

Transactional paths between children and parents in pediatric asthma: Associations between family relationships and adaptation

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Abstract

Introduction. The particular challenges posed by pediatric asthma may have a negative impact on the adaptation of children and their parents. From a transactional approach it is important to examine how reciprocal links between children and parents contribute to explain their adaptation and under which conditions these associations occur. This cross-sectional study aimed at examining the direct and indirect links between children's and parents' perceptions of family relationships and adaptation, separately (within-subjects) and across participants (cross-lagged effects), and the role of asthma severity in moderating these associations. **Method.** The sample comprised 257 children with asthma, aged between 8 and 18 years-old, and one of their parents. Both family members completed self-reported questionnaires on family relationships (cohesion and expressiveness) and adaptation indicators (quality of life and psychological functioning). Physicians assessed asthma severity. Structural Equation Modeling was used to test within-subjects and cross-lagged paths between children's and parents' family relationships and adaptation. **Results.** The model explained 47% of children's and 30% of parents' adaptation: family relationships were positively associated with adaptation, directly for children and parents, and indirectly across family members. Asthma severity moderated the association between family relationships and health-related quality of life for children: stronger associations were observed in the presence of persistent asthma. **Conclusion.** These results highlight the need of including psychological interventions in pediatric healthcare focused on family relationships as potential targets for improving children's and parents' quality of life and psychological functioning, and identified the children with persistent asthma as a group that would most benefit from family-based interventions.

Keywords

Adaptation • Asthma severity • Children and parents • Family relationships • Pediatric asthma

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Introduction

Asthma is an episodic chronic health condition that is characterized by asymptomatic periods alternating with exacerbation episodes (i.e., asthma attacks or acute asthma). The exacerbations are marked by progressive increases in shortness of breath, coughing, wheezing, or chest tightness or by a combination of these symptoms (Global Initiative for Asthma Program [GINA], 2008). A complex interaction between genetic susceptibility and environmental factors (e.g., air pollution, tobacco smoke, and microbial exposure) influences the development and manifestations of asthma (Von Mutius, 2009). Beyond these well-known environmental triggers, psychological factors, such as emotional stress, negative emotions, and passive coping strategies, have also been identified as emotional triggers of asthma symptoms (Lehrer, 1998; Wood et al., 2007). In the pediatric context, asthma affects not only the child but also the entire family and implies rearranging family organization and interaction patterns to avoid environmental and emotional triggers and manage treatment (Fiese, 2008; Morris, Silk, Steinberg, Myers, & Robinson, 2007), thereby requiring cooperation of all the family members. The influence of family and parental functioning on children's adaptation has been extensively addressed and is well documented in pediatric literature. In a literature review, Drotar (1997) concluded that supportive family relationships (e.g., families with high levels of cohesion) were associated with more positive psychological outcomes of children with chronic health conditions (e.g., fewer behavioral problems and better self-esteem). Conversely, family conflict, maternal distress and parental child-rearing practices characterized by overprotection consistently predicted children's psychological problems, such as lower self-control, behavioral problems and psychological distress (Drotar, 1997). However, scholars and researchers are increasingly acknowledging the reciprocity of influences between parents and children to better understand family adaptation in pediatric contexts (Fiese, 1997; Fiese & Sameroff, 1989). The present study used a transactional framework (Sameroff, 2009) to examine the ways in which family relationships were associated with adaptation for children and parents.

Studies of family processes and family interventions in pediatric asthma have a deep-rooted history (Fiese, 2008). Since the pioneering work of Minuchin and colleagues with families with a child with a psychosomatic illness (Minuchin et al., 1975), the psychobiological influence of family relationships on the emotional and physiological regulation of pediatric asthma patients has been addressed by several studies. Specifically, studies have demonstrated that higher levels of family cohesion are associated with children's better self-worth and few emotional and behavioral problems (Reichenberg & Broberg, 2005) and that a negative family emotional climate, characterized by low levels of expressiveness, is linked to children's depressive symptoms, which in turn are linked to asthma severity (Wood et al., 2007, 2008). The links between family relationships and adaptation outcomes of children with asthma are complex. Most studies have found that these pathways are

not always direct and are potentially mediated by individual and relational characteristics. For example, parent-child interaction patterns were found to mediate the links between a negative family emotional climate and children's depressive symptoms (Wood et al., 2008) and between the burden related to family routines to manage asthma and children's anxiety and quality of life (QoL) (Fiese, Winter, Anbar, Howell, & Poltrock, 2008). Annett, Turner, Brody, Sedillo, and Dalen (2010) also found that the association between a positive family environment and children's QoL was mediated by children's psychological functioning.

Undertaking research with children with chronic health conditions implies considering their social-ecological foreground, where the continuous reciprocal interactions between children and family members provide a context for understanding the individual and family adaptation (Kazak, 1989). Additionally, the transactional model of development emphasizes that children are active and influential participants in their life contexts (Fiese & Sameroff, 1989; Sameroff, 2009). Despite the growing awareness of the reciprocity of influences between children and parents, few empirical studies have addressed the influence of children's functioning on parents' adaptation in the specific context of pediatric asthma, and even those have examined parents' adaptation independently from children's adaptation (e.g., Annett et al., 2010; Bender et al., 2000). However, there is evidence of bidirectional associations between the QoL of children with asthma and their parents (Marsac, Funk, & Nelson, 2007; Vila et al., 2003) and of the influence of the psychological functioning of children with asthma on parents' QoL (Annett et al., 2010) and on the quality of parent-child relationships (Papp, Cummings, & Goeke-Morey, 2005).

