Reliability and Validity of the Asthma Trigger Inventory Applied to a Pediatric Population

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Objective To test the reliability and validity of the Asthma Trigger Inventory (ATI) applied to a pediatric population. **Method** Children with asthma ($N = 272$, 56% male, age 7–17) and their primary caregivers answered together an asthma trigger inventory, ATI (Ritz, Steptoe, Bobb, Harris, & Edwards, 2006) developed for adults. Cronbach's α, principal component analysis (PCA), hierarchical regression, and correlations of the ATI subscales with skin prick tests, psychological questionnaires, and disease severity were used to assess the psychometric properties of the ATI. **Results** The ATI subscales demonstrated excellent reliability regardless of gender, race, socioeconomic status (SES), or age. PCA confirmed and replicated the theoretical structure of the ATI. Hierarchical multiple regressions illuminated the association of ATI subscales with demographics and asthma history. Evidence in support of construct validity was found in associations between ratings of triggering and disease severity and asthma-related quality of life (PAQLQ). Criterion validity for allergy triggering was partially supported by correlations between ATI animal allergens subscale and the cat dander skin prick test, and construct validity for emotional triggering by associations between the emotional trigger subscale score and the anxiety (STAIC) and depression (CDI, CDI-P, CDRS-R, and CBCL-I) scores. **Conclusion** The ATI holds promise as a reliable, valid, and useful clinical and research tool to assess the type and degree of asthma triggering in a pediatric population (age 7–17) of varied gender, race, and SES.

Key words emotions; pediatric asthma; stress; trigger.

A variety of triggers stimulate airway obstruction in bronchial asthma. Among the most frequent triggers are allergens, infections, cold air, physical activity, or air pollution (National Heart, Lung and Blood Institute, NHLBI, 2003). Identification of triggers that evoke asthma in an individual child is central to the diagnosis and management of their disease. Nonetheless, little attention has been paid to developing a systematic method for identifying types of triggers, and for quantifying the actual extent of trigger-proneness in asthma. To date there has been no comprehensive and psychometrically validated measure of perceived asthma triggers for children. The Family Asthma Management System Scale (FAMSS) assesses asthma triggers in the context of symptom assessment and management, and thus has the advantage of assessing triggers as part of a comprehensive evaluation of child and family management of asthma (McQuaid, Walders, Kopel, Fritz, & Klinnert, 2005). However, it is not designed to provide a quantitative index of trigger-proneness for different types of triggers in order to systematically evaluate asthma triggering for clinical or research purposes.

Recently, robust evidence has accrued which suggests that psychological factors and emotions impact on disease severity in children with asthma (McQuaid, Kopel, & Nassau, 2001; Waxmonsky et al., 2006), and clinical observation indicates that children with asthma do report that emotions and stress trigger their asthma. Nonetheless, these reports are either anecdotal, or assessed by clinical interviews or rating scales of

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unknown reliability and validity which do not allow objective measurement of the effect of emotional triggering (Purcell, 1973). This important domain of pediatric asthma is under-researched, and furthermore is not systematically assessed clinically.

Ritz and colleagues developed for adults the Asthma Trigger Inventory (ATI) which is a self- report assessment of the major categories of asthma triggers including emotional or psychological triggers. The ATI consists of 32 items comprising six trigger-type subscales: (a) emotions (e.g., angry, feeling alone, home stress, tense, depressed, worried, unhappy, arguments, excited, weak), (b) animal allergens, (c) pollen, (d) physical activity, (e) air pollution/irritants, and (f) infections. Patients rate on a 5-point scale (0 = never, 1 = rarely, 2 = sometimes, 3 = most of the time, 4 = always) how often, in general, their personal experience of a particular trigger is related to their asthma symptoms. (Ritz, Steptoe, Bobb, & Edwards, 2001; Ritz, Steptoe, Bobb, Harris, & Edwards, 2006).

