Using Structural Equation Modeling to Understand Child and Parent Perceptions of Asthma Quality of Life

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Objective   Using structural equation modeling, test a conceptual model of associations between constructs predicting parent and child asthma quality of life.   **Methods**   Children with a confirmed asthma diagnosis and their parents completed measures of health status and independently reported on psychological functioning, family functioning, and quality of life.   **Results**   Measurement and structural models for predicting parent and child quality of life provided a good fit of data to the conceptual model. Parent and child independent reports of quality of life are dependent upon family functioning and child psychological functioning. Long-term asthma symptom control is the only health status variable that impacts quality of life.   **Conclusions**   With minor modifications, both parent and child data fit the conceptual model. Child psychological functioning and long-term asthma control jointly contribute to quality of life outcomes. Findings suggest that both acute and long-term asthma health status outcomes have different determinants.

Key words   asthma; quality of life; structural equation modeling.

Introduction

Because of its relevance to evaluating treatment success, quality of life has gained increasing importance in pediatric asthma trials (e.g., Everden et al., 2004) and conceptual models postulating the relative contributions of family context and psychological factors to asthma health outcomes have been proposed (Annett, 2001; Kaugars, Klinnert, & Bender, 2004; Wood et al., 2007). Each of the models hypothesizes inter-relationships among variables that may function as either mediators or moderators of asthma health status and quality of life and provide both an important stimulus for pediatric asthma research as well as complex analytic challenges. The model offered by Kaugars and colleagues (2004), for example, focuses upon the pathways through which family characteristics influence asthma outcomes such as quality of life, patterns of asthma symptomatology, medical care utilization, activity restrictions, and school attendance. In the model proposed by Annett (2001), family context was comprised of child and parent characteristics, including such features as psychological functioning, coping, appraisal and interpretation of asthma symptoms, and quality of life.

Recently Wood and colleagues (2007) have modeled family expressiveness and child emotional symptoms to understand the contribution of these processes to asthma health status.

Research to date has suggested there is only a weak relationship between asthma health status in children (clinical symptoms, treatment and functional impairment of disease) and quality of life (Annett, Bender, DuHamel, & Lapidus, 2003; Juniper et al., 1999; Juniper, Wisniewski, Cox, Emmett, Nielsen, & O'Byrne, 2004). These findings are complicated by several limitations in prior research. Since quality of life measures have been based on parent reports about their child (Ungar, Mirabelli, Cousins, & Boydell, 2006) rather than obtaining direct child reports, the scores may be contaminated by the parent's perception of their own quality of life. Furthermore, domains of quality of life have often been rationally derived and have not held up under statistical confirmation with factor analysis (e.g., Annett, Bender, Lapidus, DuHamel, & Lincoln, 2001). Studies examining the relationship of pediatric health status to quality of life have often failed to consider that other variables, such as child psychological

functioning and family characteristics, may mediate the relationship between health status and quality of life (e.g., Juniper et al., 1999). Unfortunately there have been few efforts to link conceptual models with empirical findings in pediatric asthma research.

Examination of the preceding conceptual models and relevant literature has led to the development of a conceptual model that we evaluate in the current study (Figure 1). This model adopts a biopsychosocial health perspective to conceptualize pediatric asthma quality of life (Engel, 1977) as being dependent on biological, psychological, and social factors. Together these factors play a significant role in human functioning in the context of disease, and they have been widely cited as an accepted framework for understanding illness (Fava & Sonino, 2007).

The current conceptual model offers several new contributions. First, it proposes that asthma health status is comprised of symptom control, medication use, and impairment in daily life, similar to the characterizations of the Expert Panel (NHLBI, 2007). Few studies to date have attempted to discern the interrelationships between these aspects of pediatric asthma status (Zorc et al., 2006). The proposed conceptual model uniquely includes both child and parent perspectives on the family psychological functioning to better understand quality of life outcomes. Furthermore, the model hypothesizes associations between measures of child psychological functioning, family functioning and asthma health status characteristics, as they influence a specific outcome: quality of life. Distinct from the model proposed by Kaugers and colleagues,

broadly framed family psychological functioning (rather than the limited spectrum of family dysfunction) was proposed for examination as the preponderance of families of children with asthma do not exhibit elevated levels of psychopathology (Bender et al., 2000), though an association between family functioning and asthma severity has been reported (Klinnert, Kaugars, Strand, & Silveira, 2008).

