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Impact of caregiver depression on child asthma outcomes in Mexicans and Puerto Ricans

Karenjot Kaur, PhD^a, Kimberly J. Arcoleo, PhD, MPH^b , Denise Serebrisky, MD^c, Deepa Rastogi, MBBS, MS^d, Flavio F. Marsiglia, PhD^e and Jonathan M. Feldman, PhD^{a,f} 

^aFerkauf Graduate School of Psychology, Yeshiva University, Bronx, NY, USA; ^bCollege of Nursing, University of Rhode Island, Providence, RI, USA; ^cJacobi Medical Center, Bronx, NY, USA; ^dChildren's National Medical Center, GW University School of Medicine and Health Science, Washington, DC, USA; ^eSchool of Social Work, Arizona State University, Phoenix, AZ, USA; ^fAlbert Einstein College of Medicine, Children's Hospital at Montefiore, Bronx, NY, USA

ABSTRACT

Objective: Examine whether caregiver depressive symptoms at baseline predict longitudinal child asthma outcomes in the two populations with the largest asthma disparities: Mexicans and Puerto Ricans.

Methods: Two hundred and sixty-seven Hispanic caregiver–child dyads (Mexican = 188, Puerto Rican = 79; children 5–12 years) were recruited from clinics and hospitals in Phoenix, AZ and the Bronx, NY. The Center for Epidemiological Studies Depression Scale assessed caregiver depressive symptoms; higher scores indicate greater depressive symptomology. Medical records verified child asthma diagnosis. Assessments for outcome variables occurred at baseline, 3, 6, 9, and 12-month follow-ups. Pulmonary function was measured by spirometry, asthma control was measured by the Asthma Control Test, steroid bursts and acute healthcare utilization were assessed by caregiver report and medical records, and adherence was measured by doser devices on controller medications. Structural equation modeling analyzed baseline caregiver depressive symptoms as a predictor of longitudinal child asthma outcomes, and differences between subgroups.

Results: Higher caregiver depressive symptoms predicted better pulmonary function ($\beta = .02$, $p = .001$) in Mexican children, and fewer steroid bursts ($\beta = -.41$, $p = .01$) and better medication adherence ($\beta = .02$, $p = .07$) in Puerto Rican children. Caregiver depressive symptoms did not predict pediatric asthma control or acute healthcare utilization in either subgroup.

Conclusions: Caregiver depressive symptomology had unexpected effects on child asthma outcomes. Results may be explained by the Hispanic paradox, caregiver resilience, acculturation, and the study's longitudinal nature. Further research is needed on social determinants of health that may influence differences in child asthma outcomes in heterogeneous Hispanic communities.

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Introduction

The largest disparities in asthma prevalence and control exist between Puerto Ricans and Mexicans (1,2). Puerto Rican children exhibit the highest rates of asthma prevalence and mortality among all ethnic groups (1,3) and Mexican children exhibit the lowest rates (4). Differences in environmental triggers may contribute to these asthma disparities (5). Puerto Rican children living in the Bronx are more likely to be exposed and sensitized to cockroaches, mice, rats, and mold than children living in other urban regions

of the U.S (6). Acculturation and social factors may also contribute to asthma disparities (7). The role these factors play is complex, as there is conflicting evidence regarding the directionality of their influence. Acculturation has been associated with worse health outcomes in some studies (8) and with positive health outcomes in others (9). Mexican children with less acculturated caregivers had lower asthma-related burden (10). Social support has predicted better asthma control in both Mexicans and Puerto Ricans (11). An increase in social and familial support may reduce asthma morbidity through reduction in

caregiver acculturation-related stress in Hispanic population (12).

Caregiver depression may be an important factor contributing to ethnic disparities in asthma outcomes, as caregiver mental health has been associated with the onset and unfavorable trajectory of child asthma (13). Among Hispanic populations in the United States, Puerto Ricans have the highest prevalence of depressive symptoms and Mexicans have the lowest (14). Puerto Rican women also have higher rates of depression diagnoses than Mexican women (15). In general, mothers of children with asthma have more depressive symptoms than mothers of children without asthma (16). The greater presence of depressive symptoms in these caregivers is problematic since mothers consistently report having a large responsibility for their child's asthma management (17). Additionally, both persistent and increasing maternal depressive symptomology are associated with greater likelihood of child asthma (18).

Caregiver depressive symptoms have been linked to worse asthma outcomes in children and increased asthma morbidity, as determined by: increased asthma symptoms (19), fewer symptom-free days (20), and lower pulmonary function (21). Caregiver depressive symptoms have prospectively predicted more asthma symptoms in children (22). Caregiver depression has also been associated with more asthma-related emergency room visits (23), greater rates of hospitalizations (24), and poorer asthma control in children (25).