The purpose of this article is to report on the reliability and validity of the ATI applied to pediatric asthma and to examine whether the psychometrics are comparable for males and females, and for African American, Caucasian, and Hispanic samples. Special attention was paid to the validity of the assessment of emotional/psychological triggers because despite evidence that stress and emotions may influence pediatric asthma, emotional triggering is understudied as a phenomenon in pediatric asthma.

Reliability of the ATI in a pediatric population was assessed by inter-item and item–total correlations and internal consistencies (Cronbach's αs) of the subscale scores. Possible differences in reliability based on gender, race, and socioeconomic status (SES) were explored. A principal component analysis (PCA) was conducted to test the factor structure of the proposed subscales. Based on Ritz' findings with an adult asthmatic population (Ritz et al., 2006), we constructed and tested the following hypotheses to assess the reliability of the ATI for a pediatric sample:

(a) Inter-item and item–total correlations of the ATI are acceptable with internal consistencies >70;
(b) The PCA factor solution of the ATI corroborates the subscale component structure.

There were no specific theoretically or empirically based predictions regarding gender, race, or socioeconomic status (SES), nor age of disease onset because of lack of previous research on these demographics as they apply to asthma triggering.

Validity assessment included criterion and construct validity approaches. Asthma disease severity and quality of life are determined by several factors. Nonetheless, they are believed to be also influenced by the number and intensity of exposure and response to asthma triggers. Therefore it was reasoned that an association between the asthma trigger scores and disease severity and quality of life would support the inference of construct validity for the ATI, whereas a lack of association would disconfirm validity.

Criterion validity of the ATI allergy subscales was tested by evaluating associations between self-report of triggers and results of skin prick tests. Assessment of construct validity of the ATI emotions subscale was based on theoretical predictions derived from an empirically supported model of the influence of emotions on asthma (Miller, 1987; Miller & Wood, 1994, 1997, 2003; Waxmonsky et al., 2006; Wood, Klebba, & Miller, 2000; Wood et al., 2006a). This model predicts that emotion dysregulation (anxiety and depression) will be associated with emotional triggering of asthma.

To assess validity of the ATI in a pediatric sample the following hypotheses were tested:

(c) ATI subscale scores are correlated with disease activity and quality of life;
(d) ATI allergy trigger subscale scores are correlated with skin prick results;
(e) ATI emotional/psychological trigger scores are correlated with emotion dysregulation (i.e., depressive and anxious symptoms).

Methods

Subjects

Children and their families ($N = 272$, 56% male) were serially recruited from patients coming to a pediatric Emergency Department (ED) between the dates of June 2001 to March 2005 for treatment of asthma symptoms. There is only one pediatric ED in the city, therefore it was possible to sample from a wide range of asthma severity, SES, and race. Inclusion criteria: (a) patient age 7–17, (b) diagnosis of asthma, (c) at least one adult caregiver. Exclusion criteria: (a) patients actively treated for comorbid chronic medical conditions other than allergies, (b) patients living in residential facilities.

The recruiter attempted face-to-face or telephone contact with all parents of pediatric patients presenting to the ED for asthma symptoms. Consent of the custodial parent was obtained to answer a demographic questionnaire in order to determine eligibility for the study

and to collect information that would allow comparison of contacted patients versus completers of the study. Of the patients and families who were contacted, 59% ($n = 384$) were enrolled in the study. Of those who did not enroll, 32% ($n = 89$) were not eligible and 68% ($n = 188$) refused. Seventy-one percent of the enrolled patients completed the study. The contacted versus enrolled and completed subjects were highly similar with respect to age (mean 11.4, *SD* 2.9 vs. mean 11.5, *SD* 2.9), gender (58% vs. 56% male), race (52% vs. 60% AA, 30% vs. 21% CA, 18% vs. 19% other), and Medicaid status (18% vs. 18% Medicaid). According to NHLBI criteria for asthma disease severity (NHLBI, 2003), the final sample was characterized as: 16% mild intermittent, 18% mild persistent, 37% moderate persistent, and 29% severe persistent.

