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PREDICTING CHILDREN'S ADHERENCE TO ASTHMA MEDICATION REGIMENS

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Adherence to asthma medications is a significant problem among children. Research suggests that less than half of all children on such regimens are adherent (Bender, Milgrom, & Rand, 1997). This study examined potential predictors of non-adherence to asthma treatment regimens among 60 children, 8 to 12 years of age, and included demographic and disease-related measures, and psychosocial measures derived from Social Learning Theory. The children's adherence to inhaled steroids was measured for 2 weeks using an electronic monitor. Hierarchical regression modeling indicated that the psychosocial measures did not significantly augment the prediction of children's mean adherence expressed as a continuous variable. By contrast, when adherence was converted into the traditional status measure (non-adherent versus adherent, depending on whether mean adherence ≥ 80%), the combination of the child's belief in self-efficacy and the child's treatment outcome expectancy significantly improved upon the prediction of adherence achieved by demographic and disease-related measures. Unlike the latter measures, the psychosocial measures are potentially ameliorable by intervention. Therefore, treatment providers might consider working with children to increase their sense of self-efficacy and their confidence in treatment outcomes.
Keywords: asthma, adherence, self-efficacy

Asthma is a common and potentially life-threatening disease often diagnosed in young children. Recent estimates indicate that 5 million children in the United States have asthma (American Academy of Allergy Asthma and Immunology, 2006). The disease is chronic and characterized by episodes of spasms or contrac tions of the bronchial smooth muscle, resulting in wheezing, coughing, tachycardia, and a marked increase in respiratory effort. An untreated asthmatic episode may lead to progressive obstruction of the large and small airways. Such obstructions can fairly rapidly result in a substantial loss of oxygen throughout the body, accumulation of toxic levels of carbon dioxide in the blood, and eventually death (McCance & Huether, 1990).

The acute asthma attack can be treated by the immediate use of bronchodilators. However, the most effective method of managing the disease is to focus on preventing acute asthmatic attacks. Prevention regimens typically include daily use of corticosteroids, taken orally or inhaled, combined with use of an inhaled bronchodilator, taken as needed, to reverse acute constriction of the airways. The steroids decrease the overall inflammation associated with asthma, thereby protecting against airway constriction on a continual basis. When a preven-

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tive and managed regimen of corticosteroids is followed, patients show marked improvement in their overall lung functioning (Smith, Seale, Ley, Mellis, & Shaw, 1994).

Non-adherence and Health Consequences Adherence, typically defined as taking at least 80% of one's prescribed doses (Rapoff, 1999), is often not attained by children with asthma. After monitoring for three months, researchers reported that full adherence to both inhaled corticosteroid and bronchodilator treatment occurred, on average, less than 3% of the time, and participants failed to take any prescribed steroid medication on 41% of study days (Bender, Milgrom, Rand, & Ackerson, 1998). Similarly, after monitoring children between the ages of 8 and 16 for one month, it was reported that less than 46% of the prescribed doses of daily controller medication were actually taken (Walders, Kopel, Koinis-Mitchell, & McQuaid, 2003). This general finding appears to be stable, as Bender and colleagues (1997) previously reviewed ten studies and concluded that children take less than 50% of their prescribed doses of asthma medication.

The health implications of not following one's asthma treatment regimen are well documented. Non-adherence correlates with exacerbations of asthma symptoms, such as greater breathing difficulty and greater variability in peak flow measures (Cluss, Epstein, Galvis, Fireman, & Friday, 1984). Poor adherence is also related to increased hospitalizations, increased health care utilization, increased medical expenses, and decreased school attendance (Bender, Milgrom & Rand, 1997; Chryssanthopoulos, Laufer, & Torphy, 1983; Lemanek, 1990; McQuaid, Kopel, Klein, & Fritz, 2003; Weinstein, 1985). Thus, non-adherence to asthma regimens is common, it poses significant health threats to the child with asthma, and it results in significant unnecessary costs to the family and the health-care system.