Caregiver depression may be linked to increased asthma morbidity in children through low self-efficacy in managing children's asthma attacks and poor medication adherence (26). Higher caregiver depressive symptoms have previously been linked to decreased child asthma medication adherence (27). Poor adherence to inhaled corticosteroid (ICS) medications is common in children with asthma, especially in racial minorities (28,29), and often declines over time (30). Only 26%–53% of prescribed ICS doses are taken (28,31). ICS use is particularly low in children of Caribbean-Hispanic descent (32), especially Puerto Rican children (28). Although caregiver depressive symptoms have previously been linked to worse pediatric asthma outcomes, the longitudinal effects are not known. Given that caregiver depressive symptomology can be identified and treated (33), understanding this relationship is crucial in managing barriers to child asthma management.

This study assessed whether caregiver depressive symptoms at baseline prospectively predicted child asthma outcomes across 12 months in Mexicans and Puerto Ricans. We hypothesized that caregiver

depressive symptoms would be maladaptive and predict worse asthma control (pulmonary function, self-report of asthma symptoms, steroid bursts), greater asthma-related healthcare utilization, and lower ICS adherence in both ethnic subgroups. We also analyzed social and acculturation-related factors to address the historical discrepancies between the Hispanic subgroups that may contribute to asthma disparities (7).

Methods

Subjects

Details on the setting, sample, and recruitment procedures have been previously reported (34) and will be briefly summarized here. Hispanic caregiver-child dyads ($n=267$) were recruited by provider mailings, phone calls, and in-person enrollment at two school-based health clinics and Phoenix Children's Hospital Breathmobile in Phoenix, AZ, and two inner-city hospitals in the Bronx, NY from 6/23/10 to 10/1/13. An average of 6.7 dyads were enrolled each month. The enrolled dyads identified, per caregiver self-report, as Puerto Rican ($n=79$) or Mexican ($n=188$). The children were 5–12 years old and diagnosed with asthma, as confirmed by electronic medical chart reviews. Other inclusion criteria were English or Spanish speaking dyads and caregivers with primary or equal management responsibility for the child's asthma. Exclusion criteria were severe learning or cognitive disabilities impacting study participation and other significant pulmonary conditions in the child.

Procedure

This study on caregiver depressive symptomatology was part of a larger, multisite, longitudinal study aimed to better understand the impact of caregivers' illness representations on pediatric asthma disparities within Puerto Rican and Mexican subgroups (34). The parent study was approved by Albert Einstein College of Medicine, Arizona State University, Ohio State University, Phoenix Children's Hospital, and Scottsdale Healthcare Institutional Review Boards. Dyads provided written consent/assent at baseline and then completed study measures in either English or Spanish (based on preference) at baseline and 3, 6, 9, and 12-month follow-up sessions. Retrospective medical record reviews were completed for the 12-month study period to obtain data on healthcare utilization and prescribed asthma medications. Spirometry testing was

utilized to assess children's pulmonary function at all sessions. Dyads were financially compensated for their participation and travel to appointments.

Measures

Exogenous variables

Caregiver depression. To assess depressive symptomology in caregivers, the Center for Epidemiological Studies Depression Scale (CES-D) was administered at baseline. This 20-item measure asks caregivers to rate depressive symptoms over the past week with emphasis on affect. Responses for each item range from 0 to 3; higher scores indicate greater symptom severity. A cutoff score of 16 or higher indicates risk for clinical depression (35). For this study, the CES-D was examined as a continuous measure; however, categorical cutoffs were created for descriptive purposes. The CES-D was utilized due to its high internal-consistency ($\alpha = .85-.90$) in English and Spanish ($\alpha = .93$) (36), good construct validity, and moderate test-retest correlation ($r = .40$) (35). We reported good internal consistency for the English ($\alpha = .82$) and Spanish ($\alpha = .78$) CES-D versions in this sample (34).

Social/contextual factors. Several social and contextual measures at baseline were included in the structural equation models (SEM) based on literature identifying these variables as key factors in children's asthma health disparities and asthma outcomes (7). These were child and caregiver sex, caregiver marital status, caregiver reported poverty status, caregiver education, caregiver preferred language, child and caregiver age, child's asthma duration, and number of family members with asthma.

Study clinicians rated asthma severity as intermittent, mild persistent, moderate persistent, or severe persistent based on national guidelines (37). Dyads completed the Childhood Asthma Symptom Checklist (CASCL), which is a 47-item measure of asthma symptoms experienced during exacerbations (38). The adult version has good internal consistency ($\alpha = .91$) and validity in both English (39) and Spanish (40), and was modified to create the child version (C-CASCL) (38). The instrument demonstrated good internal consistency for both versions, in this sample ($\alpha = .81-.94$) (34).

Acculturation was measured by the Stephenson Multigroup Acculturation Scale (SMAS), which has good internal consistency ($\alpha = .86$) (41). This 32-item self-report measure is comprised of two subscales that

measure caregiver degree of immersion in ethnic and dominant societies through choice in language, food, social interactions, and media. A higher score on the Ethnic Society Immersion (ESI) subscale would indicate higher retention of cultural values and a higher score on the Dominant Society Immersion (DSI) subscale would indicate greater acculturation. We reported good and acceptable reliability for the English ($\alpha = .84$) and Spanish ($\alpha = .79$) versions in this sample for the total scale, the English ($\alpha = .71$) and Spanish ($\alpha = .63$) ESI subscale, and the English ($\alpha = .70$) and Spanish ($\alpha = .68$) DSI subscale (34).