This study is part of a larger investigation of the pathways of effects of family and psychological factors on pediatric asthma. See Wood et al. (2006b) for details.

Measures

The *Asthma Trigger Inventory (ATI)* (Ritz et al., 2001, 2006) described above was used to assess category and degree of triggers for the child's asthma.

The *State–Trait Anxiety Inventory for Children (STAIC)* is a 40-item child self-report measure with established reliability and validity (Spielberger, 1973). Half the items measure ''state anxiety'' (''how you feel right now'') and the other half measure ''trait anxiety'' (''how you generally feel''). The trait subscale was used in this study (α coefficient .78 for males and .81 for females) (Walker & Kaufman, 1984). The α coefficient for this study was .86.

The *Children's Depression Inventory (CDI)* (Kovacs, 1985) is a child self-report of depressive symptoms with moderate to high internal consistency and test–retest reliability and established validity (Saylor, Finch, Jr., Spirito, & Bennett, 1984; Smucker, Craighead, Craighead, & Green, 1986; Twenge & Nolen-Hoeksema, 2002). The α coefficient for this study was .86.

The *Children's Depression Inventory-Parent (CDI-P)* (Garber, 1984) was included as a parent report of child symptoms in order to provide convergent validity of the child's report. The CDI-P is derived directly from the CDI and is scored identically to the CDI. It has high test–retest reliability (.75), internal consistency (.74), content validity, and is well correlated with the CDI score in nonclinical samples (Wierzbicki, 1987). In this sample, the α coefficient was .88, similar to published results (.85).

The *Children's Depression Rating Scale-Revised (CDRS-R)* (Poznanski & Mokros, 1995), a clinician-guided measure of depressive symptoms, served as an added validity check for the CDI. The CDRS-R has demonstrated test–retest reliability (.80), internal consistency (α coefficient .85), and inter-rater reliability (.86) (Poznanski et al., 1984). It is sociodemographically validated for age, sex, ethnicity, and SES (Poznanski & Mokros, 1995). Children under the age of 12 were interviewed with their parent. Adolescents were interviewed separately to maximize the likelihood of accurate self-reporting. When symptom reports were discrepant between reporters, the clinician used both scores to compute a final composite score with greater weight given to the reporter deemed more valid by the clinician. The α coefficient for this study was .84.

The *Child Behavior Checklist (CBCL)* (Achenbach, 1991) is a 138-item questionnaire completed by parents to assess child global functioning, which is composed of internalizing and externalizing subscales. This scale has been widely used in studies of child psychopathology and has extensive reliability and validity support (Sattler, 2001). The internalizing scale was used in this study as an additional validity check for child depression. The α coefficient for this study was .84.

The *Pediatric Asthma Quality of Life Questionnaire (PAQLQ)* (Juniper, Guyatt, Willan, & Griffith, 1994) is a 23-item questionnaire that measures the physical, emotional, and social impairments experienced by children (7–17 years old) with asthma. The PAQLQ has been widely tested and is a reliable and valid instrument. It has been validated against spirometry, weekly peak flow rates, medication use, diary of symptoms, school absenteeism, clinical evaluations of asthma symptoms (Juniper et al., 1996), and against number of school absences and health care use (Okelo et al., 2004), with psychometric support for both Caucasian and African American children (Mishoe et al., 1998). The α coefficient for this study was .92.

The *Skin Prick Test* uses a panel of seasonal and perennial allergen extracts. The Dermapik (Greer Laboratories) testing kit was used, and solutions were obtained from Center Labs as a concentrated allergen aqueous solution (1:20 w/v). Histamine was used as a positive control, and saline as a negative control. The scoring for a skin prick test is 0, 1, or 2 (0 for $\geqslant$normal saline (NS); 1 for $>$NS $<$histamine; and 2 for $\leqslant$histamine).