The chronic nature of asthma and the unpredictability of its exacerbations pose particular challenges to children and their families and thus hinder the adaptation of all family members (Rolland, 2004). Physical limitations and restrictions on daily and social activities, dependence on medication and healthcare services, absence from school and work, and sleep disturbances are a few of the effects of pediatric asthma on the everyday life of children and their parents (Dean et al., 2010; Schmier et al., 2007). A growing body of research has demonstrated that children with asthma have more compromised global health-related quality of life (HrQoL) than their healthy peers (e.g., Schmier et al., 2007; Van Gent et al., 2007) and lower physical domain sub-scores than children with other chronic health conditions (e.g., Austin, Smith, Risinger, & McNelis, 1994). Additionally, asthma has been linked to a higher risk of developing emotional and behavioral problems (e.g., Goldbeck, Koffmane, Lecheler, Thiessen, & Fegert, 2007; McQuaid, Kopel, & Nassau, 2001; Vila et al., 2003), even though most children do not present with clinically significant psychopathological symptoms (Barlow & Ellard, 2006).

Asthma severity has been addressed extensively in empirical research; however, the role of this variable on children's QoL (for a review, see Everhart & Fiese, 2009) and psychological problems (McQuaid et al., 2001) remains unclear. Some studies have reported decreased HrQoL among

children with severe asthma (e.g., Sawyer et al., 2001), but other studies have failed to detect significant associations between asthma severity and children's QoL or emotional and behavioral symptoms (e.g., Goldbeck et al., 2007). These inconsistent findings highlight the limitations of clinical parameters for predicting patients' QoL (Juniper et al., 1999) and suggest possible interaction effects between clinical and psychosocial factors. For example, Patterson (2002) has suggested that when family members are exposed to increased stress, as in severe asthma, family organizational and communication patterns might improve adaptation by serving as coping strategies for withstanding and rebounding from adversity. For the parents of children with asthma, QoL impairments (e.g., Dean et al., 2010; Everhart, Fiese, & Smyth, 2008) and increased depression and anxiety prevalence (e.g., Brown et al., 2006) have been consistently linked to higher asthma severity indicators. In these studies, however, severity has been mainly reported by parents, and less is known about the role of severity as assessed through clinical parameters or expert opinion.

The rationale for the present study was based on evidence supporting the central but complex associations between family relationships and children's and parents' adaptation indicators, and on the transactional model of development that assumes a dynamic interplay between children and parents (Sameroff, 2009). The examination of the role of asthma severity on adaptation indicators was based on the hypothesis raised by Patterson (2002), according to which family relationships would be more important for family members' adaptation in more stressful circumstances. In the context of the present study, we considered "adaptation" within a positive theoretical framework, extending beyond the psychopathological conceptualization of the child and family responses to chronic illness and considering adaptation as a process that accounted for resiliency and variability on adaptation indicators (Harper, 1991). The children's and parents' adaptation was cross-sectionally evaluated through multiple indicators. We assessed children's internalizing and externalizing psychological problems and parents' psychological distress, including depression and anxiety symptoms, based on a more traditional research line pointing to these specific psychological functioning outcomes as potentially compromised in pediatric asthma patients and their parents. Following a more positive and recent trend that has emphasized the QoL as an important outcome criterion for assessing physical, emotional and social well-being and function in pediatric contexts (Bullinger, Schmidt, Petersen, & Ravens-Sieberer, 2006) we also included children's HrQoL and parents' QoL as adaptation indicators.

Within this conceptual framework, we sought to address some of the aforementioned gaps in the pediatric asthma literature by examining (a) the direct and indirect links between children's and parents' perceptions of family relationships and adaptation both separately (the within-subjects effects) and across family members (the cross-lagged effects); and (b) the moderating role of asthma severity on these associations. Three main hypotheses were formulated. First, we predicted positive associations between better family relationships and individual adaptation for both children and

parents, separately. Second, we hypothesized that: (a) children's perception of more positive family relationships would be linked to parents' better adaptation both directly and indirectly through children's adaptation; and (b) parents' perception of more positive family relationships would be associated with children's better adaptation both directly and indirectly via parents' adaptation. Finally, we expected that these links within and across family members would be stronger in families in which a child had more severe asthma. We also assessed whether these links were moderated by children's age and gender but made no specific predictions on this issue.

Method

Participants

The sample comprised 257 dyads consisting of Portuguese children with asthma, users of Pediatric and Immunoallergology outpatient services of three Portuguese public hospitals, and one of their parents. The children (163 boys and 94 girls) were between 8 and 18 years old ($M = 12.14$; $SD = 2.54$) and had had a clinical diagnosis of asthma for at least one year ($M = 7.54$ years; $SD = 3.98$). Regarding the asthma severity as assessed by physicians, 144 children (56%) had intermittent asthma, 65 children (25.3%) had mild persistent asthma, 40 children (15.6%) had moderate persistent asthma, and 8 children (3.1%) had severe persistent asthma. Most of children were using medication (98.1%, $n = 252$). The parents' sample, which consisted of 221 mothers (86%) and 36 fathers (14%), included those parents who were assuming the primary caregiver role in the children's healthcare issues. The parents' ages ranged from 27 to 64 years ($M = 41.11$; $SD = 5.71$). The great majority of parents were married or were living with a partner (80.5%, $n = 207$), while 18.7% ($n = 48$) of families lived in a single-parent household. Most of the families had low (60.3%, $n = 155$) and middle (26.8%, $n = 69$) socio-economic status.