Understanding Nonadherence

Given that non-adherence is clearly related to increased health behavior problems, one major research focus has been on identifying risk factors and potential causes of nonadherence. Many factors have been proposed as potential predictors of non-adherence. However, among children with asthma our understanding of this behavior and the role of these potential predictors remain unclear and limited. For example, although some researchers have reported an association between non-adherence and the complexity of the treatment regimen and dosing pattern (Chung & Naya, 2000). Others have failed to find this relationship (Walders, Kopel, Koinis-Mitchell, & McQuaid, 2003). Furthermore, because the age range varies widely across studies, it is difficult to compare results. One other potential predictor which may be useful in understanding this behavior is that of self-efficacy, as based upon

Social Learning Theory

Social Learning Theory strongly emphasizes personal beliefs about one's own behavior. In particular, it is proposed that one's beliefs about self-efficacy ("…a judgment of one's ability to organize and execute given types of performances") and outcome expectancies ("…a judgment of the likely consequences such performances will produce") can predict the occurrences of a wide variety of behaviors, including health-related behaviors (Bandura, 1997, p. 21).

Self-efficacy predicts adherence across a variety of adult health behaviors, including smoking cessation (Stuart, Borland, & McMurray, 1994), HIV protective behaviors (Mahoney, 1995), and adherence to medical regimens for diabetes (McCaul, Glasgow, & Schafer, 1987). Among adolescents with asthma, self-efficacy for asthma prevention and management predicts self-reported adherence (Zebracki & Drotar, 2004). Among younger populations, self-efficacy is positively correlated with age and with knowledge of one's medical regimen (Miles, Sawyer, & Kennedy, 1995; Schlosser and Havermans, 1992). However, despite the previous findings suggesting that self-efficacy and outcome expectancy play a role in child health behaviors, an adequate measure of self-

efficacy of young children with asthma has not been studied in the context of electronic monitoring of adherence. Similarly, although outcome expectancy has been included in several studies, it has not been assessed consistently, nor has it been evaluated relative to adherence among young children with asthma.

Parental self-efficacy for asthma management and outcome expectancy may also relate to adherence behavior among children with asthma. For example, Bursch and colleagues (1999) reported a significant relationship between parental self-efficacy for asthma management and child health status, as well as a significant relationship between child and parent self-efficacy reports. Others have reported a relationship between parental self-efficacy and number of school days missed by the child due to asthma (Grus, et al., 2001), but failed to find an overall relationship with health status.

The current study was designed to determine whether child and parent self-efficacy and/or treatment outcome expectancy can contribute to the prediction of adherence to regimens of treatment with inhaled steroids. We expected that, after controlling for demographic and disease-related variables, high self-efficacy and high outcome expectancy of both parent and child would be significantly related to adherence. The data were collected during the 14-day baseline period of a behavioral intervention trial aimed at improving adherence.

METHOD

Participants

This study was approved by the institutional review board. Potential participants were patients in one of two asthma/allergy clinics. One clinic was urban, the other suburban. Eligible children (1) were between 8 and 12 years of age; (2) had moderate to severe asthma, as diagnosed by one of the clinic physicians; and (3) had been prescribed an inhaled steroid to be taken daily. The age range was based on the use of standardized measures and our interest in health behaviors in children, rather than adolescents. Children with mild persistent asthma were excluded because their treatment would not include daily steroid inhalation. Potential participants were identified through their physician and approached by an experimenter during a scheduled clinic appointment.

Eighty-six children were invited to participate. Of those invited, 21 declined to participate, and 5 others were not included in the final sample due to failure of the monitoring device to record properly. The principal reasons for declining to participate were lack of time and/or lack of interest. The final sample consisted of 60 child/parent dyads. The children's mean age was 9.99 years (SD = 1.7).

Predictor Variables

Demographics. The demographic questionnaire yielded the child's age, sex, and ethnicity (Non-Hispanic White, African American, Hispanic, Asian American, Other); parents' ages, education levels (less than Jr. High School / Jr. High School grad / some High School / High School grad / some college / college grad / grad school.) and occupations; mother's marital status (not married / married); household income, and number of children in the home. The Hollingshead Four-factor Index of Social Status (Hollingshead, 1975) was computed as the measure of socio-economic status (SES), yielding a summary score ranging from 8 to 66, with higher scores indicating higher SES.

Disease-related measures. Age at diagnosis and time since diagnosis were derived from the medical record. In addition, three spirometric (lung-function) tests were done, including forced vital capacity (FVC, the total amount of air from deep inhalation to extreme forced expiration); forced expiratory volume per 1 second (FEV_1, the speed of the expiration); and mean forced expiratory flow between 25% and 75% of the forced vital capacity ($FEF_{25-75\%}$, a measure of small airway function) (Miller et al., 2005). These lung-function tests were obtained at the beginning of the study by trained personnel, who conducted the evaluation in the home.