Pulmonary function test: FEV_1 (Forced Expiration Volume in 1 s) was measured using a portable spirometer (Nelcor Puritan Spirometer Renaissance #220) that meets American Thoracic Society (ATS) performance standards

and computes values standardized for gender, weight, and race. The software on this spirometer computes flow volume loops, and based on a validated algorithm rejects blows that are ''not good'' (i.e., not valid blows). The best of two ''good'' blows were used in the data analyses. A trained laboratory technician conducted the spirometric maneuvers in the manner outlined in the recent ATS position paper on spirometry (ATS, 1994).

The *NHLBI criteria for disease severity* was used to establish diagnosis and characterize level of disease (NHLBI, 2003). The disease severity rating is based upon a configuration of objective measures of pulmonary function (FEV_1) (average of three measures, ~1 week apart, with medication withheld) along with frequency of daytime and nighttime symptoms. Disease severity was rated by the research nurse T.S. and asthma specialist M.B. with independent assignment (blind) by a Masters Degree level health clinician (81% perfect agreement; 91% agreement within one step). All discrepancies were reconciled, and consensus scores were used in analyses.

Procedure

This study was approved by the IRB of the children's hospital, and consent (parents) and assent (children) were obtained. The ATI was administered by the research nurse T.S. during a clinical assessment of the child's asthma, which included pulmonary function test (FEV_1) and allergy testing. The (ATI) questions were read to the child/adolescent and parent together in order to avoid literacy problems, and they were asked to decide on the answer together in order to maximize accuracy. If the child/adolescent and parent disagreed as to the answer, the interviewer made her best judgment as to which answer was the most accurate. The disagreement rate was extremely low, <2%. Next, a clinical assessment of asthma and skin prick allergy tests was conducted. On the second week, pulmonary function (FEV_1) was assessed, followed on the third week by the STAIC, CDI, CDI-P, CBCL, and PAQLQ questionnaires, and the CDRS-R interview.

Data Analyses

Cronbach's α tested the reliability of ATI subscales. PCA with orthogonal Varimax rotation was used to assess the factor structure of asthma trigger subscales. Hierarchical multiple regressions were used to analyze the associations of ATI subscales with demographics and asthma history. Pearson and Spearman correlation analyses tested associations between ATI subscales and the skin prick allergy tests, the psychological variables, disease severity, and quality of life.

Results

Reliability of the ATI in a Pediatric Population

Table I presents means, standard deviations, correlations, and internal consistencies of the trigger subscales for our pediatric sample. The internal consistencies were generally high, and the pattern of strength of internal consistency by scale type was similar to Ritz's findings with an adult sample (Ritz et al., 2006). ATI subscale inter-correlations ranged from .22 to .60 (Table II).

Factor Analysis

Results of the PCA were similar to those reported by Ritz (Ritz et al., 2001, 2006) using the ATI in an adult population. PCA with orthogonal Varimax solution explained 59.2% of the total variance (Ritz: 54.1%), with the following identified factors: emotional factors contributing to 16.5% of total variance (Ritz: 15.1%); air pollution/irritants 10.7% (Ritz: 11.2%); pollen allergens 9.8% (Ritz: 6.5%); physical activity 8.2% (Ritz: 8.3%); infection 7.2% (Ritz: 5.4%); animal allergens 6.8% (Ritz: 7.7%). All items which were intended to assess a

Table I. Psychometric Properties of the ATI Subscales: Item Means, Inter-Item Correlations, Item–Total Correlations, and Internal Consistencies ($n = 272$)

Trigger subscale	Number of items	$mean_i \pm SD$	r_{ii} (mean)	r_{it} (range)	α
Emotions	10	0.76 ± 0.77	.46	.47–75	.89
Animal allergens	3	1.38 ± 1.27	.59	.59–71	.81
Pollen allergens	3	1.76 ± 1.33	.75	.80–81	.90
Physical activity	5	2.01 ± 0.86	.36	.39–67	.73
Air pollution/ irritants	6	1.48 ± 0.97	.42	.39–70	.81
Infection	4	2.33 ± 1.04	.39	.38–57	.72

M_i, item mean; SD_i, item standard deviation; r_{ii}, item inter-correlation; r_{it}, item–total correlation; α, Cronbach's α.