In the proposed conceptual model, we sought to determine the unique contributions of psychological and family functioning and made the a priori assumption that family functioning influenced child psychological functioning, though this relationship may be bi-directional. The findings from structural equation modeling (SEM) procedures were expected to provide additional insights regarding the relative influence of child psychological and family functioning as perceived by parents and their children. We are aware of only one other study that examined the relative contribution of psychological factors from both the child and parent perspectives, and pieced these together with quality of life outcomes (Marsac, Funk, & Nelson, 2007). Pediatric asthma research to date has seldom examined both parent and child reports of quality of life, though findings have suggested that child quality of life was associated with parent quality of life in another structural model (Vila et al., 2003). Remarkably, Vila and colleagues did not find any contribution of health status measures to the relationship between psychological functioning and quality of life. The current model advances the scientific understanding of these complex relationships by gaining the perspective from both parents and children on the
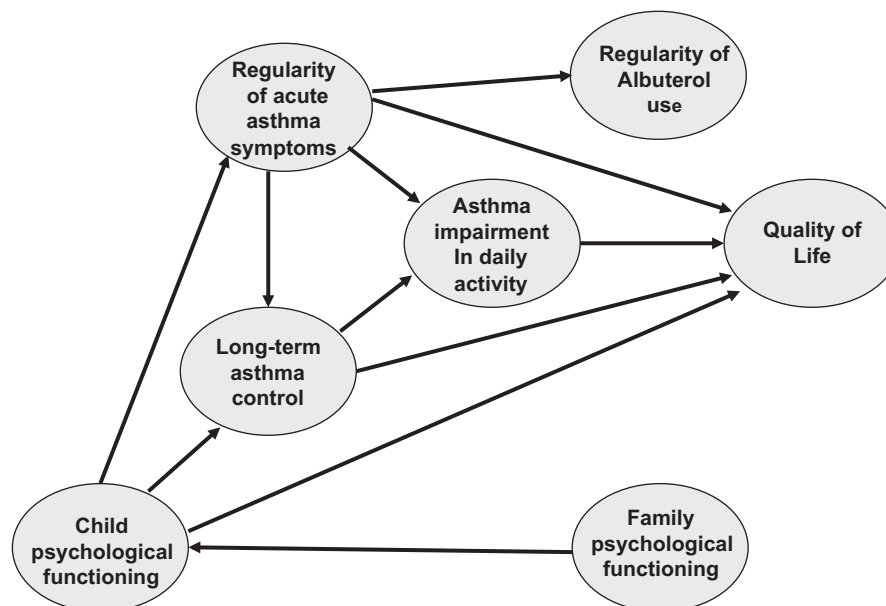

Figure 1. Conceptual model.

relationship of psychological indicators and health status characteristics to quality of life endpoints.

The study herein presents two tests of the conceptual model; the first tests the model with parent quality of life data and the second with child quality of life data. Specifically, we anticipate that psychosocial and health status variables have both direct and indirect effects upon quality of life, and that child psychological functioning and asthma symptoms are interrelated. Previous conceptual models based predominantly upon parent reports lead us to hypothesize that the conceptual model fits the parent data. Additionally, we expect to demonstrate that parent quality of life has a significant relationship with psychological and health status variables. We also test our conceptual model on data obtained directly from the child. In this model, we hypothesize that child psychological functioning, rather than family functioning is the primary exogenous variable for predicting the child's quality of life. The test of the model with the child data is important from a biopsychosocial perspective. The child's reports of their psychological functioning and their perspectives on family relationships may contribute to their perceived quality of life in a way that is different from the perspective of the parents about their child.

To test these hypotheses, SEM was used to assess the independent and mediational effects of family functioning, child psychological functioning and asthma health status characteristics on the parent's and the child's quality of life. Standard SEM modeling procedures, including the development of a measurement model and then testing a structural model were used.

Method
Participants

The sampling frame for this study included children with a medical diagnosis of asthma residing within the state of New Mexico. Several procedures were used to identify possible participants, including media advertisements, mailings to families who have a child with asthma and referrals from schools and pediatric clinics. Families contacting the study were screened to determine eligibility. Statewide recruitment for participants occurred between August 2002 and February 2008.

A total of 217 families with a children diagnosed with asthma responded to the recruitment procedures and were scheduled for the research procedures. Forty-five families did not enroll in the study procedures due to a variety of reasons (e.g., no show, declined to be rescheduled); 172 families were enrolled and completed all study procedures.

Children ranged in age from 10 to 18 years ($M = 13.8$ years; $SD = 1.7$ years). The ethnic distribution was 48% Caucasian, 40% Hispanic, and 12% mixed or other. Child gender was predominantly male (58%; $n = 100$). All children had a pre-study medical diagnosis of asthma from their primary care physician. The parents ranged in age from 24 to 59 years ($M = 41.9$ years; $SD = 7.2$ years). Parent ethnicity was self-reported as 54% Caucasian 36% Hispanic and 10% as mixed or other. Parent gender was predominantly female (91%; $n = 157$). Mother-child dyads comprised the majority of participants, with 38 families completing procedures with both parents. Household income was $60,000 or less for 65% of participants and 38% reported a primary residence as non-urban.

Procedures

The data used for analysis were gathered within two studies approved by the Human Research Review Committee at the University of New Mexico and by the institutional review board at the Presbyterian Health System. Informed consent was provided by parents and assent by children prior to beginning study procedures. These procedures began with parents and children being asked to work together to complete the Asthma History Questionnaire. This activity was followed by a comprehensive medical examination by an asthma specialist. Examination procedures included allergy/skin testing, spirometry, and current classification of asthma severity using NHLBI guidelines that were available when the study began (NHLBI, 2002) and provided a confirmation of a diagnosis of asthma. Once the examination had been completed, parents and children separately completed a Medical Attitudes Questionnaire while in the same room at the clinic.

Thereafter, families came to the research offices where they completed several questionnaires as part of two larger studies examining family decision-making concerning participation in asthma research. Family members completed questionnaires in the same room; however, the research assistant monitored data collection to ensure that questionnaires were completed independently, without discussion of responses. Parents and children were compensated for their time and then debriefed regarding study procedures.