Asthma illness representations were measured by the Asthma Illness Representation Scale (AIRS). English (42) and Spanish (43) versions of the measure were administered to assess asthma-related health beliefs and caregiver–healthcare provider relationship (44). We reported good internal consistency for the total score in this sample, for both English ($\alpha = .79$) and Spanish ($\alpha = .77$) versions (34). The Social Networks (SN) questionnaire (45) assessed caregiver perception of social support from family and friends. We reported acceptable reliability for both the family support subscale ($\alpha = .59$ for English, $\alpha = .58$ for Spanish) and the friend support subscale ($\alpha = .71$ for English, $\alpha = .62$ for Spanish) in this sample (34).

Endogenous variables

Pulmonary function. Spirometry testing was used to measure pulmonary function (46) and was performed at each session. Children were trained using the American Thoracic Society's guidelines (47) to perform maximal effort blows using a spirometer (nSpire Health, Longmont, CO). The predicted value for the volume of air exhaled during the first second of a forced vital capacity maneuver ($FEV_1\%$) was the measure of pulmonary function.

Steroid bursts. The total number of times children were prescribed steroid bursts was assessed by caregiver report and medical chart review at all sessions. This is a measure of asthma control; greater frequency of bursts indicates worse control. If there was a greater number of steroid bursts obtained by self-report than by chart review, the higher number was used to account for any prescriptions by providers outside the study sites' medical record availability.

Adherence monitoring. Electronic Doser devices (Meditrack, Massachusetts, USA) were used to measure ICS adherence by recording the daily frequency of inhaler use. Dosers are more reliable for tracking

medication use than self-report or pharmacy records (48). Dosers were attached to metered dose inhalers (MDI) brought to baseline, and data were downloaded at all follow-ups. Families were instructed on Doser function and how to transfer the devices between MDIs in the event they received new medication refills. Doser data were downloaded at each session and reflected the child's use of the MDI for the past 30 days. Longitudinal adherence data across the follow-up periods were available for 123 (89 Mexican and 34 Puerto Rican) children who were prescribed ICS medications that were compatible with Dosers and had at least 2 adherence assessment periods. Data were available for 64% of dyads with dosers. Missing adherence data were due to: ICS medications incompatible with Dosers, malfunction or battery failure, or loss of Dosers. Children who used a combination ICS/LABA medication not compatible with a doser ($n=73$) or who did not have a controller medication prescription ($n=2$) were excluded from these analyses. Percent adherence was calculated as the number of total daily doses taken by a child, divided by the number of prescribed doses per day. Data were processed as per standard cleaning procedures for adherence (49) that accounted for any accidental dose recordings or dumping of medication prior to sessions.

Asthma control. The Childhood Asthma Control Test (C-ACT) (50) was administered at all sessions to children 5–11 years old and their caregivers, and measured a child's asthma control over the past month. Four of the seven items are directed toward the child and 3 toward the caregiver. Children who were 12 years old completed the 5-item Asthma Control Test (ACT) (51) on their own. Both measures assess interference with activities, asthma symptoms, and nighttime awakenings in the child. Scores of 19 or below indicate poor asthma control on both measures. The ACT has good internal-consistency and reliability among patients with varying levels of asthma control ($\alpha=.84$), including those with poor asthma control ($\alpha=.83$) (51). The C-ACT also has good internal consistency ($\alpha=.79$) (50). The ACT and C-ACT are both reliable and valid in English (50,51) and the ACT has good reliability in Spanish ($\alpha=.84$) (34,52).

Acute health care utilization. Acute health care utilization (HCU) included three components: asthma-related ED visits, hospitalizations, and outpatient clinic sick visits. The HCU measure combined these three categories together. The total number of HCU visits

was assessed by caregiver report at all sessions and medical chart reviews throughout the study. If a higher number of visits was obtained by self-report than by chart review, the higher number was used to account for any visits outside the study sites' medical record availability.

Data analysis

Statistical analysis

Descriptive statistics were calculated to summarize information and assess patterns within the data using SAS version 9.4 (copyright 2017, SAS Institute Inc.). Baseline differences between Mexicans and Puerto Ricans were investigated using effect sizes (Cohen's d) for continuous variables and odds ratios for categorical variables, including 95% confidence intervals. Patterns in missing data were assumed to be missing at random. Multiple imputation was done when exogenous variables were missing. Five separate two-group (Mexican and Puerto Rican) latent growth curve models examined whether exogenous variables (child sex, child and caregiver age, caregiver marital status and education, poverty status, caregiver depression, child's asthma duration, severity, and symptom reports (caregiver and child), number of family members with asthma, acculturation, caregiver asthma illness representations, quality of relationship with the healthcare provider, and social support) were predictors of children's asthma outcomes (pulmonary function, steroid bursts, controller medication adherence, asthma control, and acute healthcare utilization). These two group latent growth models were specified to examine changes in children's asthma outcomes over time. The exogenous variables were treated as time-invariant variables in each model. Figure 1 illustrates the basic model for children's asthma control. Cases were eligible for analyses if at least 3 of 5 outcome assessments were completed. Growth curve analyses do not require complete data and use robust maximum likelihood estimation for the missing time-points. The analyses were conducted using MPlus version 8.1, with $p < .10$ indicating statistical significance per SEM convention (53). To test whether each of the models was statistically significantly different for Puerto Ricans and Mexicans, two group models with only the main predictor (caregiver depression) were run using the chi-square difference test: one unconstrained and the other constraining the intercepts and slopes to be equal (54). The sample size for the Puerto Rican group was too small to run two group models with all the exogenous variables included. Degradation in model fit between the