Table II. Bivariate Inter-correlations (Spearman's ρ) of ATI Subscales ($N = 267$)

	1	2	3	4	5	6
1. Emotions		.31***	.30***	.50***	.60***	.31***
2. Animal allergens			.54***	.23***	.51***	.35***
3. Pollen allergens				.22***	.48***	.34***
4. Physical activity					.42***	.27***
5. Air pollution/irritants						.40***
6. Infection						

***$p < .001$.

particular trigger subscale loaded on the corresponding subscale with factor loadings of >.40.

Association between ATI Subscales, Demographics, and Asthma History

Females reported more physical activity, air pollution/irritants and infection triggering than did males. Non-Caucasian patients were more likely to report physical activity and air pollution/irritants than Caucasian patients. Patients with earlier onset of asthma were more likely to report animal and pollen allergens as asthma triggers (Table III). It is noteworthy that there were no differences in the ATI emotions subscale scores based on SES (mother's education), race, age at time of study, and age of asthma onset. However, there were small, but significant, differences found between male and female patients for ATI emotions subscale scores ($M = 6.75$, $SD = 7.39$ for males; $M = 8.66$, $SD = 7.88$ for females), $t(267) = -2.04$, $p < .05$. Internal consistencies of ATI emotions subscale items were similar across gender, racial group, SES (mother's education), and age (Table IV).

Table III. Associations between ATI Subscales and Demographics and Asthma History ($N = 244$)

Significant for ATI subscale[a]	Predictor	Frequency or mean ± *SD*	*t*[b]	β	*p*
Pollen allergens	Age at asthma onset years	3.9 ± 3.84	−2.23	−.14	.03
Animal allergens	Age at asthma onset years	3.9 ± 3.84	−2.78	−.18	.01
Physical activity	Gender, female	44%	3.91	.24	.00
	Ethnic origin, non-Caucasian	81%	2.65	.16	.01
Air pollution/ irritants	Gender, female	44%	2.14	.14	.03
	Ethnic origin, non-Caucasian	81%	1.99	.13	.05
Infection	Gender, female	44%	3.51	.22	.00

Results from hierarchical multiple linear regressions analyses with individual ATI subscales as dependent variable and predictors gender, ethnic origin, education level of mother, and age in step 1, and age at asthma onset in step 2.

[a]Significant ($p < .05$) predictors are reported from equations with individual ATI subscales as dependent variables.

[b]*t*-test results for beta weights.

Validity of the ATI in a Pediatric Population

All subscales, including the ATI emotions subscale, were correlated with disease severity. ATI emotions, physical activity, and air pollution subscales were predictive of poor asthma-related quality of life ($r = -.41$, $p < .001$; $r = -.44$, $p < .001$; and $r = -.30$, $p < .001$, respectively) (Table V).

Significant correlations were found between the ATI animal allergens subscale and the cat dander skin prick test ($r_s = .23$, $p < .01$). Cat dander and animal hair trigger items in the ATI were also both correlated with the cat dander skin prick test ($r_s = .18$, $p < .05$ and $r_s = .23$, $p < .01$, respectively). No significant correlation was found between animal allergens on the ATI and the skin prick test for dog dander, and no significant correlation was found between pollen allergens on the ATI and pollen allergens in the skin prick test.