Measures

Asthma History Questionnaire
This 32-item questionnaire examined asthma diagnosis, symptom history, impairment, and treatment. Questions were developed from the NHLBI guidelines for diagnosis

and management of asthma, with a subset of items being used to reflect asthma health status outcomes, and these items estimated the latent constructs in subsequent analyses. The latent constructs included the regularity of acute asthma symptoms, asthma symptom impairment in daily activity, regularity of Albuterol use, and long-term asthma symptom control, and are comprised of the indicators presented in Table I. Lower numeric scores were indicative of less severe asthma symptoms. Parents and children together completed this questionnaire.

Medical Attitudes Questionnaire

Attitudes held by parents and children about asthma care and quality of life were assessed in this 13-item questionnaire developed for these two studies. Item content was drawn from our previous work, including questions regarding responsibility for asthma care (e.g., ''I am in charge of my asthma care''; ''My teen is in charge of their asthma care''), parent and physician influence on asthma treatment (e.g., ''My parents are in charge of my asthma care''; ''My doctor is in charge of my asthma care''), and attitudes toward current asthma medication therapy (e.g., ''I will become sicker if I do not take my medicines''; ''My teen will become sicker if he/she does not take their medicines''). The questionnaire used also included parent self-reported and child reported quality of life questions developed specifically for this study using a 5-point Likert scale format (''Not true'' to ''Very True''). Parent self-reported and child quality of life indicators are presented in Table I, where higher scores indicate poorer quality of life.

Behavior Assessment System for Children—Parent Rating Scales (BASC-PRS; Reynolds & Kamphaus, 1992)

The BASC-PRS is comprised of four composite scores: externalizing problems, internalizing problems, adaptive skills and the Behavior Symptoms Index. Based upon the literature on psychological functioning in pediatric asthma (e.g., Chen, Hermann, Rodgers, Oliver-Welker, & Strunk, 2006; McQuaid, Kopel, & Nassau, 2001; Wood et al., 2007), only the scales comprising anxiety, depression, and somatization were used as indicators within the SEM model. National age norms are based on 3,483 parents of 4–18-year-olds, with composite coefficient alphas ranging from .85 to .93 and test–retest reliability ranging from .71 to .75 in children.

Behavior Assessment System for Children—Self-Report of Personality (BASC-SRP; Reynolds & Kamphaus, 1992)

The BASC-SRP is comprised of 186 true/false questions that provide information on four major domains of psychological functioning. Scales specifically assessing child reported anxiety, depression and somatization were used as indicators in the SEM analysis (see Table I). Child-reported anxiety, depression and somatization are conceptually equivalent and intended to be comparable to the domains assessed with the parent-report version of the BASC (Reynolds & Kamphaus, 1992, p. 6). The BASC-SRP has demonstrated test-retest alpha coefficients of .88 to .96.

Family Relations Inventory (FRI; Moos & Moos, 1986)

The FRI consists of three domains from the Family Environment Scale: cohesion, expressiveness, and conflict. These three indicators were used to form the latent construct of family psychological functioning in subsequent analyses (see Table I). Cronbach's alpha has been reported as .89 (Grotevant & Carlson, 1989) and concurrent validity has been established (Hoge, Andrews, Faulkner & Robinson, 1989). The FRI has been employed in pediatric medical populations and has been strongly linked to psychosocial adjustment (Varni, Wilcox, & Hanson, 1988). Parents and children completed identical versions of the FRI. Total raw score from each domain of was calculated. However, in order to compute alpha reliability, the conflict scale was reverse scored.

Data Analysis Plan

The conceptual model in Figure 1 was evaluated using SEM with LISREL software (Jöreskog & Sörbom, 1999). This process begins with the development of a measurement model and is followed by the test of the measurement model in a structural equation model. The approach to analyses assumed independence of the reports for measures that were separately completed by parent and child (i.e., Medical Attitudes Questionnaire, BASC-PRS/BASC-SRP, and the FRI constructs) (see Supplementary Data).

A typical assumption in the SEM approach is that the various constructs (called latent variables) in the model cannot be directly measured so that they must be estimated indirectly from observed (i.e., manifest) variables. Since each indirect indicator is likely to provide an imperfect representation of the concept, researchers are encouraged to identify several indicators for each construct, which is the process that occurs in developing the measurement model (see Supplementary Data). Our initial analyses required identification of the indicators for each of the hypothesized constructs for the current research (presented in Table I). SEM is then used to develop a confirmatory factor analysis procedure that creates a composite score from the multiple indicators to represent a single score for each person on the latent construct.