Psychosocial measures. Child self-efficacy was assessed using the Asthma Management Efficacy Scale (Bursch, Schwankovsky, Gilbert,

& Zeiger, 1999). This 14-item scale asks respondents to rate on a 5-point scale how sure they are that they are able to manage their asthma and successfully cope with an asthma attack (1 being "not at all sure," and 5 being "completely sure."). This measure has satisfactory internal consistency (α = .87), and yields scores on two subscales, attack prevention and attack management. In the present study the full scale (14 items) yielded Cronbach's α = .78. The attack management subscale was also acceptably reliable (6 items, α = .76). However, reliability of the attack prevention subscale was less than desirable (8 items, α = .54). For this reason, only the full scale scores were used in the analyses.

Parental self-efficacy beliefs were assessed using the Parent Asthma Management Self-Efficacy Scale (Bursch et al., 1999). This 13-item scale is similar in structure to the child version. It has satisfactory internal consistency (α = .87). In the present study the scale (13 items) yielded Cronbach's α = .82.

Child outcome expectancy was assessed using the Child Belief in Treatment Efficacy Scale, which was developed by the authors for purposes of the present study. This 5-item scale is based on the Parent Treatment Efficacy Scale (Bursch et al., 1999). The items were changed to apply to the child. For example, the question "How helpful is keeping a child calm in stopping a serious breathing problem?" was modified to read "How helpful is staying calm in stopping a serious breathing problem?" In the present study this outcome expectancy measure yielded Cronbach's α = .64.

Parent outcome expectancy was assessed using the Parent Treatment Efficacy Scale (Bursch et al., 1999). This is a 5-item scale on which respondents are asked to indicate how helpful they perceive various disease-related behaviors, such as maintaining regular contact with physicians and avoiding allergens, to be in controlling and managing asthma. The scale has satisfactory internal consistency (α = .76). The present study yielded Cronbach's α = .60. Although the measure demonstrated lower internal consistency in this study, as compared to previous studies, it was within the range of acceptability.

Criterion Variables

Adherence. Previous studies have reported that electronic monitors are more accurate in their assessment of adherence than either patient self-report or canister weight loss (Gong, Simmons, Clark, & Tashkin, 1988; Nides, Tashkin, Simmons, Wise, Li, & Rand, 1993). The electronic monitor used in the present study to assess adherence to prescribed doses of an inhaled steroid was the MIDILog (Forefront Technologies, Lakewood CO). . This device is embedded in the casing of an inhaler, and it records the time and date of each actuation, including whether or not the inhaler was shaken prior to actuation. Moreover, based upon changes in temperature, it records whether or not the medication was inhaled or merely dispensed. The stored data are downloaded into a PC for analysis.

The primary adherence measure was the daily percentage of prescribed actuations of the MIDILog, calculated as the number of inhaled actuations divided by the number of prescribed actuations. Daily values that exceeded 100% were set to 100%, as one could not "make up" for missed doses. The daily percentages were averaged to yield the overall 14-day score, mean adherence.

The secondary adherence measure was adherence status (adherent / non-adherent). Children whose mean adherence was at least 80% were classified as adherent, all others as non-adherent. This 80% criterion is common in the adherence literature (Rapoff, 1999), and is associated with reduced asthma episodes (Burkhart, Rayens, Oakley, Abshire, & Zhang, 2007).

Procedure

Once eligibility was established, the child and parent (or other caregiver) were approached by a researcher and invited to participate. The project was described as an examination of how children take their asthma medication, along

with their feelings about the medication and their illness. After obtaining parental permission and child assent, an appointment was made for a home visit to be conducted within one week. At this visit the demographic and psychosocial questionnaires were completed, and spirometrics were obtained. The researcher also gave the child the MIDILog, informed him or her that the MIDILog would record inhaler use, and then instructed the child to continue to take their medication as usual. The most frequent dosing schedule (94%) was 2 puffs twice

Table 1. Descriptive Statistics (Means and Standard Deviations, or Ns and Percents) for Predictor and Criterion Variables (N = 60)