Procedure

The present study was approved by the Ethics Committees of the following three Portuguese public hospitals: Coimbra University Hospitals, Coimbra Pediatric Hospital, and Leiria Santo Andre Hospital. The participants were selected from the readily available cases, i.e., the children who had medical appointments in the aforementioned health institutions' outpatient services during the period between March 2010 and January 2012 (non-probabilistic convenience method). For inclusion in the sample, the children had to meet the following criteria: (1) be between 8 and 18 years old; (2) be diagnosed with asthma by a physician according to the International

Classification of Diseases system (ICD-10); (3) have asthma for at least one year; (4) have no significant developmental delays, comorbidities with other chronic health conditions, or severe psychiatric disorders; and (5) be accompanied by a parent currently assuming the primary caregiver role. The children who met the aforementioned criteria were identified by the physicians, based on their medical file. A trained research assistant approached the children and their parents, while they were waiting for their medical appointments, and invited them to a separate room designated for research purposes in the health institution they attended. The study's aims and procedures were explained to all participants, and informed consent forms were requested from all of the parents and children older than 13 years; informal assents were obtained from the younger children. The children and parents who agreed to participate completed the protocols with the assistance of the assigned researcher, who helped the participants with difficulties in reading or understanding the item content and prevented the exchange of information between children and parents.

Measures

Family relationships

The children's and parents' perceptions of family relationships were measured as latent variables comprising two subscales – Cohesion and Expressiveness – from the relationship dimension of the Portuguese version of the Family Environment Scale (Moos & Moos, 1986; Portuguese version: Matos & Fontaine, 1992), as assessed by the children and parents, respectively. The Cohesion subscale (nine items) assessed the family members' perceptions of the degree of commitment, help and support that family members provided to each other, and the Expressiveness subscale (nine items) measured the extent to which family members were encouraged to express their feelings. Both subscales used a 6-point Likert scale ranging from 1 (*completely disagree*) to 6 (*completely agree*), with higher scores indicating better family relationships. The reliability and validity of these two subscales were demonstrated in the original validation studies, conducted with a heterogeneous sample consisting of children as young as 8 years, adolescents and adults (Moos & Moos, 1986). Additionally, studies with the Portuguese version of the Family Environment Scale have shown adequate reliability of the Cohesion and Expressiveness subscales for use in different age groups (e.g., Crespo, Carona, Silva, Canavarró, & Dattilio, 2011). The Cronbach's alpha values in the current sample exceeded .70 for all subscales, except for the Expressiveness subscale as reported by the children, and .80 for the latent variables (see Table 2).

Children's adaptation

Children's adaptation was considered a latent variable that consisted of three observed indicators as assessed by the children: generic HrQoL, generic HrQoL for chronic health conditions

and psychological problems. Generic and chronic-generic HrQoL were respectively measured by the Portuguese self-reported versions of the KIDSCREEN-10 Index (Ravens-Sieberer et al., 2010; Portuguese version: Gaspar & Matos, 2008), a 10-item questionnaire assessing children's general subjective health and well-being, and of the DISABKIDS Chronic Generic Module (The DISABKIDS Group Europe, 2006; Portuguese version: Carona et al., 2013), a 37-item questionnaire assessing the impact of chronic conditions and treatments on children's QoL. Both questionnaires were answered using a 5-point Likert scale ranging from 1 (*never*) to 5 (*always*), with higher scores indicating better HrQoL. These two questionnaires were specifically designed and tested for use in children and adolescents aged between 8 and 18 years-old (Ravens-Sieberer et al., 2007). The Portuguese versions of the KIDSCREEN and DISABKIDS questionnaires were semantically and psychometrically validated in studies conducted with children and adolescents from the general population aged between 10 and 16 years (Gaspar & Matos, 2008) and with children and adolescents with asthma or epilepsy aged between 8 and 18 years (Carona et al., 2013), respectively.

Psychological problems were measured with the total Difficulties score of the Portuguese self-rated version of the Strengths and Difficulties Questionnaire [SDQ] (Goodman, 2001; Portuguese version: Fleitlich, Loureiro, Fonseca, & Gaspar, 2005). This scale included the assessment of emotional symptoms, conduct problems, hyperactivity/inattention and peer relationship problems, based on 20 items that used a Likert-type response scale with three options (*not true*, *somewhat true*, or *certainly true*), with higher values indicating more psychological problems. The self-rated version of the SDQ was originally developed for use with children aged between 11 and 16 years-old, depending on their cognitive abilities and educational level (Goodman, 2001). However, the Portuguese self-rated version has presented good psychometric properties in samples of children as young as 8 years-old (e.g., Santos, Crespo, Silva, & Canavarro, 2012). The Cronbach's alpha in the current sample was .94 for the latent variable and ranged from .76 (psychological problems) to .92 (chronic-generic HrQoL) for the observed indicators (see Table 2).

Parents' adaptation

Parents' adaptation was a latent variable composed of three observed indicators, as assessed by the parents: QoL, which was measured by the Portuguese version of the EUROHISQOL-8 (Schmidt, Mühlan, & Power, 2006; Portuguese version: Pereira, Melo, Gameiro, & Canavarro, 2011), psychological distress and psychological well-being, both of which were measured by the Portuguese brief version of the Mental Health Inventory [MHI-5] (Veit & Ware, 1983; Portuguese version: Pais-Ribeiro, 2001). The EUROHIS-QOL 8-item Index provided an overall QoL score that evaluated the physical, psychological, social and environmental QoL domains using eight items scored on a 5-point Likert scale ranging from 1 (*not at all/ very dissatisfied*) to 5 (*completely/very satisfied*), with higher scores indicating better QoL.

The MHI-5 consisted of five items that focused on the psychological symptoms of depression, anxiety, loss of emotional and behavioral control, and positive affect. These items were clustered in two dimensions – Distress (three items) and Well-being (two items) and were measured using a Likert-type response scale with six responses ranging from 1 (*none of the time*) to 6 (*all of the time*). In the current sample, Cronbach's alpha was .89 for the latent variable and ranged from .69 (psychological well-being) to .87 (psychological distress) for the observed indicators (see Table 2).