Table I Latent constructs and indicators

Latent construct and indicators	Response scale	M (SD)	Factor loading
Regularity of acute asthma symptoms (N = 165)[a]			
1. How often does your child have coughing, wheezing or shortness of breath?	1–4[b]	1.78 (0.98)	.72
2. How often does your child have nighttime symptoms of asthma?	1–4[c]	1.65 (1.03)	.69
3. In the past 4 weeks, how frequently has your child had coughing, wheezing or shortness of breath at night that has awakened him/her?	1–4[d]	1.82 (0.99)	.63
4. In the past 4 weeks, how frequently has your child had coughing, wheezing or shortness of breath in the early morning?	1–4[e]	2.11 (1.08)	.56
5. In the past 4 weeks, how often has your child had asthma symptoms after exercise	1–4[f]	2.99 (1.12)	.46
6. To what extent do the symptoms of coughing, wheezing or shortness of breath influence your child's activity?	1–4[g]	2.07 (0.99)	.60
Standardized alpha: .77; Eigenvalues[h]: 2.63; 0.85			
Asthma-related impairment in daily activity (N = 165)[a]			
1. How many asthma-related visits to the doctor's office has your child had in the last 12 months?	Raw number	2.94 (4.39)	.91
2. How many days of school has your child missed due to asthma in the past 12 months?	Raw number	5.04 (8.56)	.62
3. How many Emergency Room visits due to asthma has your child had in the past 12 months?	Raw number	0.52 (1.36)	.84
Standardized alpha: .83; Eigenvalues[h]: 2.25; 0.52			
Regularity of albuterol use (N = 165)[a]			
1. In the past 12 months, has your child used Albuterol to help him/her breath easier?	Yes/no	0.91 (0.29)	.66
2. Are your child's symptoms relieved when Albuterol is used?	Yes/no	0.91 (0.30)	.46
3. About how many times has your child used Albuterol in the past 4 weeks?	None/GE 1 time	0.72 (0.45)	.70
Standardized alpha: .60; Eigenvalues[h]: 1.67; 0.74			
Long-term asthma symptom control (N = 162)[a]			
1. During the past 12 months, how severe has your child's overall asthma symptoms been?	1–7[i]	3.66 (1.63)	.86
2. During the past 12 months, how much has your child's asthma influences his/her daily living?	1–7[j]	3.12 (1.65)	.82
3. How happy have you been with your child's asthma care during the past 12 moths?	1–7[k]	3.01 (1.91)	.52
4. How effective has your child's asthma medication been during the past 12 months?	1–7[l]	2.52 (1.61)	.45
Standardized alpha: .78; Eigenvalues[h]: 2.43; 0.89			
Quality of life—parent (N = 163)[a]			
1. I feel helpless when it comes to my child's asthma symptoms.	1–5[m]	2.47 (1.28)	.77
2. I get upset because of my child's asthma symptoms.	1–5[m]	2.57 (1.40)	.66
3. I have sleepless nights due to my child's asthma.	1–5[m]	2.37 (1.44)	.67
4. I worry about the side effects of my child's asthma medication	1–5[m]	2.97 (1.48)	.55
Standardized alpha: .76; Eigenvalues[h]: 2.31; 0.71			
Family psychological functioning: FRI—Parent (N = 165)[a]			
1. Cohesion	True/false	7.63 (1.53)	.76
2. Expressiveness	True/false	6.46 (1.75)	.58
3. Conflict	True/false	5.79 (2.18)	.58
Standardized alpha: .67; Eigenvalues[h]: 1.81; 0.68			
Psychological functioning: BASC—Parent (N = 163)[a]			
1. Anxiety	0–3	54.24 (10.64)	.85
2. Depression	0–3	50.79 (9.78)	.76
3. Somatization	0–3	64.44 (14.98)	.73
Standardized alpha: .82; Eigenvalues[h]: 2.21; 0.48			
Quality of life—child (N = 162)[a]			
1. My asthma symptoms worry me.	1–5[m]	2.65 (1.27)	.76
2. I feel different and left out because of my asthma.	1–5[m]	1.80 (1.24)	.57
3. I feel frightened about having an asthma attack.	1–5[m]	2.59 (1.40)	.71
4. I am always bothered by shortness of breath	1–5[m]	2.80 (1.42)	.70
Standardized alpha: .77; Eigenvalues[h]: 2.40; 0.69			

Table I Continued

Latent construct and indicators	Response scale	M (SD)	Factor loading
Family psychological functioning: FRI—Child (N = 165)[a]			
1. Cohesion	True/false	6.96 (1.94)	.95
2. Expressiveness	True/false	4.39 (1.83)	.45
3. Conflict	True/false	5.87 (2.16)	.64
Standardized alpha: .68; Eigenvalues[h]: 1.86; 0.79			
Psychological functioning: BASC—Child (N = 162)[a]			
1. Anxiety	0–3	46.61 (9.19)	.70
2. Depression	0–3	46.60 (7.11)	.78
3. Somatization	0–3	51.55 (10.24)	.63
Standardized alpha: 0.74; Eigenvalues[h]: 1.98; 0.62			

[a]N values differ due to listwise deletion of cases where data was missing.
[b](1) Two times per week or less; (2) more than two times per week; (3) daily; (4) continually.
[c](1) Two times per month or less; (2) more than two times per month; (3) more than one time per week; (4) frequently.
[d](1) Never; (2) at least once per week, but not weekly; (3) at least once per week, but not nightly; (4) almost every night.
[e](1) Never; (2) at least once per week, but not weekly; (3) at least once per week, but not every morning; (4) almost every morning.
[f](1) Never; (2) at least once per week, but not weekly; (3) at least once per week, but not every time; (4) almost every time.
[g](1) Rarely; (2) sometimes; (3) frequently; (4) always.
[h]First and second eigenvalues from the confirmatory factor analysis.
[i](1) Mild; (7) severe.
[j](1) Not at all; (7) severe.
[k](1) Very Happy; (7) very unhappy.
[l](1) Very Effective; (7) very ineffective.
[m](1) Not true; (5) very true.