Variables	N	*M* (*SD*) or *n* (%)
Predictor		
Demographic		
Child's age (years)	60	9.99 (1.75)
Age at diagnosis (years)	57	6.04 (2.76)
Time since diagnosis (years)	57	3.93 (3.13)
No. of children in the home	59	2.33 (1.27)
Sex (% female)	59	30 (50.80)
Ethnicity (%)	60	
Non-Hispanic white		43 (71.67)
African American		8 (13.33)
Hispanic		4 (6.67)
Asian American		1 (1.67)
Other		4 (6.67)
Mother's marital status (% married)	59	41 (69.50)
Mother's age (years)	58	37.38 (6.06)
Mother's education (%)	58	
< Jr. High School grad		1 (1.72)
Jr High School grad		3 (5.17)
Some High School		4 (6.90)
High School grad		10 (17.24)
Some college		16 (27.59)
College graduate		15 (25.86)
Graduate school		9 (15.52)
Disease-related, lung function		
Midexpiratory flow rate ($FEF_{25-75\%}$)	57	66.25 (20.05)
Forced expiratory volume (FEV_1)	57	79.39 (13.46)
Forced vital capacity (FVC)	57	92.57 (17.01)
Psychosocial		
Child's outcome expectancy	60	18.39 (4.88)
Child's management efficacy	60	53.44 (9.63)
Parent's outcome expectancy	60	22.44 (2.79)
Parent's management efficacy	60	52.12 (9.18)
Criterion		
Mean adherence	60	66.03 (26.14)
Adherence status (% non-adherent)[a]	60	40 (66.67)

a day.

A follow-up home visit was scheduled for two weeks after the first contact. At this time, the MIDILogs were collected in order to download and record the data obtained over the 14-day measurement period. Additional measures, taken as part of the larger intervention study, are not reported here.

Statistical Analyses

The analysis focused on potentially predictive measures obtained at the start of the measurement period. It proceeded in two steps. In Step 1 we computed the zero-order Pearson correlations among the predictor variables and between the predictor variables and the criterion variables. All predictors that were significantly correlated with a criterion variable were included in the prediction analysis of that variable. In Step 2 we conducted parallel prediction analyses on the two criterion measures, mean adherence and adherence status. For each measure, the goal was to determine which predictors were useful in a hierarchical multivariate context, with the first model including predictors from among the demographic and disease-related measures, and the second model including those from among the psychosocial measures. The final model added the second model to the first, and thus showed whether prediction was significantly improved by the addition of psychosocial variables. Given the limited sample size, prior to computing the final model, each of the first two models was reduced to its simplest form by backward elimination (Tabachnick & Fidell, 2001).

Using mean adherence as the outcome measure, the univariate prediction potential of continuous variables was tested using Pearson or Spearman correlation, while categorical variables were tested using Student's t or factorial analysis of variance. Using adherence status (dichotomous) as the outcome measure, univariate prediction potential of all variables was tested using univariate logistic regression. For all of the univariate tests $\alpha = .05$. Those variables that met this criterion (candidate predictors) were entered into the hierarchical multivariate analyses described above, unless the candidate had more than 5% (i.e., > 3/60) missing values. For those candidates with three or fewer missing values, the missing values were imputed using the mean (continuous variables) or the mode (categorical variables). All analyses were done using SPSS 15.0 (SPSS, Chicago, Ill.).

RESULTS

Descriptive Analyses

Socio-economic status and household income were available for too few subjects to be included in multivariate prediction equations. Summary statistics for all other measures having no more than three missing values are shown in Table 1. Across all subjects, mean adherence was 66% (SD 26%) of prescribed doses. By two-tailed one-sample t-tests, this is significantly better adherence than previously reported for children with asthma, including estimates of 46% (Walders et al., 2003), $t(59)=5.936$, $p < .001$, 50% (Bender et al., 1997), $t(59)=4.750$, $p < .001$, or even 59% (Bender et al., 1998), $t(59)=2.082$, $p = .042$. Perfect adherence was found in 6/60 (10%) of our sample, significantly higher than the 3% reported by Bender et al. (1998), one-sample $\chi^2(1) = 7.84$, $p < .006$. Despite this higher than typical adherence level, adherence status showed that 40 / 60 (67%) of the children failed to achieve at least 80% mean adherence and were thus classified as non-adherent.

Zero-order Correlations among Predictor Variables

Zero-order Pearson correlations were computed among all the predictor variables (Table 2). Because of the limited sample size, ethnicity was collapsed into two categories before assessing its predictive value: Non-Hispanic white (71.7%) / Other (28.3%). The p values shown in Table 2 were not corrected to protect family-wise alpha, so those significant at $\alpha = .05$ should be interpreted with caution. Mother's education was treated as an ordered variable with four le-

vels. Although the Pearson coefficients for these and the other non-continuous variables are not directly comparable to those obtained with two continuous variables, the p values for the non-continuous variables are practically identical to those we obtained by treating them as the grouping variable of a t-test or analysis of variance, or as categories for χ^2 analysis.