Asthma severity

Following the Global Initiative for Asthma [GINA] guidelines (2008), the asthma severity was classified by physicians into four categories: intermittent, mild persistent, moderate persistent and severe persistent. This classification was based on the expert opinion, considering the level of symptoms, airflow limitation and lung function variability. Due to the heterogeneous severity level distribution observed in our sample, this variable was dichotomized and dummy coded (0 – intermittent, $n = 144$; 1 – persistent [mild, moderate, and severe], $n = 113$).

Clinical and socio-demographic characteristics

Other relevant clinical information (e.g., disease length and medication) and socio-demographic data were collected from the parents. The socio-economic level was determined using a classification system for the Portuguese context, based on parents' job and educational level (Simões, 1994). For the group comparison analyses, children were divided into two age groups based on the DISABKIDS Group Europe's (2006) approach: children (8-12 years old) and adolescents (13-18 years old). For remaining analyses, we adopted the term children when referring to the pediatric sample, which included both age groups.

Statistical analyses

The statistical analyses were performed with the Statistical Package for the Social Sciences v. 17.0 (SPSS Inc., Chicago, IL). Missing data, that were random and constituted less than 5% of the values, were handled by replacement with the individual mean score for each variable, excluding clinical and demographic data. For all observed variables, descriptive statistics were calculated and differences between asthma severity groups (intermittent vs. persistent) were tested with multivariate analyses of covariance (MANCOVA). These analyses were controlled for age and gender, by including them as covariates. Effect-size measures (partial Eta squared) were presented for the comparison analyses, considering $\eta_p^2 \geq .01$ as small effects, $\eta_p^2 \geq .06$ as medium effects and $\eta_p^2 \geq .14$ as large effects (Cohen, 1988).

The structural equation modeling (SEM) was implemented with the Analysis of Moments Structures (AMOS, v.18). The models' goodness of fit was assessed in two steps (the measurement model and the structural model) using the reference values for the main fit indexes: maximum-likelihood χ^2 p -value $\geq .05$, comparative fit index (CFI) $\geq .95$ and root mean square error of approximation (RMSEA) $\leq .06$ (Hu & Bentler, 1999). In the first step, to analyze the appropriateness of the multi-dimensionality of the theoretical constructs, we conducted a confirmatory factor analysis (CFA) testing the hypothesized links between latent variables (family relationships as reported by the children, family relationships as reported by the parents, children's adaptation and parents' adaptation) and their observed indicators (Byrne, 2010). In the second step, we constructed a structural model to test the direct and indirect effects of children's and parents' perceptions of family relationships on adaptation, separately (within-subjects) and across participants (cross-lagged effects). Following recent recommendations (Preacher & Hayes, 2008; Williams & MacKinnon, 2008), the statistical significance of the indirect effects was estimated using bootstrap resampling procedures with 2,000 samples [95% bias-corrected bootstrap confidence interval (BC 95% CI)]. Multi-group analyses were conducted to determine whether the parameters tested in the model were valid for different groups (children's age, gender and asthma severity groups). We used the Chi square difference method to compare the unconstrained measurement weights model with the structural weights model in which the factor loadings and variances/covariances were fixed and equal across groups (Byrne, 2010). Post-hoc Z-tests were performed to examine which structural coefficients significantly differed between the groups.

Finally, to further investigate the paths that significantly differed between the groups, we conducted separate moderation analyses for each adaptation indicator (children's generic HrQoL, chronic-generic HrQoL and psychological problems). We performed multiple regression analyses by entering the centered independent variable (family relationships as assessed by the children), the categorical moderator (asthma severity levels: intermittent vs. persistent) and the interaction term (family relationships \times asthma severity) into the equation, in sequential steps. The significant interaction effects were plotted using Mod-Graph (Jose, 2008), and the statistical significance of each regression line was analyzed with post hoc simple slope computations.

Results

Descriptive statistics and multivariate analyses of covariance

Descriptive statistics for all observed variables are presented in Table I. For children's adaptation indicators, there was a statistically significant multivariate effect according to asthma

severity groups (intermittent vs. persistent), controlling for age and gender, Wilks' Lambda = .97, $F_{(3, 251)} = 2.85$, $p = .04$, $\eta_p^2 = .03$. The univariate analyses, which are presented in Table 1, showed that children with intermittent asthma reported better chronic-generic HrQoL and fewer psychological problems than children with persistent asthma. While controlling for age and gender, no multivariate effects of asthma severity groups were found for parent's adaptation indicators, Wilks' Lambda = .99, $F_{(3, 251)} = 0.43$, $p = .73$, $\eta_p^2 = .01$, neither for family relationships as assessed by the children, Wilks' Lambda = .99, $F_{(2, 252)} = 0.68$, $p = .51$, $\eta_p^2 = .01$, or as assessed by the parents, Wilks' Lambda = .99, $F_{(2, 252)} = 1.23$, $p = .29$, $\eta_p^2 = .01$.