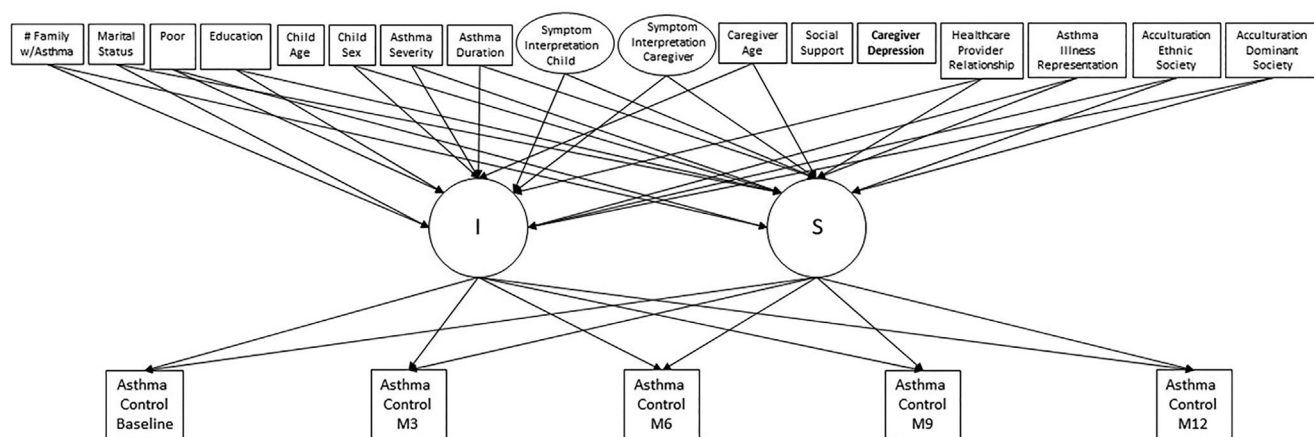


Figure 1. Illustrative two group latent growth model examining maternal depression on children's asthma control. *Note:* I: intercept for asthma control; S: slope for the growth factor of asthma control. Grouping: 1: Mexican; 2: Puerto Rican

Table 1. Sample characteristics at baseline ($n = 267$).

Variable	Mexican ($N = 188$)	Puerto Rican ($N = 79$)		<i>p</i> -Value
	<i>N</i> (%)	<i>N</i> (%)	Odds ratio	
Child sex (% Female)	62 (33.0)	32 (40.5)	.72	.24
Caregiver sex (% Female)	180 (95.7)	74 (93.7)	1.52	.52
Marital status (% Yes)	104 (55.3)	24 (30.4)	2.84	.0002
Poverty (% Yes)	126 (67.0)	25 (31.7)	4.39	<.0001
Caregiver education (% Graduated HS)	85 (45.5)	48 (60.8)	.54	.02
Language of caregiver interview (% Spanish)	170 (90.4)	15 (19.0)	40.0	<.0001
Caregiver clinical depression (% Yes)	45 (23.9)	34 (43.0)	2.40	.002
Any controller medication use past month-self-report (% Yes)*	130 (69.1)	62 (78.5)	1.63	.12
Asthma severity (Clinician-rated)				.02
Intermittent (reference group)	32 (17.2)	11 (14.7)		
Mild persistent	63 (33.9)	16 (21.3)	.74	
Moderate persistent	74 (39.8)	31 (41.3)	1.22	
Severe persistent	17 (9.1)	17 (22.7)	2.91	
	Mean (SD)	Mean (SD)	Cohen's <i>d</i>	<i>p</i>-Value
Child's age (Years)	9.67 (2.15)	9.23 (2.23)	.20	.13
Caregiver's age	35.47 (6.31)	38.42 (10.47)	.34	.02
Asthma duration (Months)	67.94 (39.54)	88.46 (31.77)	.57	<.0001
# Family members w/asthma	1.24 (.73)	0.91 (1.09)	.36	.02
Social network (SN)	3.19 (.47)	2.95 (.54)	.47	.0004
Caregiver depressive symptoms (CES-D)	10.95 (10.15)	16.03 (12.30)	.46	.002
Asthma control test (ACT/C-ACT)	19.94 (3.82)	16.44 (3.90)	.91	<.0001
# Steroid bursts	0.56 (0.66)	1.07 (1.36)	.48	.06
Acculturation: Ethnic Society Immersion	3.23 (.35)	3.22 (.41)	.03	.89
Acculturation: Dominant Society Immersion	2.98 (.39)	3.40 (.44)	1.01	<.0001

*Note: $N = 123$ for inhaled corticosteroid (ICS) adherence data.

unconstrained and constrained models indicated that the two groups were different.