Thus, items comprising a single construct statistically share common variance that is greater than that shared with other items (not part of the construct) and other constructs within the model. The estimating procedures for the latent constructs remove measurement errors which otherwise would attenuate correlations among latent constructs. These procedures also provide novel information about the direction of the relationships between latent constructs. This single estimated score is assumed to be a more reliable and valid estimate of the latent construct than could be obtained from any of the original observed variables. The common component of each latent variable is statistically removed from each of the indicator variables for the construct. These residual components of each indicator represent the error or misfit of the model to the data. When the model provides a good fit to the data, these residual components are uncorrelated with each other since they would represent randomly distributed errors.

The latent construct for parent-report of child psychological functioning was developed from the BASC-PRS and the parallel variable for child psychological functioning was developed from the BASC-SRP. The latent construct for quality of life from parent and children were constructed from the Medical Attitudes Questionnaire. The parent and child indicators for family functioning came from the Family Relations Inventory (see Table I).

The structural (regression) equations representing hypothesized relations among the constructs are tested using the estimates for the latent variables. The statistical procedures of SEM simultaneously estimate the factor loadings for each latent construct and the regression coefficients for the hypothesized pathways or associations among the constructs. Goodness of fit indices provide an estimate of whether the data are actually consistent with the proposed model. The Root Mean Square Error of Approximation (RMSEA) provides an overall estimate for the goodness of fit of the hypothesized model to the data (Browne & Cudeck, 1993). The range of possible values is between 0.0 and 1.00 and smaller values represent a better fit. Values smaller than 0.10 represent an adequate fit while values below 0.05 are very good fits.

Results
Sample Characteristics

A total of 172 ethnically diverse study participants enrolled in the two studies. However, the final data set used in the SEM procedures was 165 cases, with 7 cases being dropped in the analyses due to missing data on all of the indicators. Only participants with complete data on the specific indicators are presented in Table I.

Child participants had been diagnosed with asthma for an average of 8.5 years prior to study participation

($SD = 4.17$ years; range: 0–17 years). Parents reported that the child's primary medical diagnosis was asthma 91 percent of the time, with allergies being the other major primary diagnosis. In the 12 months prior to study participation, children had been to their physician for an asthma-related visit from 0 to 36 times ($M = 3.00$, $SD = 4.5$), had from 0 to 65 days of asthma-related school absences ($M = 5.15$; $SD = 8.8$), and had from 0 to 12 asthma-related emergency room visits ($M = 0.53$; $SD = 1.4$). Features of the child's asthma control, regularity of Albuterol use, and long-term asthma symptom control are described in Table I.

All participants had their asthma diagnosis confirmed by the study asthma specialist. NHLBI classification of asthma severity while receiving treatment resulted in 113 children being classified with mild intermittent asthma, 27 with mild persistent asthma, and 11 with moderate persistent asthma. There were 21 participants where asthma severity classification was not available as it was misplaced at the asthma specialist's office.

Table I presents parent reports of child psychological functioning and parent perception of family relationships. The parent BASC scores are standard scores within the normal range, with a slight elevation in the Somatization domain. Parent BASC score and child BASC score for the latent variables created ($r = 0.32$; see Supplementary Table SI) were observed to be slightly higher than that obtained in the standardization population when the corresponding scales were correlated for children and parents (range $r = 0.12$ to $r = 0.22$; Reynolds & Kamphaus, 1992, p. 187). Information on child self-reported psychological functioning and perception of family relationships are also presented in Table I.

Latent Variable Analysis

The conceptual model in Figure 1 represents seven latent constructs: Regularity of acute asthma symptoms; Asthma-related impairment in daily activity; Regularity of Albuterol use; Long-term asthma symptom control; Quality of life; Family psychological functioning; and Child psychological functioning (see Table I). Missing data occurred for approximately 1% of the parents or the children. The cases retained for analysis ($n = 165$), had 0.65% missing data, and we used full information likelihood procedures in LISREL to account for the missing data.

Prior to hypothesis testing, evaluation of the internal consistency of a hypothesized construct or scale with coefficient alpha was performed. Table I reports the standardized alpha coefficients for each of the latent constructs to be evaluated in the SEM procedure.

Predicting Parent Quality of Life

The first hypothesis tested was that the conceptual model would fit the parent data. The analysis for this hypothesis began with assessing the zero-order correlations, means and standard deviations for the latent constructs used in the parent conceptual model (see Supplementary Table SI). We examined the loading of each indicator on its corresponding latent variable, and each of these loadings (λ) was statistically significant ($\lambda > .41$; $Z > 3.9$, $p < .001$). These results were consistent with the alphas reported in Table I. Figure 1 represents the hypothesized structural model that was used to predict parent quality of life. We used LISREL to estimate all parameters. The overall goodness of fit indices from the analyses suggested that the proposed model provided a reasonably good fit to the data. The RMSEA $= 0.055$, and this value was not significantly larger ($p = .217$) than the threshold value of 0.05 which represents a very good fit of the model to the data (Browne & Cudeck, 1993). The full information likelihood goodness of fit statistic χ^2 (288) $= 432.58$, $p < .001$ also is consistent with a good fit of the data.

Although the measurement model fit was good, the results revealed that the coefficients for three of the hypothesized paths between latent variables were not significant (see Figure 2). Specifically, the paths to quality of life from the asthma daily impairment, the regularity of acute asthma symptoms and Albuterol use were not statistically significant. All of the remaining hypothesized pathways were statistically significant. None of the modification indices among latent constructs were statistically significant.