Table 1 | Descriptive analyses and differences in children's and parents' perceptions of family relationships and adaptation indicators between asthma severity groups

	Intermittent asthma (<i>n</i> = 144)	Persistent asthma (<i>n</i> = 113)	Asthma severity effects		
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	$F_{(1, 253)}$	<i>p</i>	η_p^2
Children					
Family relationships					
Cohesion	4.96 (0.85)	4.94 (0.90)	0.03	.87	.00
Expressiveness	4.52 (0.71)	4.43 (0.69)	0.92	.34	.00
Adaptation indicators					
Generic HrQoL	4.29 (0.52)	4.19 (0.62)	2.01	.16	.01
Chronic-generic HrQoL	4.32 (0.43)	4.15 (0.54)	7.70	.01	.03
Psychological problems	0.50 (0.25)	0.57 (0.27)	3.79	.05	.02
Parents					
Family relationships					
Cohesion	4.84 (0.77)	4.89 (0.75)	0.29	.59	.00
Expressiveness	4.58 (0.72)	4.71 (0.71)	1.95	.16	.01
Adaptation indicators					
QoL	3.70 (0.56)	3.77 (0.53)	1.15	.29	.01
Psychological well-being	3.85 (1.08)	3.87 (1.12)	0.04	.84	.00
Psychological distress	2.64 (0.90)	2.59 (1.04)	0.20	.66	.00

The measurement model

The measurement model (CFA) with the four latent variables (family relationships as reported by the children and parents and children's and parents' adaptation) had a very good fit, with $\chi^2_{(29)} = 35.60$, $p = .19$; CFI = .99 and RMSEA = .03, and all of the observed indicators showed factorial validity with factor loadings above .50 and statistically significant (see Table 2). The squared multiple correlations between each observed variable and all the other variables (R_{smc^2}) were lower than .90 and the tolerance values ($1 - R_{smc^2}$) were higher than .10 (see Table 2), indicating that each one of the observed variables explained a substantial proportion of the total standardized variance, and thus the model was not limited by multicollinearity problems (Kline, 2005). Except for expressiveness reported by the children, the Cronbach's alphas were adequate for the observed

indicators and good (above .80) for all four latent variables (see Table 2). As shown in Table 2, the family relationships were moderately to strongly associated with adaptation, and these associations were significant for both children and parents separately, and also across family members. The asthma severity was negatively correlated with the children's chronic-generic HrQoL.

The structural equation model

A structural model was constructed to examine the direct and indirect links between family relationships and adaptation, for children and parents separately (within-subjects) and across participants (cross-lagged effects). Following the trimming procedures described by Kline (2005), the non-significant paths were removed. The final model, which is depicted in Figure 1, had a very good fit, with $\chi^2_{(31)} = 38.24$, $p = .17$; CFI = .99 and RMSEA = .03, and explained 46.7% of the variability in children's adaptation, and 29.7% of the variability in parents' adaptation. Significant indirect effects were found between family relationships and adaptation across family members. The standardized indirect effect of family relationships as reported by children on parents' adaptation, via children's adaptation, was .10 ($p = .002$; BC 95% CI = .04/ .17), and the standardized indirect effect of family relationships as reported by parents on children's adaptation, via parents' adaptation, was .05 ($p = .002$; BC 95% CI = .02/ .10).

The multi-group analyses confirmed that the model was valid for the children's age and gender groups. However, the model significantly differed for the two asthma severity groups (intermittent and persistent), with $\Delta\chi^2_{(3)} = 10.21$, $p = .02$. Only the coefficient of the regression path between the children's perception of family relationships and children's adaptation was significantly different ($Z = -2.08$, $p < .05$) in the post hoc Z-tests. A stronger regression weight was observed in the persistent asthma group ($B = .45$, $SE = .07$) than in the intermittent asthma group ($B = .26$, $SE = .06$).

Table 2 | Matrix of inter-correlations (Pearson), factor loadings and Cronbach's alphas for observed and latent variables

Variable	Children					Parents					R_{smc}^2	Tolerance ($1 - R_{smc}^2$)	Factor loadings	α				
	1	2	B	3	4	5	C	6	7	D					8	9	10	
Children																		
A. Family relationships			.64**				.47**			.29**								
1. Cohesion														.89	.11	.95**	.85	
2. Expressiveness	.68**													.52	.48	.72**	.56	
B. Adaptation							.44**			.41**								.94^a
3. Generic HrQoL	.52**	.40**												.65	.35	.81**	.81	
4. Chronic-generic HrQoL	.46**	.33**		.65**										.64	.36	.80**	.92	
5. Psychological problems	-.41**	-.30**		-.52**	-.53**									.44	.57	-.66**	.76	
Parents																		
C. Family relationships										.51**								.87
6. Cohesion	.37**	.30**		.30**	.31**	-.27**								.76	.24	.87**	.81	
7. Expressiveness	.39**	.33**		.28**	.28**	-.28**		.73**						.71	.29	.84**	.73	
D. Adaptation																		.89^a
8. QoL	.25**	.16**		.22**	.28**	-.26**		.36**	.30**					.46	.54	.68**	.84	
9. Psychological well-being	.23**	.20**		.22**	.26**	-.22**		.38**	.35**		.51**			.62	.38	.79**	.69	
10. Psychological distress	-.21**	-.12		-.18**	-.36**	.24**		-.35**	-.33**		-.59**	-.68**		.74	.26	-.86**	.87	
Asthma severity ^b	-.01	-.06		-.09	-.17**	.12		.03	.09		.07	.01	-.03					

Note. Inter-correlations and Cronbach's alphas for latent variables are shown in boldface.

^a In order to estimate Cronbach's alpha of the latent variables, the negative dimensions (children's psychological problems and parents' psychological distress) scores were reversed, so that all items were in same direction and positively correlated. ^b Dummy-coded variable (0 – intermittent asthma; 1 – persistent asthma).