Table VI presents the descriptive statistics of the psychological measures. The mean depression score (CDI) was 8.15 ($SD = 6.78$), which is comparable to scores in the general population (Twenge & Nolen-Hoeksema, 2002). About 5% scored above a conservative clinical cutoff (raw score of 12) for the CDI, 6% for the CDRS-R, and 21% for CBCL-I scores (which was likely elevated due to maternal depression (Waxmonsky et al., 2006). The mean anxiety score *(STAIC-T)* was *34.60* (SD = 7.*34)* which is comparable to scores for children with cancer, other chronic illnesses, and healthy controls (Phipps & Steele, 2002).

Table IV. Internal Consistencies (Cronbach's α) of ATI Subscales within Gender, Racial Group, SES (Mother's Education), and Age

	Gender		Race			Socioeconomic status		Age	
Asthma Trigger Inventory subscale	Male $N = 153$	Female $N = 119$	African American $N = 162$	Caucasian $N = 57$	Hispanic $N = 39$	High school or below $N = 92$	Some college or above $N = 179$	7–12 $N = 178$	13–18 $N = 94$
Emotions	.90	.88	.87	.93	.90	.88	.91	.88	.90
Animal allergens	.79	.83	.81	.75	.80	.80	.83	.81	.82
Pollen allergens	.88	.92	.91	.91	.85	.91	.89	.89	.91
Physical activity	.75	.64	.67	.83	.66	.66	.79	.72	.74
Air Pollution/irritants	.85	.74	.77	.88	.78	.74	.87	.82	.78
Infection	.69	.71	.70	.75	.72	.67	.75	.74	.65

Table V. Pearson's Correlation Coefficients between ATI Subscales and Psychological Variables, Disease Severity, and Asthma-Related Quality of Life

	Asthma Trigger Inventory subscale					
	Emotions	Animal Allergens	Pollen Allergens	Physical Activity	Air Pollution/Irritants	Infection
CDI	30^{***}	.06	−.02	$.16^{**}$	$.12^{*}$	.10
STAIC-trait	$.20^{**}$	.02	−.02	$.23^{***}$	$.22^{***}$	.09
CDI-P	$.35^{***}$	$.14^{*}$	−.05	.08	.11	.02
CDRS-R	$.42^{***}$	.11	−.01	$.23^{**}$	$.16^{*}$	.12
CBCL-I	$.25^{***}$	$.18^{**}$	.07	$.17^{*}$	.11	.06
Disease severity	$.23^{***}$	$.18^{**}$	$.12^{*}$	$.30^{***}$	$.30^{***}$	$.18^{**}$
PAQLQ	$-.41^{***}$	$-.16^{*}$	−.15	$-.44^{***}$	$-.30^{***}$	$-.16^{*}$

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table VI. Psychological Variable Means and Standard Deviations

Variable	Mean	*SD*	Range
Child Depression Inventory (CDI)	8.15	6.78	32
State–Trait Anxiety Inventory for Children (STAIC-trait)	34.60	7.34	35
CDI Parent about Patient (CDI-P)	7.41	6.75	37
Children's Depression Rating Scale – Revised (CDRS-R)	31.88	9.38	45
CBCL *T* score Internalizing Problems	56.72	10.93	60
Pediatric Asthma Quality of Life Questionnaire (PAQLQ)	101.38	28.94	123
Disease severity	2.79	1.03	3

The CDI scores correlated ($r = .30$, $p < .001$) with emotional triggering, and more modestly with the physical activity and air pollution triggers ($r = .16$, $p < .01$ and $r = .12$, $p < .05$, respectively). The CDI was *not* significantly correlated with animal or pollen allergens or infection. These child self-report findings were further corroborated by parent and clinician reports of depressive and internalizing symptoms in the child. Parent report of child depressive symptoms (CDI-P) was correlated with emotional triggering ($r = .35$, $p < .001$) as was parent report of internalizing symptoms (CBCL-I; $r = .25$, $p < .001$). Clinician interview and rating of depressive symptoms based on the structured CDRS-R correlated robustly with emotional triggering ($r = .42$, $p < .001$). Self-report of anxious symptoms were correlated with the emotional triggers ($r = .20$, $p < .01$), physical activity ($r = .23$, $p < .001$), and air pollution ($r = .22$, $p < .001$) (Table V).

