma Management System Scale (FAMSS; McQuaid et al. 2005). This semi-structured interview consists of 8 subscales which assess different domains of family asthma management behaviors over the past 6 months. The FAMSS has been demonstrated to have excellent reliability and validity (McQuaid et al. 2005; Klinnert et al. 1997). Ratings were made based on a combination of informant reporting and behavioral observations (McQuaid et al. 2005). Each subscale was given a score from 1 to 9 by a rater, with higher ratings indicative of better management. The majority of tapes were coded independently by 2 raters (43%) or by the entire research team (44%). Intraclass correlations were computed and across all subscales, the average coefficient was .84 (range .69–.91). The FAMSS subscales included:

Asthma Knowledge. Families were asked to explain their understanding of asthma, including anatomy, symptoms, and medications. *Knowledge and Assessment of Symptoms*. Children and parents were asked to report the course of symptomatology during the child's typical asthma exacerbation, and ratings were based on knowledge of triggers, early warning signs, seasonality and course of symptoms. *Appropriateness of Family's Response to Symptoms and Exacerbations*. Families were asked to describe their course of management strategies in response to asthma exacerbation. *Appropriateness of Child's Response to Symptoms and Exacerbations.* Children were asked to describe their course of management strategies if they were not with their parents during an asthma exacerbation. *Environmental Control.* Exposure to environmental triggers of asthma was assessed, as well as any preventive strategies to reduce their child's exposure to triggers. *Adherence with Asthma Medications.* Families were asked how often their child took rescue inhalers and daily preventive medications, how often their child had medications with them when away from home, about systems for taking medications, and about difficulties with adherence. *Collaborative Relationship with Provider*. Families were asked about their relationship with their physician, including how often they saw him or her, how well they communicated, and how up to date their treatment plan was. *Balanced Integration of Asthma into Family Life*. Families reported the extent to which asthma interfered with their regular activities or routines, and their balance of attention between asthma vs. other aspects of daily life.

No symptoms, no asthma: the acute episodic disease belief

Children were asked, "do you think you have asthma all of the time, or only when you are having symptoms?" Response choices were: all of the time, most of the time, some of the time, or only when symptomatic (Halm et al. 2006). This question was developed within the Leventhal Common Sense Self-Regulation Model framework (Leventhal et al. 2003) to examine patients' underlying beliefs about asthma and its treatment (Halm et al. 2006). The least sophisticated understanding of asthma, termed the "no symptoms, no asthma" belief is considered a suboptimal belief that does not acknowledge the chronicity of asthma (Halm et al. 2006). Among children in our sample, 54.7% thought they had asthma only when they had symptoms, 27.9% thought they had asthma some of the time, 2.3% thought they had asthma most of the time, and 15.1% of respondents reported they had asthma all of the time. In accordance with Halm and colleagues (Halm et al. 2006), this variable was dichotomized into two groups: those children who thought they had asthma only when they had symptoms comprised one group (the "no symptoms, no asthma" group) with all other respondents grouped together, and considered to have a more sophisticated conceptualization of the chronicity of asthma.

Biological and clinical measures

Basal immune markers

Three cc of peripheral blood was drawn into an ethylenediaminetetraacetic acid (EDTA) tube and a complete blood count with differential (Bayer ADVIA 70 hematology system, Holiston, Massachusetts) was performed to enumerate eosinophil count. Eosinophils are implicated in the allergic response associated with asthma.

Endocrine measures

Salivary cortisol was collected for 2 days after each laboratory visit using Salivettes (Sarstedt, Nuembrecht, Germany) at 1, 4, 9 and 11 h after awakening in accordance with MacArthur Research Network of Socioeconomic Status and Health (2000) guidelines. This protocol is described in detail elsewhere (Wolf et al. 2008), but briefly, involved instructing children to chew gently on a sterile Salivette cotton swab for 1 min. Compliance was monitored using MEMS caps (MEMS 6 TrackCap Monitors, Aardex Ltd., Switzerland), which recorded the date and time when a bottle housing all Salivettes was opened. We defined compliance as being within 1 h in either direction of the predetermined collection time, and when this definition was applied, 88% of participants met our criteria. Samples were mailed back to the laboratory when completed, and Salivettes were centrifuged at 800 g for 5 min to extract saliva. Samples were frozen at −30°C until data collection was complete, and were then shipped to Dresden, Germany for analysis. Free cortisol levels in saliva were measured in duplicate using a commercially available chemiluminescence assay (IBL, Hamburg, Germany). Inter- and intra-assay variation was below 10%. Because of substantial skew, cortisol data were log transformed (Tabachnick and Fidell 2001). Daily cortisol profiles were calculated using area-under-the-curve (AUC; trapezoid formula; Pruessner et al. 2003) for each of the 2 days and then averaged.