** $p \leq .01$, two-tailed; * $p \leq .05$, two-tailed.

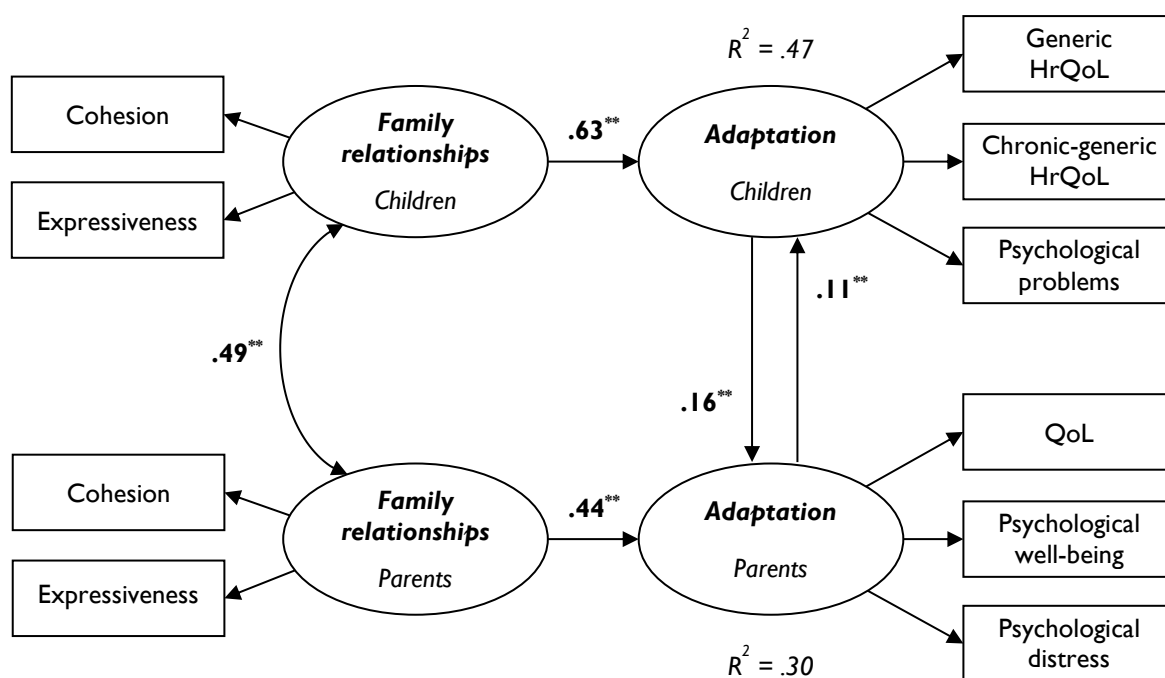


Figure 1 | SEM testing the direct and indirect effects of family relationships on children's and parents' adaptation

Note. Non-significant paths are not represented (trimmed model). Bold figures represent standardized coefficients; italic non-bold figures represent Pearson correlation coefficients. For simplicity, measurement error terms are not shown. ** $p \leq .01$; * $p \leq .05$.

Moderation analyses

To further investigate the role of asthma severity on the link between family relationships as reported by children and children's adaptation, we separately tested the moderating effect of asthma severity on the associations between the children's perception of family relationships and each of the three indicators of children's adaptation (generic and chronic-generic HrQoL and psychological problems). The interaction between asthma severity and family relationships was significantly associated with generic HrQoL ($b = .19$; $t = 2.63$, $p < .01$) and with chronic-generic HrQoL ($b = .20$; $t = 2.66$, $p < .01$) (see Figure 2) but was only marginally associated with psychological problems ($b = -.13$; $t = -1.68$, $p = .09$).

The post hoc simple slope analyses revealed that family relationships were more strongly associated with HrQoL for the children with persistent asthma ($b = .52$; $t = 8.22$, $p < .001$ for generic HrQoL, and $b = .40$; $t = 6.32$, $p < .001$ for chronic-generic HrQoL) than for the children with intermittent asthma ($b = .30$; $t = 5.46$, $p < .001$ for generic HrQoL, and $b = .20$; $t = 4.52$, $p < .001$ for chronic-generic HrQoL).

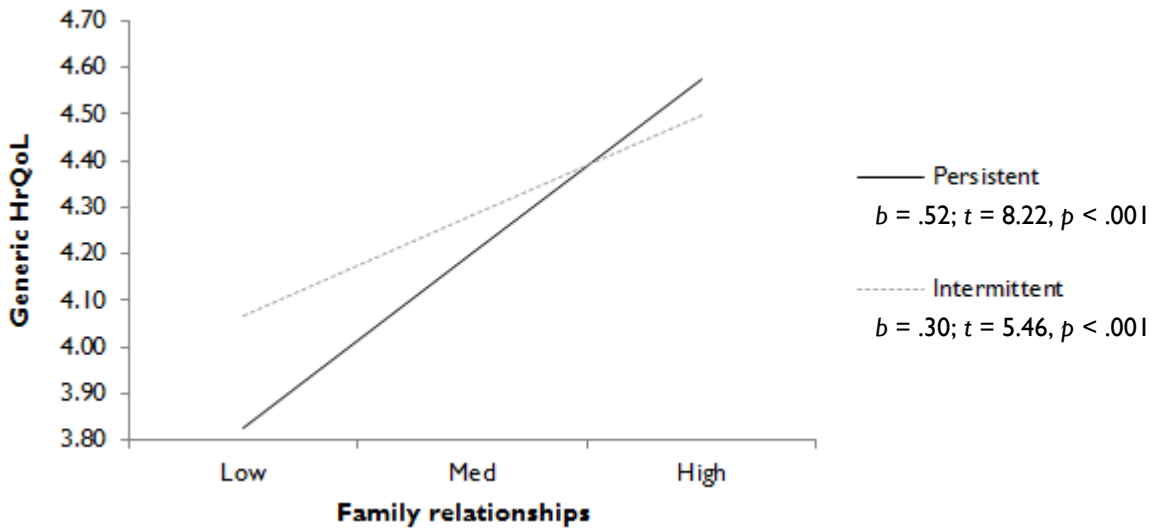


Figure 2 | The moderating effect of asthma severity on the associations between children’s perception of family relationships and children’s generic HrQoL