The Revised Parent Structural Model

To test the structural model and our first hypothesis, we deleted the three non-significant pathways and repeated the model estimation. The resulting path coefficients with standard errors are presented in Figure 2. The revised RMSEA $= 0.054$ was still adequate, and this value was not significantly larger ($p = .239$) than the threshold value of 0.05, which represents a very good fit of the model to the data. The revised full information likelihood goodness of fit [χ^2 (291) $= 433.72$, $p < .001$] was also consistent with a good fit of the data. The difference in fit between the original and the revised fit [χ^2 (3) $= (433.72 - 432.58) = 1.14$, $p < .25$] indicated that the deletion of the three pathways did not significantly impair the quality of fit of the model to the data. The revised model had no significant modification indices for any of the omitted pathways in the structural model (see Supplementary Data).
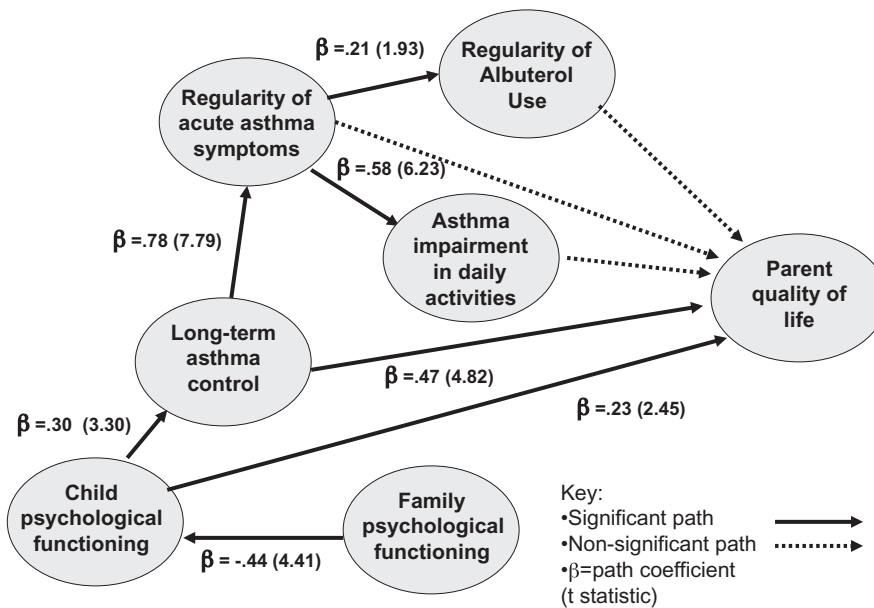
Figure 2. Parent Structural Equation Prediction Model.

The structural results indicated that the latent construct representing the parent's perception of the family psychological functioning had a strong predictive relationship to the other latent constructs in the model. First, family functioning predicted the parent's perception of the child's psychological functioning ($\beta = -.44$, $Z = -4.41$, $p < .001$). Next, child psychological functioning predicted both the long-term control of asthma symptoms ($\beta = .30$, $Z = 3.30$, $p < .01$), as well as the parent's quality of life ($\beta = .23$, $Z = 2.45$, $p < .01$). The long-term asthma control predicted both the acute asthma symptoms ($\beta = .78$, $Z = 7.76$, $p < .001$) as well as the parent's quality of life ($\beta = .48$, $Z = 4.82$, $p < .001$). Acute asthma symptoms predicted the child's Albuterol use ($\beta = .21$, $Z = 1.94$, $p < .05$) as well as impairment in daily functioning ($\beta = .58$, $Z = 6.22$, $p < .001$). This final model explained 34% of the variance in parent-reported quality of life.

The findings provide support for the hypothesis that the parent's perceived quality of life is dependent upon their perception of the family psychological functioning. The influence of the family functioning is mediated by the parent's perceptions of the child's psychological functioning and one aspect of asthma health status. We did not find support for three of the health status constructs influencing quality of life.

Predicting Child Quality of Life

The proposed structural model was based primarily upon prior research in which the respondents were parents of

treated children. The present study also collected measures on the children who received treatment for their asthma, including independent measures of child psychological functioning and child perception of family functioning. The hypothesis tested was that the child psychological functioning, rather than family functioning would be the primary exogenous variable for predicting quality of life. As such, we conducted an analysis to determine whether the structural model tested for the parents could also be used to explain child's perceptions and support our second hypothesis.

As with the parent model, the LISREL overall goodness of fit indices suggested that the proposed measurement model provided a reasonably good fit to the data. The RMSEA = 0.054, and this value was not significantly larger ($p = .256$) than the threshold value of 0.05 which represents a very good fit of the model to the data (Browne & Cudeck, 1993). The full information likelihood goodness of fit statistic [χ^2 (288) = 427.55, $p < .001$] also was consistent with a good fit of the data. Four of the hypothesized path coefficients were not statistically significant. That is, the paths to child quality of life from the long-term asthma control, regularity of acute symptoms, Albuterol use and the daily impairment in activities constructs were not significant in the measurement model. The other hypothesized pathways were statistically significant.