Results

Study sample

Of the 267 dyads in the study, 188 were Mexican and 79 were Puerto Rican. Overall retention was 82% across the 12-month period. This was calculated by including only participants who completed at least 3 of 5 total sessions; 75% of participants completed the 12-month visit. As seen in Table 1, the majority of children were male and the majority of

caregivers were female. Mexican caregivers were more likely to be married, younger, living in poverty, and complete questionnaires in Spanish. Mexican caregivers also had more social support and were more acculturated to the dominant society (higher DSI). Puerto Rican children had a longer duration of asthma than Mexican children, but Mexican children had a greater number of family members with asthma. A majority of Puerto Ricans had moderate to severe persistent asthma, while Mexicans typically had mild to moderate persistent asthma. Puerto Ricans had a higher number of steroid bursts at baseline compared to Mexicans. Puerto Rican

caregivers reported more depressive symptoms; 43% of this sample met the threshold for depression ($N=34$) versus only 24% for Mexicans ($N=45$). There was higher attrition in the Puerto Rican group than the Mexican group. No other differences existed between those who completed the study and those who withdrew.

Caregiver depression

Caregiver depression at baseline predicted better asthma outcomes across the 12-month follow-up for both groups. Caregiver depression predicted better pulmonary function in Mexicans ($\beta = .02$, $p = .001$), but not in Puerto Ricans ($\beta = .14$, $p = .16$; Table 2). The overall model accounted for slightly more variance in pulmonary function for Mexicans (64%) than Puerto Ricans (61%) and the chi-square difference test revealed that the models were significantly different ($\chi^2_{\text{diff}} = 25.57$, $\text{df}_{\text{diff}} = 3$, $p < .0001$). Baseline caregiver depression was a significant predictor of fewer steroid bursts in Puerto Ricans ($\beta = -.41$, $p = .01$), but not in Mexicans ($\beta = -.12$, $p = .28$). The model for oral steroid bursts accounted for 76%

variance in Puerto Ricans and 22% variance in Mexicans and these differences were significant ($\chi^2_{\text{diff}} = 389.56$, $\text{df}_{\text{diff}} = 3$, $p < .0001$). Caregiver depression also predicted better ICS medication adherence in Puerto Ricans ($\beta = .02$, $p = .07$; Table 2), but not in Mexicans ($\beta = .32$, $p = .12$). The model accounted for a greater percentage of variance in ICS adherence in Puerto Rican families (41%) than Mexican families (13%) and these differences were significant ($\chi^2_{\text{diff}} = 334.56$, $\text{df}_{\text{diff}} = 3$, $p < .0001$).

Baseline caregiver depression was not a significant predictor of asthma control (ACT) for either Mexicans ($\beta = -.08$, $p = .43$) or Puerto Ricans ($\beta = .05$, $p = .79$; Table 3). This model accounted for a higher proportion of variance in asthma control in the Puerto Rican group (52%) than the Mexican group (39%) and the two group models were significantly different ($\chi^2_{\text{diff}} = 312.68$, $\text{df}_{\text{diff}} = 3$, $p < .0001$). Baseline caregiver depression was not a predictor of acute healthcare utilization for either Mexicans ($\beta = -.16$, $p = .25$) or Puerto Ricans ($\beta = -.21$, $p = .31$; Table 3). This model accounted for more variance in acute healthcare utilization in Puerto Rican families (39%) compared to Mexican families (12%) ($\chi^2_{\text{diff}} = 20.55$, $\text{df}_{\text{diff}} = 3$, $p < .0001$).

Table 2. Caregiver depression as a predictor of children's FEV₁% predicted, steroid bursts, and controller medication adherence.