Pulmonary function

Pulmonary function was assessed using spirometry (Vmax/Spectra, SensorMedics, Yorba Linda, California). Children were coached in-lab in appropriate blowing techniques, and 6–8 trials were done for each child to obtain a laboratory best FEV_1, according to American Thoracic Society guidelines (Miller et al. 2005). Measures were taken at least 4 h after the last use of a beta agonist. Measurements included Forced Expiratory Volume in 1 s (FEV_1), the maximal amount of air forcibly exhaled in the first second starting from full lung capacity. Percentiles were calculated by comparing this value to reference values based on child age, ethnicity, gender, height and weight. Lower FEV_1 percentiles indicated poorer pulmonary function.

Medical variables

Children were asked the number of times they had to use a beta agonist inhaler because of asthma symptoms during the last 2 weeks (beta agonist use), as well as the number of times they took inhaled corticosteroids (ICS) during the last 2 weeks (ICS use). Asthma severity was determined from the NAEPP/EPR2 guidelines based on the higher of symptom frequency and medication use, paralleling the approach of previous researchers (Bacharier et al. 2004).

Procedure

Families came to the laboratory for two visits: at baseline, and then 18 months later. The FAMSS interview was administered and health beliefs were assessed at baseline, and biological measures were administered at both visits. Families who participated in this study were first screened for eligibility, and then scheduled for an appointment at our laboratory. Consent and assent forms were signed at the laboratory. A local topical anaesthetic cream (EMLA) was applied to the antecubital area of the child's arm an hour before the blood draw. The FAMSS interview was administered and audiotaped. Medications were brought in by the parents, and prescription information was recorded. Height and weight were taken on a standard medical-grade balance beam scale. At each visit, the child's lung function was assessed via spirometry, and then a sample of the child's blood was drawn. Participants were paid an honorarium of $25 each for their time. Following both laboratory visits, children collected saliva samples (from which we measured salivary cortisol) at home 4 times per day, for 2 days.

Data analysis

For all of the child biological and clinical measures, change scores were first computed to assess the difference in these variables over the time children were involved in the study. Scores were computed by subtracting earlier values from later values (e.g. Time 1 values subtracted from Time 2 values). All analyses controlled for baseline biological variables (eosinophils, FEV_1%, and cortisol values) and child age. For cortisol analyses, ICS use in the 2 weeks prior to the visit was also added as a control variable. If participants were missing data for a specific variable, they were excluded from analyses using that variable. To test whether asthma disease beliefs were related to asthma management, we conducted one-way ANOVAs to examine differences in the "no symptoms, no asthma" groups on the FAMSS. Next, we tested whether disease beliefs were related to biological outcomes by conducting one-way ANCOVAs to examine the effect of the "no symptoms, no asthma" disease belief on change in lung function, eosinophils and cortisol over time (controlling for baseline values and child age). Finally, we tested whether family asthma management

was related to biological outcomes by conducting partial correlations in which the FAMSS dimensions were correlated with change in lung function, eosinophils and cortisol over time, again controlling for baseline values and child age.

Results

Preliminary analyses

Preliminary analyses revealed associations between age and eosinophil counts ($r = -.297$, $p < .05$), as well as between age and AUC (r's $> .319$, $p < .05$); given these associations we controlled for age in all analyses. Other potential confounders (socioeconomic status, gender, ethnicity, asthma severity, inhaled corticosteroid (ICS) use, and beta agonist use) were unrelated to biological outcomes (FEV_1, eosinophil counts, and AUC) so they were not included as covariates. Table 1 contains demographic information for the sample.