Relations among Child and Parent Psychosocial Measures. As expected, the children's outcome expectancy scores were significantly correlated with their management efficacy scores, r (58) = .26, p = .045. However, neither of these scores were correlated with its corresponding parent score (rs = –.03 and –.05 respectively), nor were the parent scores correlated with one other (r = –.02). This differs from the Bursch et al. (1999) study, in which significant relationships were reported between parent and child self-efficacy, and between parent outcome expectancy and child self-efficacy.

Zero-order Correlations between Predictor and Criterion Variables

In order to identify candidates for the hierarchical regression analyses, zero-order Pearson correlations were computed between the predictor measures and the two criterion measures, mean adherence and adherence status (see Table 3). The p values shown in Table 3 were not corrected to protect the family-wise alpha. Given the 16 independent correlations, we would expect less than one to be significant by chance at α= .05. Six significant correlations were actually observed at α= .05, supporting confidence in the analyses that follow. Mean adherence was significantly correlated with one demographic measure (mother's education) and one psychosocial measure (child self-efficacy). By contrast, adherence status was significantly correlated with three demographic measures (age at diagnosis, mother's age, mother's education), one disease-related measure (FEV_1), and two psychosocial measures (child outcome expectancy and child self-efficacy).

Predicting Adherence

Mean Adherence. Given the zero-order correlations, mother's education was entered in Block 1, child self-efficacy in Block 2. The Block-1 model was significant, p = .045, R^2 = .067. The full model was also significant, p = .049, R^2 =.101. The increase in R^2 was not significant, however, p = .152. Thus, child self-efficacy did not significantly improve prediction of mean adherence beyond that achieved by mother's education alone.

Adherence Status. Given the zero-order correlations, age at diagnosis, mother's age, mother's education, and child's FEV_1 were entered simultaneously into Block 1 of the hierarchical logistic regression predicting adherence status. This model was significant, p = .028, Cox & Snell R^2 = .166, with 66.7% correct classification of cases. Backward elimination reduced the model to two measures, mother's age and FEV_1, p = .017, Cox & Snell R^2 = .128, with 61.7% correct classification. The Block-2 partial model, child outcome expectancy and child self-efficacy, was also significant, p = .010, Cox & Snell R^2 = .144, with 70% correct classification. Backward elimination resulted in retention of both predictors. Therefore, for the final hierarchical model, Block-1 included mother's age and FEV_1, and Block-2 included child outcome expectancy and child self-efficacy. As previously, the Block-1 model was significant, p = .017, Cox & Snell R^2 = .128, with 61.7% correct classification. In addition, the full model was also significant, p = .005, Cox & Snell R^2 =.220, with 75.0% correct classification, and the Block-2 measures significantly improved prediction of adherence status beyond that achieved by the combination of mother's age and child's lung function (FEV_1), $\chi^2(2) = 6.72$, p = .035. The final prediction model for Adherence Status is shown in Table 4.

DISCUSSION

The present study demonstrated that self-efficacy and outcome expectancies reported by the children in our sample were related to their level of adherence to their medication, even after controlling for significant demographic and

Table 3. Zero-order Correlations between Predictor and Criterion Variables

Predictor variables	N	Mean adherence	Adherence status[d]
Demographic			
1. Child's age	60	−.04	.05
2. Age at diagnosis	57	−.23	−.27*
3. Time since diagnosis	57	.17	.26
4. No. of children in the home	59	−.09	−.23
5. Sex[a]	59	.13	.10
6. Ethnicity[b]	60	−.24	−.21
7. Mother's marital status	59	.18	.22
8. Mother's age	58	.14	.27*
9. Mother's education[c]	58	.26*	.26*
Disease-related, lung functioning			
10. Midexpiratory flow rate ($FEF_{25-75\%}$)	57	.16	.16
11. Forced expiratory volume (FEV_1)	57	.12	.27*
12. Forced vital capacity (FVC)	57	.09	.15
Psychosocial			
13. Child's outcome expectancy	60	.10	.29*
14. Child's management efficacy	60	.28*	.31*
15. Parent's outcome expectancy	60	.09	.07
16. Parent's management efficacy	60	−.15	−.13