Variable	FEV ₁ % predicted				Steroid bursts				Controller medication adherence			
Root mean square error of approximation	.08				<.0001				<.0001			
	Mexican		Puerto Rican		Mexican		Puerto Rican		Mexican		Puerto Rican	
Model R ²	64%		61%		22%		76%		13%		41%	
	β (SE)	p-Value	β (SE)	p-Value	β (SE)	p-Value	β (SE)	p-Value	β (SE)	p-Value	β (SE)	p-Value
Child sex	-.07 (.08)	.02	-.19 (.15)	<.0001	-.08 (.11)	.45	-.39 (.13)	.003	-.79 (.39)	.86	.15 (5.71)	.20
Marital status	-.04 (.08)	.01	-.09 (.15)	.05	.14 (.12)	.26	.14 (.14)	.32	-.19 (.20)	.27	.33 (.52)	.16
Poverty	.05 (.08)	.02	.10 (.16)	.16	.002 (.12)	.99	.05 (.14)	.73	.28 (.18)	.17	.29 (1.90)	.18
Caregiver Education	-.02 (.08)	.004	-.14 (.14)	.22	-.15 (.11)	.18	-.22 (.12)	.06	-.08 (.24)	.72	.10 (4.35)	.23
Child age	-.33 (.08)	.01	-.49 (.19)	.06	-.14 (.12)	.25	-.19 (.12)	.12	.09 (.19)	.29	-.71 (4.76)	.23
Caregiver age	-.12 (.08)	.004	.11 (.17)	.05	-.12 (.11)	.25	-.11 (.15)	.49	.30 (.22)	.64	.72 (1.90)	.22
Asthma duration	-.20 (.08)	.001	.10 (.13)	.003	-.04 (.13)	.74	.39 (.13)	.002	-.13 (.18)	.008	.15 (2.78)	.36
# Family members with asthma	-.04 (.08)	.02	-.43 (.14)	.12	-.06 (.11)	.56	.14 (.15)	.35	-.35 (.17)	.21	-.47 (.85)	.07
Asthma Symptom Report (child)	.02 (.11)	.09	.70 (.34)	.02	.17 (.14)	.21	.33 (.17)	.05	-.16 (.23)	.33	.25 (.8.09)	.22
Asthma Symptom Report (caregiver)	.20 (.10)	<.0001	-.35 (.33)	.02	.17 (.13)	.19	.05 (.19)	.77	.24 (.27)	.21	-.57 (12.32)	.22
Asthma severity	.03 (.09)	.18	.24 (.15)	.004	-.14 (.11)	.22	-.04 (.17)	.82	-.33 (.16)	.007	.39 (3.81)	.07
Illness representations	.07 (.10)	.008	-.06 (.15)	<.0001	.10 (.14)	.47	-.22 (.16)	.16	.25 (.21)	.003	.32 (1.28)	.01
Healthcare Provider Relationship	-.02 (.09)	.004	-.20 (.14)	.07	.11 (.13)	.42	-.08 (.15)	.57	.17 (.19)	.02	-.25 (2.49)	.19
Social support	.03 (.09)	.04	-.13 (.14)	<.0001	-.20 (.11)	.08	.30 (.15)	.05	.36 (.20)	.37	.13 (3.83)	.14
Ethnic society immersion	-.10 (.10)	<.0001	-.47 (.19)	.02	-.14 (.13)	.29	-.92 (.21)	<.0001	-.43 (.19)	.05	.06 (5.87)	.16
Dominant society immersion	.07 (.09)	<.0001	.55 (.19)	.14	.13 (.13)	.33	.48 (.21)	.02	.02 (.18)	.04	-.17 (7.09)	.16
Caregiver depression	.02 (.08)	.001	.14 (.15)	.16	-.12 (.11)	.28	-.41 (.16)	.01	.32 (.17)	.12	.02 (1.98)	.07

Social/contextual factors

ESI significantly predicted worse pulmonary function ($\beta = -.10$, $p < .0001$) and worse adherence ($\beta = -.43$, $p = .05$) in Mexicans. ESI also predicted worse pulmonary function ($\beta = -.47$, $p = .02$) but fewer steroid bursts ($\beta = -.92$, $p < .0001$) in Puerto Ricans. ESI was not a significant predictor of asthma control or acute health care utilization in either group. DSI predicted better pulmonary function ($\beta = .07$, $p < .0001$) and greater controller medication adherence in Mexicans ($\beta = .02$, $p = .04$), but more steroid bursts ($\beta = .48$, $p = .02$) in Puerto Ricans. DSI was not a significant predictor of asthma control or acute health care utilization in either group.

Social support at baseline predicted better pulmonary function ($\beta = .03$, $p = .04$), less steroid bursts, and lower acute health care utilization ($\beta = -.25$, $p = .07$) in Mexicans. The opposite pattern was found in Puerto Rican children: social support predicted worse pulmonary function ($\beta = -.13$, $p < .0001$) and more steroid bursts. The relationship between social support and healthcare utilization was not significant in Puerto Ricans. Social support was not a significant predictor of asthma control, steroid bursts, or controller medication adherence in either group.

Discussion

Caregiver depressive symptoms prospectively predicted greater adherence to ICS medications and fewer steroid bursts in Puerto Rican children, and better pulmonary function in Mexican children over 12 months.

These longitudinal effects were the opposite of what was hypothesized. Caregiver depressive symptoms have previously been associated with negative asthma outcomes in children. Associated pathways for this relationship have included: poor understanding of asthma medication use (55), cognitive deficits (56), low maternal self-efficacy in managing children's asthma attacks (26), and negative parenting leading to child internalizing symptoms (57).

The present study focused on Mexicans and Puerto Ricans, for whom the associated pathways in this relationship may differ. Previous literature has examined the relationship between caregiver depressive symptoms and child asthma outcomes in Black (58), White (58), and Puerto Rican populations (21). This is the first study to analyze the relationship between Mexicans and Puerto Ricans, contrasting the Hispanic subgroups with the lowest and highest asthma prevalence, respectively. Caregiver depressive symptoms in previous literature primarily ranged from 27 to 33% (20,21,55), which is consistent with the Mexican subgroup in this current study; however, the Puerto Rican subgroup had a higher rate.