Discussion

The results of this study support the reliability, validity and age, race, and gender comparability of the ATI in a pediatric asthma population. The findings were highly comparable to Ritz's findings with adult asthmatic patients, thus providing convergent support for the reliability, validity, and generalizability of the instrument.

Evidence in support of construct validity of the whole ATI was demonstrated by associations between the ATI subscale scores and disease severity and asthma-related quality of life. Criterion validity was supported for the animal allergy subscale by associations between the animal allergy subscale and the cat dander skin prick test. The criterion validity of ATI pollen allergy subscale was not supported. This was also true for Ritz's adult sample, and is consistent with other research on patients' predictions of skin test responses (Ritz et al., 2006). It may be more difficult for children and adults to identify exposure to pollen than to animals. Alternatively seasonal changes in pollen exposure might have obscured observations and self-report. This lack of correspondence suggests the importance of including skin prick allergy tests as a complement to self-report assessments of pollen triggers.

The finding that females reported more physical activity, air pollution/irritants, and infection triggering than males suggests that gender may play an important role in environmental exposure or in mechanisms by which such triggers affect asthma. Differences in male and female life style or in physiology may cause differential susceptibility to the effects of these triggers on airway function. Alternatively, or in addition, males may be inclined to disattend to, or not notice, symptoms due to physical activity if they are highly motivated to participate in sports. Furthermore, they may not be as attentive to symptoms in general, thus failing to perceive an association between pollution/irritants and infections and asthma symptoms whereas animal allergies may be relatively easy for both genders to notice. The finding that non-Caucasian patients were more likely to report physical activity and air pollution/irritants than Caucasian patients also suggests the importance of examining ethnic

differences in life style or environment in order to understand these differential effects. The association between earlier onset of asthma and self-report of animal and pollen allergic triggers may be simply due to early onset of asthma being characterized by high susceptibility to allergens, whereas exposure to all the other triggering factors (pollution/irritants, infections, physical activity, and emotional distress) might be more similar across developmental stages. Such possibilities are certainly not exhaustive, and further investigation is clearly indicated in order to replicate and further explicate these observations.

The findings for the emotional/psychological trigger subscale are of particular importance because there are no ''lab'' tests for such triggers as there are for pollens, irritants, and exercise. Ritz's psychometric study of this instrument included a laboratory-based standardized emotion induction procedure (emotional movie clips), with pulmonary testing before and after to validate patients' self-reports of emotionally triggered wheezing (Ritz et al., 2006). In the present study, we assessed validity by testing for associations between emotion dysregulation (i.e., depression and anxiety) and emotional triggering. Both depression and anxiety were associated with self-report of emotional triggering. Depression and anxiety were also modestly correlated with physical activity and pollution triggers, but not with allergen or infection triggers. It would not be theoretically predicted that depression and anxiety would be associated with allergen and infection triggering, nor with physical activity and pollution triggering. Further research is required in order to clarify the nature of the associations observed between depression, anxiety and physical activity, and pollution triggering.

It is important to consider whether the observed associations between CDI, STAIC, and ATI emotional triggering, disease severity, and asthma-related quality of life could be due to reporting bias, as it has been shown that depressed and anxious individuals report more concerns related to their physical illness, regardless of corroborative objective indices of illness. We do not believe that this is the explanation for our findings for the following reasons. First, the ATI trigger inventory was completed in interview format with both the patient and a parent, thus minimizing the effect of the child's depression or anxiety as a reporting bias. Second, the CDI-P, CDRS-R, and CBCL-I yielded similar patterns of associations, and these indices were from parent report and clinician interview. Third, the CDI and CDRS were more strongly associated with the ATI emotional trigger scale than the others. A depression/anxiety-based reporting bias would be expected to show itself across trigger scales. Therefore, because of the multi-informant nature of the depression assessment, it is reasonable to infer that depressive emotion dysregulation is associated with emotional triggering, thus providing evidence for validity for the ATI emotions subscale. Furthermore, disease severity was determined by objective pulmonary measures (spirometry) and by an asthma evaluation conducted by medical personnel not involved in collecting the other data. The ATI emotional triggering scores were associated with disease severity (objective and multi-informant), which is a further evidence for the clinical validity and utility of the ATI emotional trigger scale.