[a]Sex coded 0 = female, 1 = male.
[b]Ethnicity coded 0 = non-Hispanic white, 1 = other.
[b]Marital status coded 0 = not married, 1 = married.
[d]Education coded 1 = less than Jr. High School grad, 2 = Jr. High School grad, 3 = some High School, 4 = High School grad, 5 = some college, 6 = college grad, 7 = grad school.
[d]Adherence status coded 0 = non-adherent (mean adherence < 80%), 1 = adherent (mean adherence ≥ 80%).
*p<.05.

disease-related variables (i.e., the mother's age and child's FEV_1). These findings are noteworthy given the poor adherence rates of pediatric asthma patients reported in this study and in previous studies (Bender et al., 1998; Walders et al., 2003), and the potential health consequences of nonadherence among this group (Cluss et al., 1984; Bender et al., 1997; Chrys-

santhopoulos et al., 1983; Lemaneck, 1990; McQuaid et al., 2003; Weinstein, 1985). It is also important to note that the child's outcome expectancy and the child's self-efficacy were predictive of adherence, while the parent's corresponding variables were not.

Our findings add to a body of literature regarding relationships between adherence and parental and child self-efficacy and outcome expectancies. Previous research has found that self-efficacy predicts adherence across a variety of adult health behaviors (e.g., Mahoney, 1995; McCaul et al., 1987; Stuart, Borland, & McMurray, 1994). Zebracki & Drotar (2004) documented that the association between self-efficacy for asthma prevention and management predicts self-reported adherence among adolescents with asthma. On the other hand, poor adherence has been related to low perceived control of the disease (Kapote, 1977). In regard to the influence of parental self-efficacy, Bursch and colleagues (1999) found a significant relationship between parental self-efficacy for asthma management and child's health status. Additionally, Grus and colleagues (2001) found a relationship between parental self-efficacy and number of school days missed by the child due to asthma, but not to the child's overall health status. Our findings indicated that parental management self-efficacy was not predictive of adherence, which has been related to overall health status and number of school days missed (e.g., Lemanek, 1990; McQuaid et al., 2003). However, we did not assess missed school days or overall health status, thus could not investigate any meditational relationships.

In regard to outcome expectancies, previous research has found that patient and parent perceptions regarding the efficacy of treatments are related to nonadherence (Radius et al., 1978). Our findings are consistent with this previous research in respect to the significance of patient outcome expectancy.

Social Learning Theory proposes that one's beliefs about self-efficacy (i.e., one's ability to organize and execute certain behaviors) and outcome expectancies (i.e., the likely consequences of behaviors) are predictive of various behaviors, including health-related behaviors (Bandura, 1997). Given our findings regarding the importance of the child's outcome expectancies and management self-efficacy, efforts to increase adherence should target the child's expectancies and self-efficacy regarding the treatment of their asthma using Social Learning Theory as a framework for intervention. Developing more optimistic beliefs about the outcomes of treatment may be helpful in increasing adherence among children. Enhancing adherence may be accomplished by educating children about the efficacy of treatments and by providing them with concrete information. This approach is supported by previous research documenting that self-efficacy and outcome expectancies are positively correlated with knowledge of one's medical regimen (Miles, Sawyer,

Table 4. Summary of Logistical Regression Model for Variables Predicting Adherence Status

	Variables	B	SE	OR	z	1-tail *p*
	Constant	-12.345	3.720	.000	3.318	.001
Block 1	*Demographic & Disease-Related*					
	Mothers Age	.094	.060	1.099	1.409	.060
	FEV_1	.038	.027	1.039	1.554	.075
Block 2	*Psychosocial*					
	Child's outcome expectancy	.122	.075	1.130	1.626	.052
	Child's management efficacy	.049	.037	1.051	1.336	.091

& Kennedy, 1995; Schlosser and Havermans, 1992).

The present findings suggest that it may be most effective for healthcare providers to focus their educational and motivational strategies for increasing adherence upon the child and/or counseling parents to foster greater outcome expectancies and self-efficacy within their children, rather than focusing exclusively or even primarily on the expectancies or self-efficacy of the parents. Specifically, programs may be most beneficial if they are designed to increase children's belief in their own ability to manage their asthma, to take their medication correctly, and to thereby control their own health and lifestyle.