The longitudinal findings in this study for Mexican families are consistent with the "Hispanic Paradox," which refers to the phenomenon of Hispanic populations having health outcomes at least as good as non-Hispanic Whites, despite facing greater disadvantages: adversity, acculturation-related stressors, lower income, and discrimination (59). Caregiver depression in Mexicans predicted better pulmonary function (FEV_1), despite not being associated with health seeking behaviors, such as utilization. This alludes to a

Table 3. Caregiver depression as a predictor of children's asthma control and acute healthcare utilization.

Variable	Asthma control				Acute healthcare utilization			
Root mean square error of approximation	.075				.099			
Model R^2	Mexican		Puerto Rican		Mexican		Puerto Rican	
	39%		52%		12%		39%	
	β (SE)	p-Value	β (SE)	p-Value	β (SE)	p-Value	β (SE)	p-Value
Child sex	-.001 (.09)	.99	-.16 (.21)	.45	-.10 (.13)	.41	.15 (.20)	.44
Marital status	-.18 (.09)	.06	-.12 (.17)	.49	.26 (.13)	.04	-.23 (.17)	.20
Poverty	.04 (.10)	.66	.28 (.16)	.08	-.23 (.13)	.08	-.45 (.16)	.006
Caregiver education	-.13 (.09)	.16	.29 (.14)	.04	-.07 (.13)	.60	.24 (.16)	.14
Child age	-.05 (.11)	.63	.27 (.30)	.36	-.41 (.15)	.005	-.54 (.25)	.03
Caregiver age	.03 (.10)	.80	.19 (.27)	.47	-.11 (.13)	.43	.30 (.23)	.20
Asthma duration	-.10 (.10)	.31	-.10 (.18)	.58	.02 (.14)	.89	.32 (.20)	.11
# Family members with asthma	-.05 (.10)	.60	-.35 (.24)	.14	.14 (.13)	.30	.36 (.22)	.10
Asthma Symptom Report (child)	-.36 (.12)	.003	-.35 (.74)	.64	-.17 (.13)	.31	.08 (.59)	.89
Asthma Symptom Report (caregiver)	.14 (.13)	.27	.05 (.66)	.94	.06 (.17)	.71	-.07 (.53)	.90
Asthma severity	.01 (.10)	.90	.06 (.24)	.79	-.10 (.13)	.44	.24 (.22)	.28
Illness representations	.23 (.12)	.04	.04 (.21)	.84	-.35 (.16)	.03	.14 (.19)	.47
Healthcare provider relationship	-.02 (.11)	.88	.09 (.15)	.57	-.09 (.15)	.56	.11 (.16)	.49
Social support	.07 (.10)	.50	.01 (.23)	.95	-.25 (.14)	.07	.03 (.21)	.90
Ethnic society immersion	.01 (.11)	.93	.06 (.40)	.88	-.19 (.15)	.22	.07 (.34)	.85
Dominant society immersion	0 (.11)	1.0	.10 (.32)	.77	.22 (.15)	.14	-.16 (.28)	.57
Caregiver depression	-.08 (.10)	.43	.05 (.19)	.79	-.16 (.14)	.25	-.21 (.20)	.31

more direct relationship with child asthma. Mexican parent nativity is associated with better asthma control in children, and this effect is partially mediated by having fewer parent depressive symptoms (60). In the present study, 92% of the Mexican caregivers were born in Mexico. Mexican caregivers were more likely to be married; marriage status in Mexican women is associated with greater stress resilience (61), which may have aided in caregivers' management of their child's asthma. The simultaneous influence of social factors and adaptive asthma-related beliefs may have supported the depressed Mexican caregivers and their children's pulmonary function.

In this study, greater acculturation was protective for Mexicans, who had better pulmonary function and greater controller medication adherence associated with greater immersion to the dominant society (DSI). The Mexican families that were more immersed in their ethnic culture (greater ESI) had significantly worse pulmonary function and lower controller medication adherence. The protective role acculturation played in the Mexican subgroup is consistent with recent literature showing greater acculturation (62) and ethnic diversity in a caregiver's social network (63) both being associated with better pulmonary function. The findings for the Puerto Rican subgroup in this study were mixed. Puerto Ricans who were more acculturated (greater DSI) had more oral steroid bursts. Those who were less-acculturated (greater ESI), had fewer oral steroid bursts and worse pulmonary function. The results indicating that greater ESI was significantly associated with lower pulmonary function in Puerto Ricans is consistent with previous literature that indicates acculturation is adaptive and associated with improved asthma outcomes in Puerto Rican children (32). The results highlight the complexity of the relationship between acculturation and asthma outcomes in various Hispanic subgroups.