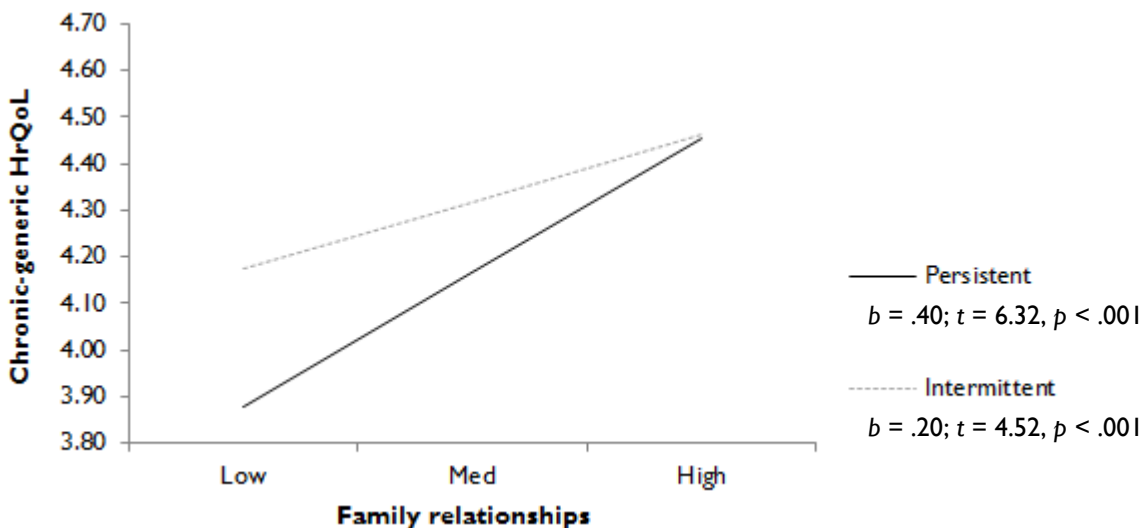


Figure 3 | The moderating effect of asthma severity on the associations between children’s perception of family relationships and children’s chronic-generic HrQoL

Discussion

This study described an examination, via SEM, of the direct and indirect links between children’s and parents’ perceptions of family relationships and adaptation, within and across family members. The model had a very good fit, which empirically supported the relevance of a

transactional approach to understanding the adaptation of children with asthma and their parents. Three main findings should be considered. First, positive family relationships, as assessed by the children, were directly associated with children's better adaptation and also positive family relationships, as assessed by the parents, were directly associated with parents' better adaptation. Second, the links between family relationships and adaptation were also verified across family members, although only indirectly. Specifically, the children's perception of more positive family relationships were linked to parents' better adaptation, via children's own adaptation; and the parents' perception of more positive family relationships were linked to children's better adaptation, through a positive association with parents' adaptation. Finally, asthma severity moderated the positive associations between the children's perception of family relationships and generic and chronic-generic HrQoL, with stronger associations found for the children with persistent asthma.

The first set of results from the present study supports previous research on the relevance of family relationships for understanding the adaptation of children with asthma and their parents (e.g., Annett et al., 2010; Wood et al., 2008), but also clarifies how family relationships contribute to explaining the adaptation variability. As stated in our first hypothesis, better family relationships, characterized by higher levels of cohesion and expressiveness as assessed by the children and parents, were positively associated with children's and parents' adaptation, respectively. Differently from the enmeshment, which is associated with exacerbated psychosomatic asthma symptoms (Minuchin et al., 1975), family cohesion (emotional bonding among family members, that is balanced between disengagement and enmeshment) has been identified as a facilitator of family functioning in general (Olson & Gorall, 2003) and of the psychological adjustment of children with asthma in particular (Reichenberg & Broberg, 2005). Family communication has been conceptualized as a facilitatory process that regulates family functioning (Olson & Gorall, 2003), promoting families' ability to adapt through its affective function (i.e., sharing feelings and emotional support) and its instrumental function, which includes role assignments, decision making and conflict resolution (Patterson, 2002). In the pediatric asthma context, a family environment perceived as a safe haven for openly express feelings, opinions and concerns could be significantly associated with children's and parents' adaptation, by promoting emotional regulation and decreasing family conflict, thus minimizing emotional asthma triggers (Minuchin et al., 1975; Wood et al., 2007). Such a family environment is also likely to facilitate the beneficial effect of well-organized daily family routines on the family members' adaptation (Santos et al., 2012), and to buffer the negative impact of the burden associated with asthma management (Crespo et al., 2011; Fiese et al., 2008).

Beyond the direct links with both children's and parents' adaptation, children's and parents' perceptions of more positive family relationships were also associated with better adaptation across family members, however only indirectly, which partially confirmed our second hypothesis. In a previous study (Crespo et al., 2011), a significant association was observed between the parents'

perception of family environment and the QoL of children with asthma. Similarly, supportive family relationships as assessed by the parents and parental psychological functioning have been widely identified in the pediatric literature as important predictors of children's adaptation outcomes (Drotar, 1997). The present study is unique in its examination of the transactional links between children and parents and the indirect pathways by which they occur. The bidirectional links between children's and parents' adaptation have barely been investigated in the particular context provided by pediatric asthma, although they are well established in the normative development literature (Sameroff, 2009) and there is growing recognition of the similarities between the functioning of families who have a child with a chronic health condition and other families (Fiese, 2008; Kazak, 1989). The associations between mother-child interaction patterns and children's QoL and anxiety found by Fiese et al. (2008) and the positive bidirectional link between children's and mothers' QoL presented by Marsac et al. (2007) are important evidence of the interdependence of family members' adaptation.