In addition to the child's outcome expectancy and self-efficacy, this study identified the mother's age as an important demographic predictor of adherence, such that children of younger mothers are at greater risk of nonadherent behavior. The reasons for this finding are unclear and warrant further investigation of correlates of maternal age that might account for it. The univariate analyses also indicated that mother's education level is associated with adherence, as has been previously documented (Radius, et al., 1978), and that the child's age at diagnosis was negatively related to adherence. This agrees with previous studies in suggesting that individuals are more adherent early in the treatment phase of a chronic condition (Kovacs, Goldstein, Obrosky, & Iyengar, 1992) and that disease duration is correlated with adherence (Bond, Aiken, & Somerville, 1992).

There are important limitations to this study. It utilized a convenience sample of children with asthma who were participating in a randomized trial. The sample was small, and there were other potentially important predictors that were not considered, such as parental stress, social support, and perceptions of the illness. In addition, any speculations about potential mechanisms underlying the observed significant relationships between predictors and adherence must be made cautiously because the study is essentially descriptive and correlational, not experimental. Future such studies will do well to include potentially mediating variables as covariates. In addition to these limitations, it is important to note the relatively narrow age range (i.e. 8 to 12-year olds) represented in the study. Thus, it would be useful to compare the utility of self-efficacy, as reported by the child, in predicting health behavior across other age ranges. It may be that for younger children, the parent ratings are more predictive and influential than the child's beliefs, compared to our group of 8- to 12-year olds. If that is the case, one might attempt to tailor the interventions to the developmental age of the targeted children in view of their relative independence from parental influence.

In conclusion, promoting adherence is important given that nonadherence to asthma medications can lead to functional morbidity and mortality. The findings from the present study suggest that psychological factors are predictive of adherence, and specifically highlight the roles of self-efficacy and treatment outcome expectancy in maintaining one's health by adhering to a medical regime for a chronic medical condition. This study also indicated that the child's assessment of these factors, not the parents' assessments, were predictors of adherence. Thus, healthcare providers may be wise to consider the psychological functioning of their child patients and the effects of such functioning on the course of their disease and adherence behavior. Further research is needed to better understand how healthcare providers might facilitate parents' contributions to their children's self-efficacy and treatment expectations.

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Table 2. Zero-order Correlations Among the Predictor Variables

Variables	N	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Demographic																
1. Child's age	60	.10	.48***	.19	−.04	−.24	.25	.47***	.29*	.15	.03	.07	.04	.17	.23	.13
2. Age at diagnosis	57	---	−.82***	.21	.10	.00	−.16	−.25	−.20	−.28*	−.26	−.14	−.19	−.23	−.01	−.31*
3. Time since diagnosis	57		---	−.07	−.10	−.14	.28*	.49***	.34*	.33*	.24	.16	.19	.29*	.14	.35**
4. No. of children in the home	59			---	−.15	.19	.20	.02	.06	−.22	−.15	.13	−.21	.01	−.26*	.02
5. Sex[a]	59				---	.03	−.06	−.21	.12	.16	−.21	−.22	.20	−.02	.02	.01
6. Ethnicity[b]	60					---	−.23	−.42**	−.21	−.36**	−.19	−.05	.19	−.13	−.18	.10
7. Mother's marital status[c]	59						---	.40**	.24	.08	−.08	−.08	.10	.05	.16	.17
8. Mother's age	58							---	.40**	.28*	.13	.08	−.02	.25	.11	−.05
9. Mother's education[d]	58								---	.38**	.26	.14	.32*	.47***	.24	−.03
Disease-related, lung function																
10. Midexpiratory flow rate ($FEF_{25-75\%}$)	57									---	.37**	−.01	.02	.24	.41**	.02
11. Forced expiratory volume (FEV_1)	57										---	.77***	.13	.16	.20	−.04
12. Forced vital capacity (FVC)	57											---	−.06	.09	.06	−.01
Psychosocial																
13. Child's outcome expectancy	60												---	.26*	−.03	.11
14. Child's management efficacy	60													---	.25	-.05
15. Parent's outcome expectancy	60														---	-.02
16. Parent's management efficacy	60															---

[a]Sex coded 0 = female, 1 = male.

[b]Ethnicity coded 0 = non-Hispanic white, 1 = other.

[b]Marital status coded 0 = not married, 1 = married.

[d]Education coded 1 = less than Jr. High School grad, 2 = Jr. High School grad, 3 = some High School, 4 = High School grad, 5 = some college, 6 = college grad, 7 = grad school.

*p<.05.

**p<.01.

***p<.001.

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