Disparities also existed in the findings regarding social support, which was maladaptive for Puerto Ricans; greater social support predicted worse pulmonary function and greater use of oral steroids. Social support in this sample was adaptive for the Mexican subgroup; those with greater social support had better pulmonary function, fewer oral steroid bursts, and less utilization of acute healthcare. These disparities might be explained by higher overall scores on the social support measure in the Mexican subgroup. Overall, the Mexican group reported more social support, however both subgroups had lower than average social support scores (45). It is possible that the Puerto Rican sample, which was the lowest, may have involved a type of floor effect that

contributed to the maladaptive results. This finding may also be understood through learning about the quality of the social support. A recent study (64) showed that social support can be maladaptive when it cues negative experiences. Puerto Ricans in this sample might have been prone to negative cueing, since Puerto Rican children had more severe asthma (and thus the potential for greater frequency of exacerbations and negative asthma-related events) and worse asthma control. Puerto Rican caregivers had greater depressive symptomology (and thus a greater likelihood to engage in negative rumination) and were more likely to be single.

The resilience in Mexican and Puerto Rican families may have been influenced by contextual factors that supported caregivers with depressive symptoms. Social support has predicted better asthma control in both Mexicans and Puerto Ricans (11) and may be indicative of a reduction in the burden of asthma management placed solely on the caregiver. The concept of "familismo" describes strong connections between family members. Greater social support and familismo have both been associated with less depressive symptoms, and may buffer the negative impact of existing caregiver depressive symptoms on child health (65) by alerting the social support network to be more involved in children's asthma management. This may contribute to the positive health outcomes.

The Puerto Rican caregivers in this study may have especially been resilient in managing their children's asthma despite facing unique challenges. Puerto Rican adults residing in the mainland-US tend to have elevated rates of psychiatric diagnoses and single-women led households (66). In this study, 75% of the Puerto Rican caregivers were born in the mainland-US. Puerto Rican caregivers in this study had higher rates of depression and were more likely to be single than Mexican caregivers. The Puerto Rican families in this study primarily resided in the Bronx, where they face urban neighborhood related stressors (12,67). High quality family relationships can buffer children from poorer asthma outcomes, especially in unsafe neighborhoods (68). Puerto Rican caregivers were older and had children with a longer duration of asthma than Mexican caregivers. More experience with managing asthma might have positively influenced asthma management ability, such as through medication adherence. The resilience of Puerto Rican caregivers and their children may have prevented caregiver depressive symptoms from interfering with asthma management.

It is important to note that these findings were longitudinal; caregiver depression at baseline predicted

better child asthma outcomes across 12 months. Many previous studies evaluating the role of caregiver depression on child asthma outcomes were cross-sectional (21) or across a shorter time span (55). Few studies have evaluated this relationship in a prospective longitudinal manner. For instance, a retrospective study showed that current caregiver depressive symptoms were associated with more self-reported asthma-related hospitalizations and sick visits over the preceding 12 months (58). Caregivers in the present study who were more depressed may have enacted coping strategies over the span of 12 months. There is much to be speculated about third factor causality. The longitudinal effect of caregiver depression over time may have allowed caregivers to mobilize resources (e.g. social and family support). Participation in this study with regular follow-ups may have also drawn more attention to asthma management. The prospective and longitudinal nature of the present study contributes to its novelty and may explain the unexpected role of caregiver depressive symptomology on child asthma outcomes.

This study has some limitations to consider. Many measures were subjective/self-report, including the primary predictor of caregiver depression. This may be a limitation if participants did not accurately report symptoms. Since baseline measures were used to predict longitudinal outcomes, fluctuations in depressive symptoms over the course of the study were not recorded. Recent literature indicates the CES-D has weak diagnostic agreement with other measures of depression and over-estimates the prevalence of depression (69). There is also limited research regarding the ability of the CES-D to discriminate between symptoms of depression and anxiety among Hispanic populations (70). Greater research is needed to better understand the psychometric discriminability of the CES-D in heterogeneous Hispanic subgroups. Another limitation was the amount of missing adherence data; only 64% of data were available from dyads with Doser devices, with more data available for Mexicans ($N=188$) than Puerto Ricans ($N=79$). Caregivers were also primarily females in their mid-30s; this may impact the generalizability of the results.

In conclusion, this study presents a novel model for understanding the role of caregiver depression in asthma outcomes in two Hispanic subgroups. Baseline measures of caregiver depression (CES-D) were associated with positive child asthma outcomes in both Mexicans and Puerto Ricans across a 12-month period. This was the opposite of what was hypothesized and has not been previously reported to our knowledge. These unanticipated results warrant further longitudinal prospective research to better

understand the mechanisms through which caregiver depression influences child asthma outcomes. It will be important to replicate these findings, which provide compelling data for future research. Improvement in maternal mental well-being has previously been associated with improvement in child asthma morbidity (33). These findings highlight the potential role of resilience in Mexican and Puerto Rican caregivers with depressive symptomology and its effects on child asthma outcomes, for which the mechanisms and implications remain to be elucidated.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper. The intent of this policy is not to prevent authors with these relationships from publishing work, but rather to adopt transparency such that readers can make objective judgments on conclusions drawn.

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ORCID

Kimberly J. Arcoleo  <http://orcid.org/0000-0001-8209-0908>
Jonathan M. Feldman  <http://orcid.org/0000-0002-7326-3026>

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