FAMSS dimensions and the "no symptoms, no asthma" disease belief

One-way ANCOVAs controlling for child age, were conducted to examine the effect of the "no symptoms, no asthma" disease belief on the eight FAMSS dimensions. Results are outlined in Table 2, along with mean ratings on each of the dimensions for both groups. The overall pattern that emerged was that those children who held the "no symptoms, no asthma" conceptualization had poorer scores on 4 of the 8 FAMSS dimensions than children with a more sophisticated belief about asthma. More specifically, those children who held the "no symptoms, no asthma" acute disease belief had poorer responses to exacerbation both when alone, and with their parents, compared to all other respondents. Further, those children who held this belief showed a trend towards a less sophisticated understanding of asthma, and were not as good at describing their typical course and overall pattern of symptoms. Effect sizes for significant findings were medium to large, as defined by Cohen (1988) with values of .2 considered small, .5 considered medium, and .8 considered large.

Table 1 Descriptive information of sample

	n	%	*M*	SD	Range
Age			12.4	2.8	9–18
Child gender - male	32	75			
Parent participating - mother	34	80			
Level of maternal education (yrs)			15.7	2.9	11–25
Categorical family income			$50,000–74,999		$5,000–$200,000 +
Child ethnicity					
Caucasian	25	59			
Asian descent	12	29			
African descent	2	4			
Latin American descent	2	4			
Native descent	2	4			
Asthma severity					
Mild intermittent	8	18			
Mild persistent	18	43			
Moderate	11	26			
Severe	6	14			
Time 1 FEV_1%			96.4	16.3	56–133
Time 2 FEV_1%			91.5	16.9	52–126
Time 1 eosinophil count (10^9 cells/L)			0.33	0.22	0–90
Time 2 eosinophil count (10^9 cells/L)			0.35	0.30	0–1.6
Time 1 AUC average			11.1	4.9	3.7–21.3
Time 2 AUC average			18.3	21.5	4.8–99.0

Asthma severity was coded as per the NAEPP/EPR2 guidelines based on the higher of symptom frequency and medication use, paralleling the approach of previous researchers (Bacharier et al. 2004). Forced Expiratory Volume in 1 s percentage (FEV_1%), the maximal amount of air forcibly exhaled in the first second starting from full lung capacity compared to a reference value. Normal range for eosinophil counts is .05–.35 $\times$ 10^9 cells/L (Nelson Textbook of Pediatrics)

Table 2 FAMSS dimensions and the "no symptoms, no asthma" disease belief

	"No symptoms, no asthma" group		All other respondents		Effect size (Cohen's d)		
	M	SE	*M*	SE		*F* (*df*)	*p*
Asthma knowledge	6.1	.37	7.1	.40	−.39	3.13 (1, 43)	.08
Knowledge and assessment of symptoms	6.1	.29	6.9	.29	−.44	3.76 (1, 38)	.06
Appropriateness of child's response to symptoms and exacerbations	4.1	.31	5.6	.31	−.79	11.49 (1, 37)	.00
Appropriateness of family's response to symptoms and exacerbations	5.8	.29	6.8	.29	−.56	5.37 (1, 38)	.03
Environmental control	3.1	.49	2.1	.53	.29	1.73 (1, 43)	.20
Adherence with asthma medications	5.1	.48	5.6	.48	−.17	0.60 (1, 38)	.44
Collaborative relationship with provider	5.3	.35	5.7	.38	−.17	0.47 (1, 43)	.50
Balanced integration of asthma into family life	5.7	.41	5.7	.41	0	0.01 (1, 38)	.92

Degrees of freedom differ because 5 children received ratings on only 3 FAMSS subscales (Asthma Knowledge, Environmental Control, and Collaborative Relationship with Provider) if they reported being asymptomatic and not having taken any medications in the previous 6 months

Asthma beliefs and management and biological outcomes

Basal immune markers. A significant effect emerged of having the "no symptoms, no asthma" disease belief on eosinophil counts over time ($F(1, 39) = 4.41$, $p < .05$). After controlling for baseline levels and child age, children with the "no symptoms, no asthma" disease belief had eosinophil counts that increased over time ($M = 0.14$) significantly more than children with a more sophisticated understanding ($M = -.06$) (see Fig. 1). In addition, Family Response to Symptoms was negatively correlated with eosinophil counts ($r = -.34$, $p = .06$), such that children from families with more proactive and prompt responses, showed a trend toward eosinophil counts decreasing over the 18 month follow-up period (see Table 3).