It is noteworthy that depressive symptoms appeared to be associated more strongly with emotional triggering, than with other triggers, whereas anxiety was associated modestly and about equally with emotional triggering and with exercise and air pollution/irritants. This differentiation of relationships between depressive and anxious symptoms suggests the possibility of distinct mechanisms by which different emotions may render a child vulnerable to various triggers. (See Wood et al., 2006a, for review and further discussion.) Alternatively, anxious children may attribute triggers more broadly to vague aspects of the environment.

Strengths and Limitations of this Study

The broad socioeconomic, cultural, and racial base of the subject pool for this study is a strength because it allowed comparison of the psychometric properties of the ATI across gender, race, and age. One limitation is the relatively modest sample size, particularly in the Caucasian and Hispanic groups, which precluded systematic evaluation of validity of each subscale by race, gender, and SES.

Another strength is the multiple informant design which provided for self plus parent consensus report for asthma triggering; self-report, parent report, and clinician assessment of depression; and objective plus medical clinician assessment of asthma disease severity. A limitation is the lack of true criterion validity measures for the emotional triggering subscale. A study is currently in progress in our laboratory in which emotional movie stimulation and family interaction stimulation are used to evoke emotional distress to test whether stress and emotions can directly trigger airway constriction. The association between ATI report of emotional triggering and observed triggering (i.e., airway constriction in response to emotional arousal) would provide validity

for the ATI emotional trigger subscale. The association between self-report and actual effects of physical activity, air pollution, and infections were not assessed in this study and require validation.

Clinical and Research Implications

Patients' perception of their asthma triggers is regularly used to inform decisions regarding treatment and management and attempts to maximize quality of life. As a reliable and valid inventory, the ATI can help to screen for the importance of a number of major trigger classes, to identify the most relevant triggers for a patient, to evaluate the perceived impact of these triggers on the daily life of the patient, and to plan management of these triggers accordingly. Thus, the ATI provides a useful complement to clinical interview, and perhaps the FAMSS (McQuaid et al., 2005), as a procedure that can be reliably and validly carried out by a variety of medical support staff. It is important to note that we did not use this instrument as an individual questionnaire. Instead, the questions were read to the parent(s) and child or adolescent together. This approach circumvents compromise in information due to limits in literacy, and furthermore, allows collaboration between two interested parties in the identification of the most important triggers. We often observed that brief discussion between the parent and child or adolescent helped them to think through and come to a new clarity regarding a particular trigger. This process itself could help in management of the disease through developing more careful and collaborative parent–child identification and avoidance of triggers.

The ATI also can support systematic research investigating the role and impact various asthma triggers have on children's lives. For example, emotions, exercise, air pollution, and irritants seem to be more related to disease severity and asthma quality of life than infections and pollen allergy. Although animal allergies were significantly associated with disease severity in the whole sample, when separated by age group they remained significant only for the younger children. These findings suggest testable hypotheses that older children are more able to avoid contact with animal allergens and that pollen may be relevant only in certain seasons, or that pollen allergy is ameliorated by allergy medications.

Finally, the ATI, with its reliability across race, gender, age, and SES, and evidence of validity, may help to advance knowledge regarding the impact of all triggers of pediatric asthma, including, importantly, stress and emotional triggers. It is of particular value to have an instrument that can be used in various subgroups as described above in order to systematically investigate factors underlying gender and ethnic, racial, or minority health disparities with respect to specific influences on pediatric asthma.

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