A second original contribution of the present study is the identification of the clinical conditions in which family relationships can be more relevant to adaptation. The comparative analyses according to the asthma severity levels presented no significant differences in family relationships, either reported by the children or reported by the parents, but showed that children with persistent asthma had poorer chronic-generic HrQoL and more psychological problems than children with intermittent asthma. Additionally, asthma severity moderated the association between family relationships as assessed by the children and children's HrQoL, with stronger associations found for children with persistent asthma. These results suggest that children's HrQoL may be better explained by the interaction between clinical and psychosocial variables rather than single clinical indicators, thus partially confirming our third hypothesis. Asthma's clinical characteristics (e.g., severity) impose different physical and psychosocial demands on children (Rolland, 2004); the means by which these demands are fulfilled within a specific family environment may influence children's adaptation. In contrast to previous studies, which have demonstrated that asthma severity and caregiving burden are the risk factors with most impact on parents' QoL (e.g., Everhart et al., 2008), for the participants in the present research, asthma severity had no effect on parents' adaptation indicators. These results may be due to the low percentage of children with severe asthma in our sample, which were included in the persistent asthma group. The absence of differences in parent's adaptation indicators regarding asthma severity levels could also be explained by the episodic nature of asthma and the uncertainty associated with asthma exacerbations. To improve asthma symptoms control, parents' concerns and involvement in caregiving tasks, including routine healthcare services attendance, medication management and avoiding environmental triggers, are kept unchanged, which may be linked to parents' decreased QoL and psychological functioning regardless of asthma severity.

Children's developmental stages and family life-cycle phases can affect how chronic health conditions and family resources are perceived and managed by family members (Kazak, 1989; Rolland, 2004), yet our model did not change for children's age and gender. These findings suggest that, when family relationships are perceived as adequately balancing the different needs of autonomy and emotional sharing that are intrinsic to children's developmental phases (Collins & Laursen, 2004), families provide a safe haven for their members, facilitating individual adaptation.

The interpretation of our findings should be read with caution, considering some limitations in the study design and procedures. The main limitation of this study is its cross-sectional design. Using SEM to test indirect effects with cross-sectional data assumed that the reciprocal causal processes had already occurred and that the system was at an equilibrium point (Kline, 2005). The latter assumption was addressed in our study by including children who had asthma for at least one year, thereby minimizing the effects of acute stress responses to recent diagnoses and enabling families to stabilize their functioning in the novel context created by pediatric asthma. However, this approach can only provide a snapshot of the ongoing dynamic processes between parents and children (Sameroff, 2009). Although the directional paths addressed in our study have been hypothesized according to the theoretical and empirical literature, the cross-sectional design excludes inferring causality among the variables. Further longitudinal research should be undertaken to clarify the direction of these associations and to examine whether individual and family developmental changes influence the parent-child interaction patterns and the adaptation process over time. Our study was also limited by the non-probabilistic sample collection method and the heterogeneous distribution of children by asthma severity levels. Although consistent with the distribution of asthma severity levels typically observed in the Portuguese pediatric population (Gaspar, Almeida, & Nunes, 2006), the low frequency of children with severe asthma required the variable to be dichotomized and increased intragroup variability. Additionally, the classification of asthma severity based on the expert opinion rather than on objective measures, although indicated for cross-sectional research purposes (GINA, 2008), should be acknowledged as a study's limitation. The specificity of our sample, namely the inclusion of families mostly from low and middle socio-economic background, a characteristic of the users of public health services in Portugal, might restrict the generalizability of the results to other contexts.

Despite these limitations, our study addressed some important gaps in the pediatric asthma literature. Assessing the perceptions of two family members regarding the relationships among the whole family provided further insight into the interactions among family members (Kazak, 1997). The importance of multiple informants extends to the children's self-reported adaptation indicators and the clinicians' assessments of asthma severity. Both of these sources can enhance parent-reported data, which is likely to be biased by parental perceptions and expectations (Everhart & Fiese, 2009). Using SEM allowed analyzing the indirect and conditional effects, thereby contributing to

understanding the processes through which family relationships are linked to children's and parents' adaptation and to examining under which clinical and developmental conditions these associations occur. Moreover, assessing the children's and parents' adaptation as latent variables allowed including general and specific indicators of adaptation, thus confirming the important role of family variables on the physical, psychological and social domains of subjective health and functioning.

Identifying the central role of family relationships for explaining the adaptation of children with asthma and their parents reinforced the need to include multidisciplinary interventions in pediatric healthcare. In addition to medical treatments aimed at controlling asthma symptoms and improving physical functioning, including intervention strategies designed to promote positive family factors would help enhance children's and parents' quality of life and psychological functioning (Fiese, 1997; Sawyer et al., 2001). Family communication and interaction patterns are specific potential targets that should be addressed by interventions aimed at strengthening a family's ability to cope with pediatric asthma demands, particularly in severe cases (Patterson, 2002).

Additionally, the reciprocal paths between children's and parents' adaptation have important clinical implications, given that less positive family relationships may lead to the deterioration of family members' adaptation over time. Interventions focused on promoting a sense of belonging to the family and communication skills may be an effective method of promoting both individual and family-wide adaptation. These interventions should target all family members to maximize their efficacy (Kazak, 1989; Minuchin et al., 1975). However, our results suggest that, when involving the entire family is impossible or undesirable, individual interventions focused on the children's or parents' perceptions of family relationships would also be effective at improving individual and family-wide adaptation.

Finally, our results identified children with more severe asthma as the group that would benefit most from family-based psychological interventions. Allocating psychological interventions to children and families within healthcare systems should be based on comprehensive evaluations of asthma severity levels and family relationships.

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