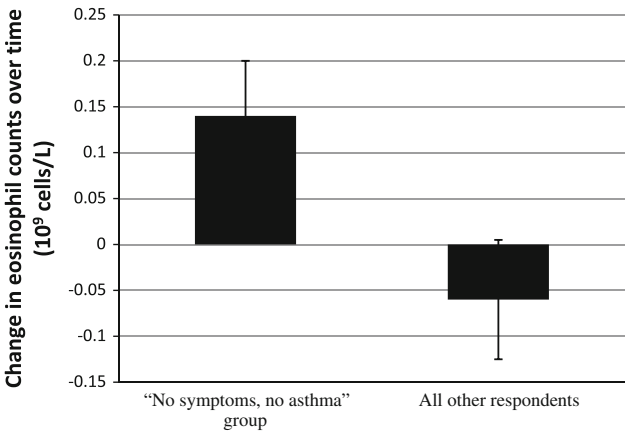

Fig. 1 Effect of disease belief on eosinophil counts. After controlling for baseline levels and child age, children with the "no symptoms, no asthma" disease belief had eosinophil counts that increased over time significantly more than children with a more sophisticated understanding

Pulmonary function. After controlling for baseline values and child age, having a collaborative relationship with one's provider was positively correlated with change scores in $FEV_1\%$ over time ($r = .36$, $p = .03$), such that those children from families who had a better working relationship with their health care provider had lung function that improved over time.

Endocrine measures. Knowledge and Assessment of Symptoms was positively correlated with change in AUC over time ($r = .48$, $p = .03$), such that children whose families were better able to identify the child's typical symptom profile, had levels of daily cortisol output which increased over time (even after controlling for baseline levels, child age, and inhaled corticosteroid use). Further, Children's Response to Symptoms were positively correlated with change in AUC over time ($r = .46$, $p = .04$), such that children with a more proactive and prompt response, had levels of daily cortisol output which increased over time.

Discussion

This study is one of the first to document longitudinal associations between family asthma management and biological processes implicated in asthma, and offers a unique focus on youth. We found that children who held a less sophisticated disease belief regarding the chronic nature of asthma (the "no symptoms, no asthma" disease belief) had poorer asthma management, in terms of poorer responses to symptoms, both when alone and with family, and a trend toward less asthma knowledge and a less sophisticated

Table 3 FAMSS dimensions and biological outcomes

	Change in eosinophils	Change in FEV1%	Change in cortisol output
Appropriateness of family's response to symptoms and exacerbations	$r = -.34$, $p = .06$	$r = .24$, $p = .14$	$r = .25$, $p = .28$
Collaborative relationship with provider	$r = -.22$, $p = .21$	$r = .36$, $p = .02$	$r = .20$, $p = .40$
Knowledge and assessment of symptoms	$r = -.03$, $p = .87$	$r = -.05$, $p = .78$	$r = .48$, $p = .03$
Appropriateness of child's response to symptoms and exacerbations	$r = -.01$, $p = .94$	$r = .07$, $p = .67$	$r = .46$, $p = .04$

description of asthma symptoms and course. Evidence of this relationship lends further support to the notion that beliefs are related to asthma management behaviors (e.g., Harris and Shearer 2001). In the present investigation we also found that more sophisticated asthma beliefs and management predicted beneficial changes over an 18 month study period in asthma-related biological profiles in children, as indicated by reduced eosinophil counts, improved lung function, and increased daily cortisol output.

In the present investigation, we found that those children who had an understanding of asthma being a chronic illness, as well as children from families who had more proactive responses to symptoms, had reduced eosinophil counts over time. This suggests that both child beliefs, as well as family response strategies, may be able to influence inflammatory profiles relevant to asthma over time. Mobilizing the entire family may be effective for administering medications appropriately and regularly monitoring asthma during times when symptoms worsen. In turn, to the extent that asthma exacerbations are managed early on, this may reduce inflammatory markers such as eosinophils over the long term. Further, previous research has found that family response to symptoms is an important mediator in the relationship between child symptom perception and asthma morbidity (McQuaid et al. 2007).

In addition, children's knowledge and assessment of symptoms, as well as response to symptoms when alone, were also found to be associated with increasing levels of daily cortisol output over time. Given cortisol's anti-inflammatory effects (Janeway et al. 2001, p. 555), it may be that higher cortisol levels over time are beneficial for reducing the chronic airway inflammation associated with asthma. In support of this notion, it has been demonstrated that nocturnal asthma symptoms are worst among children with lower cortisol levels (e.g. Szefler et al. 1991).