The Revised Child Structural Model
Based upon the conceptual model and following the structural model developed with the parent data, the three
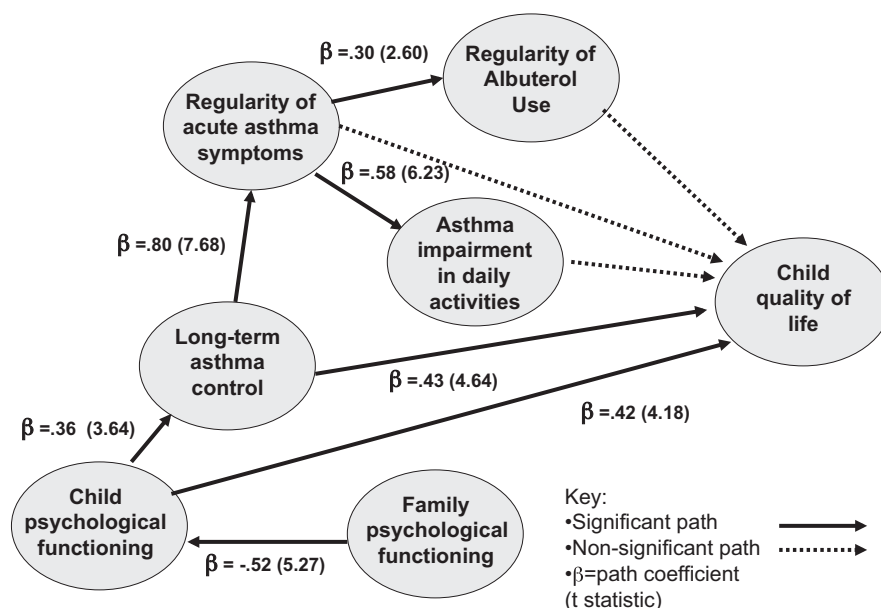
Figure 3. Child Structural Equation Prediction Model.

non-significant pathways observed in the parent model were deleted to test the hypothesis regarding the revised child model. Since there was a significant modification index between the child's rating of their psychological functioning and the regularity of Albuterol use factor, we permitted the residuals of these two latent constructs to be correlated. The resulting structural model is presented in Figure 3 and is quite similar to the parent model. Both goodness of fit indices indicated a strong fit to the data with RMSEA = 0.053, and a quite good full information likelihood goodness of fit statistic, χ^2 (290) = 424.71, $p < .001$. The observed RMSEA was not significantly larger than the desirable .05 threshold ($p < .314$). The structural results indicated that the latent construct representing the child's perception of the family psychological functioning had a strong predictive relationship to the other latent constructs in the model. None of the modification indices among latent constructs was statistically significant for this model (see Supplementary Data).

Family functioning predicted the child's psychological functioning ($\beta = -.52$, $Z = -5.27$, $p < .001$). Next, child psychological functioning predicted both the long-term asthma control ($\beta = .36$, $Z = 3.64$, $p < .01$), as well as the child's perceived quality of life ($\beta = .42$, $Z = 4.18$, $p < .01$). The long-term asthma control predicted both the regularity of acute asthma symptoms ($\beta = .80$, $Z = 7.88$, $p < .001$) as well as the child's quality of life ($\beta = .43$, $Z = 4.64$, $p < .001$). Acute asthma symptoms predicted both the child's Albuterol use ($\beta = .30$,

$Z = 2.60$, $p < .05$) as well as the impairment in daily activities ($\beta = .58$, $Z = 6.22$, $p < .001$). This final model explained 49% of the variance in child-reported quality of life. The residual correlation between the child psychological functioning and the Albuterol latent constructs was also significant ($r = -2.5$, $Z = 2.28$, $p < .05$). This finding suggests that Albuterol use is partially dependent upon the child psychological functioning in ways that are not related to the intervening acute symptoms or long-term control. In conclusion, the child data fit the conceptual model for child quality of life when three pathways were removed. The results indicated that the child's model was quite similar to the parent's model with one exception. The child psychological functioning latent construct had a much stronger association with quality of life when the data for these constructs were obtained from the child ($\beta = .42$, $p < .0002$) than from the parent ($\beta = .23$, $p < .02$).

Discussion

Through the use of SEM, we have tested a conceptual model examining child psychological functioning, family functioning, and asthma health status factors as predictors of quality of life. Each structural model was supported by the data, though each model required the deletion of paths from three health status variables in order to avoid a poor fit. The following discussion clarifies the major findings, offers hypotheses concerning the relationships among the

factors, and explains how these results may be useful for future research.

Psychological Functioning as A Predictor of Asthma-Related Quality of Life

Findings from this study provide new information on the contribution of psychological factors, including both family relationships and child psychological functioning, to asthma-related quality of life. For parents and children, psychological functioning has direct and indirect effects on asthma quality of life. The indirect effects of psychological functioning are mediated through long-term asthma control. In other words, normal psychological functioning is associated with both long-term asthma control and positive reports of quality of life. Additionally, in both the parent and child models there is a very strong correlation between family functioning and child psychological functioning ($\beta = -.44$ and $\beta = -.52$), suggesting that these variables could be used interchangeably to predict quality of life. The models for the parent and child were quite similar, which is partly due to the relatively strong correlations between the latent constructs reflecting the parent and child's views of family functioning ($r = .53$, $p < .001$), the child's psychological functioning ($r = .32$, $p < .01$.) and quality of life ($r = .45$, $p < .001$). Overall, findings in the present study are consistent with others that have employed SEM to examine the interplay of child psychological functioning and asthma outcomes (Wood et al., 2007). Moreover, these findings shed additional light upon the relationship between child psychological functioning and well-controlled asthma (Nishimura, Hajiro, & Oga, 2004).