Finally, results also indicated that children from families with a stronger collaborative relationship with their physician, had lung function which was improving over time. By having better communication with the family physician, families may be more likely to be educated about asthma, to have a well-formulated action plan, and to be aware of the benefits of peak flow monitoring, possibly resulting in improved lung function over time. Consistent with this notion, a review of the effects of educational interventions for self-management among children found that such programs were associated with modest to moderate improvements in lung function (Guevara et al. 2003). Written action plans have also been associated with reduced acute care visits among children with asthma, reduced school absenteeism, and better symptom scores, suggesting further utility of a strong collaborative relationship with physicians (Zemek et al. 2008).

Of the eight family asthma management dimensions, four were not found to have any associations with biological variables: Asthma Knowledge, Balanced Integration of Asthma into Family Life, Adherence to Asthma Medications, and Environmental Control. It may be that general knowledge about a disease does not always translate into behaviors and actions for a specific child, thus resulting in no effects on biological profiles. Balanced integration may be more relevant to other aspects of asthma, such as quality of life, than biological markers. This notion is consistent with previous research documenting that an asthma self-management intervention was accompanied by both better balance of asthma within daily life (as indicated by fewer days of limited activity) as well as improved asthma-specific quality of life (Thoonen et al. 2003). The fact that adherence to medications was not associated with asthma biological markers may have been because the time frame of the adherence measure (6 months) was not proximal enough to the laboratory visit to detect associations with biological markers. Finally, with respect to environmental control, it may be that social desirability prevented some families from accurately reporting environmental exposures.

The study's main findings indicate that having better responses on certain dimensions of family asthma management have implications for biological processes relevant to asthma in youth. This is especially important since family asthma management is amenable to improvement with education and willingness on behalf of the family. By educating families about tangible, practical management techniques such as having and implementing an action

plan, knowing the early signs and symptoms of an exacerbation, and stressing the importance of regular and effective communication with physicians, there is potential for these strategies to have a direct impact on biology. Thus far, family asthma management interventions have been effective at promoting such strategies as the use of an action plan and improving collaboration with physicians, with resultant impact on clinical variables (fewer return ER visits and more well visits, fewer limitations in activity levels, better peak flow readings, and fewer urgent calls to the hospital; Sockrider et al. 2006; Shegog et al. 2006; Guendelman et al. 2002), yet these studies have not identified possible biological mechanisms. Elucidating these mechanisms may have treatment implications—for example, alterations in cortisol levels may suggest the need for different dosing of inhaled corticosteroids.

The primary limitation to the present investigation is the small sample size, which was due to the patient population and lengthy follow-up periods; consequently, it may be that some of our null findings were due to low statistical power. Future studies with larger samples will be important for establishing the robustness of these findings. Also, there was a wide age range in this study, and although child age was controlled in all analyses, future research with larger samples should incorporate a developmental focus to discern the age at which family asthma management becomes more the responsibility of youth rather than parents, and whether this has implications for biology. A primary strength of the study is its longitudinal design, being that we were able to monitor changes in biological variables over time, helping us discern directionality between asthma management strategies and biology. Our study also used a well-validated and comprehensive interview taking into consideration both parent and child contributions to the family asthma management effort. We were able to discern which asthma domains were more specifically linked to biology, and we quantified asthma biology over time from a number of complimentary measures, including an immune measure (eosinophil count), a lung function measure (FEV_1), and an anti-inflammatory hormonal measure (cortisol).

Overall, this study is a unique longitudinal attempt to identify links between biology and different domains of family asthma management in a sample of youth with asthma. Results indicate that an acute episodic disease belief among children is related to several behavioral and knowledge-based components of family asthma management, and that poorer ratings on several categories of family asthma management predict worse biological profiles in children with asthma over time. What this implies, is that beliefs and behaviors may have a resultant impact on biology in youth with asthma; consequently, this area is rife with potential for developing new interventions in an effort to improve symptoms and disease course in this patient population. Given the substantial prevalence of asthma in Canada (13% of all children; Garner and Kohen 2008) and the United States (9.1% Akinbami et al. 2009) identifying contributors to worse biological outcomes is essential, especially within the context of such potentially modifiable factors as family asthma management, with ample opportunity for intervention.

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