Similarly, family functioning has been proposed as a significant influence upon asthma health status reports and outcomes such as quality of life (Sawyer, Spurrier, Kennedy, & Martin, 2001). Components of family functioning such as how families express emotion, the degree of organization, and how conflict is managed have been found to be related to asthma health status (e.g., Wood et al., 2007). Our findings are consistent with and extend these studies by revealing that family psychological functioning predicts one aspect of health status (long-term asthma control) and both child and parent quality of life.

Acute Asthma Symptoms and Quality of Life

Studies to date indicate that degree of lung function impairment, regularity of symptoms, and functional impairment in activities all influence reports of asthma control. Factors that may influence the perception of asthma health status include chronicity or variability of asthma, as well as child psychological functioning.

However, little empirical data has elucidated the relationship of child psychological functioning to well-controlled asthma (Nishimura, Hajiro, & Oga, 2004). Our findings indicate that the regularity of acute asthma symptoms was a significant predictor of both Albuterol use and asthma impairment in daily activities. Yet, contrary to our original prediction, and that of others (van Gent et al., 2008), none of these health status variables was a significant predictor of quality of life for either the parent or the child. Rather, our modeling confirmed the prediction that long-term asthma control over the preceding 12-month interval, in conjunction with psychological functioning, is key to understanding asthma quality of life.

Recommendations for Future Research

The findings from the current study add to a small body of research indicating that quality of life outcomes for children with asthma and their parents are as significantly influenced by psychological as health status variables. Clearly, the relationship between pediatric asthma health status and quality of life is more complex than previously known. In a cohort of children with controlled asthma, psychological variables that characterize normal individual differences contribute significantly to quality of life for both the child and their parents. These findings provide compelling data for pediatric asthma researchers to further explore measures of non-pathological function when examining quality of life outcomes. Likewise, these findings suggest that both acute and long-term asthma health status outcomes have different determinants. While the data in this study presents a picture of children with asthma at one point in time, subsequent clinical trials research may want to develop models that can carefully examine the relative contributions of acute and long-term health status determinants of quality life. Important in the current research is the implication that the construct quality of life, which is frequently used as an endpoint in clinical trials, has variance that can be ascribed to both long-term health status features and psychological factors. What remains unknown is whether the relationships observed in the current study can be applied to families that enroll in biomedical clinical trials.

Study Conclusions and Limitations

These findings provide a detailed conceptual framework to guide future research for children with asthma and their families. In particular, unique information is offered on the importance of considering psychological factors as well as health status factors in examining asthma specific quality of life outcomes. The structural models tested herein were premised upon a conceptual model with

empirical underpinnings. The findings from this study indicate the parent and child models adequately fit the data, explaining reasonable proportions of the variance (34% in the parent model and 49% in the child model).

It is possible that alternative methods for modeling the constructs or the selection of alternative indicators could result in different outcomes. For example, age of the child and ethnicity was not modeled and could result in different findings. Importantly, the indicators chosen for determining quality of life are narrowly focused in the current study, and a broader conceptualization of quality of life might result in a different outcome. Thus, if the latent variable quality of life were to be broadened or changed, a different structural model may be obtined. Similarly, improvement in the alpha reliabilities of several latent constructs may result in an alternative model. Some of the individual correlated results suggest that improvements could be made in the selection of indicators for the latent constructs or in the scaling of the latent constructs. Yet the findings from the present study do provide a more nuanced research model of the relationship between psychological functioning and asthma that has been emerging (e.g., Bender & Zhang, 2008). Finally, the findings presented need to be interpreted cautiously as they reflect a set of theoretical constructs and relationships between the theoretical constructs, which are assessed at a single point in time. For causal relationships to be clearly determined, a longitudinal dataset would be necessary.

Our participants were ethnically diverse, had well-controlled asthma, and did not have significant psychological difficulties. Moreover, the validity of psychological functioning reported in the BASC indicated general consistency within individual symptom reports and few cases of extreme symptom reporting. Furthermore, the children's asthma diagnosis, independently confirmed and classified through examination by an asthma specialist, indicated that participants had mild persistent to moderate persistent asthma, the most common asthma diagnoses in population studies (Akinbami, 2006; NHLBI, 2007). Results for participants with more severe asthma or more impaired psychological functioning may differ. It should also be noted that SEM procedures are confirmatory in nature and require a conceptual model that is data based, which may differ based upon the interpretation of available evidence. Additionally, in the application of SEM, correlations of the residuals within a construct can result in a latent construct that is not a pure measure of the construct of interest.

Taken together, this study provides insights into the joint contributions of health status and psychological functioning to asthma quality of life. It also suggests that

variables such as Albuterol use and impairments in daily activities, which have demonstrated associations with quality of life measures, may have been overemphasized in importance relative to psychological variables. Thus, a key strength of the SEM approach is that it offers a contextualized picture of the factors that provide unique and independent contributions to a particular outcome. In the case of asthma related quality of life, this analysis offers the perspective that research directed at addressing chronic health status factors as well as psychosocial functioning offers the greatest promise of benefit for both children with asthma and their parents.

Supplementary Data

Supplementary data can be found at: http://www.jpepsy.oxfordjournals.org/

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