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Associations of childhood eczema severity: A US population based study

Jonathan I. Silverberg, MD, PhD, MPH¹ and Eric L. Simpson, MD, MCR²

¹ Departments of Dermatology, Preventive Medicine and Medical Social Sciences, Northwestern University, Chicago, IL 60611, USA

² Department of Dermatology, Oregon Health & Sciences University, Portland, OR, 97239, USA

Abstract

Little is known about predictors of eczema severity in the US population. We sought to determine the distribution and associations of childhood eczema severity in the US. We analyzed data from the 2007 National Survey of Children's Health, a prospective questionnaire-based study of a nationally representative sample of 91,642 children (0-17yr). The prevalence of childhood eczema was 12.97% (95% confidence interval [95% CI]=12.42–13.53); 67.0% (95% CI: 64.8–69.2) had mild, 26.0% (95% CI: 23.9–28.1) moderate and 7.0% (95% CI: 5.8–8.3) severe disease. There was significant statewide-variation of the distribution of eczema severity (Rao-Scott chi square, $P=0.004$), with highest rates of severe disease in Northeastern and Midwestern states. In univariate models, eczema severity was increased with older age, African-American and Hispanic race/ethnicity, lower household income, oldest child in the family, home with a single mother, lower paternal/maternal education level, maternal general health, maternal/paternal emotional health, dilapidated housing and garbage on the streets. In multivariate survey logistic regression models using stepwise and backward selection, moderate–severe eczema was associated with older age, lower household income and fair or poor maternal health, but inversely associated with birthplace outside the US. These data indicate that environmental and/or lifestyle factors play an important role in eczema severity.

Keywords

eczema; atopic dermatitis; eczema severity; epidemiology; race; ethnicity; socioeconomic status

Introduction

Atopic dermatitis (AD) or eczema is a chronic inflammatory disorder of the skin that poses a significant public health burden. Several recent studies shed light on the epidemiology of

Corresponding author and reprint requests: Jonathan I. Silverberg, MD, PhD, MPH Northwestern University Department of Dermatology Suite 1400 680 Lake Shore Drive Chicago, IL 60611 JonathanISilverberg@Gmail.com Tel: 312-503-4985 Fax: 312-908-9588.

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eczema in the US. A study of 102,353 children from the 2003 National Survey of Children's Health (NSCH) found that the US prevalence of childhood eczema is 10.7%¹. A study of 27,157 adults from the 2010 National Health Interview Survey found a 10.2% prevalence of eczema². While these studies help to define the disease prevalence, little is known about the distribution of disease severity in this population.

While factors such as ethnicity, urban living¹, and climatic factors³ are known to influence disease risk, it is unclear what role factors such as these may play in determining disease severity. Mutations in the skin barrier gene filaggrin, while playing an important role in disease risk, have inconsistently been linked to disease severity⁴⁻¹⁰. Understanding the factors driving disease severity is important, as our previous work and the work of others revealed that disease severity directly correlates with the future risk for developing allergic comorbidities and asthma^{11, 12}. Additionally, children with severe disease are more likely to have a protracted disease course and a significantly worse quality of life compared to those with more mild disease¹¹. Understanding the distribution and risk factors for disease severity may help identify opportunities to intervene in the hopes of improving the overall disease course. We aimed to determine the distribution and associated factors of childhood eczema severity in the US using a large population-based cross-sectional database.

Methods

National Survey of children's Health (NSCH)

We used data from the 2007-2008 NSCH survey of 91,642 households, which was designed to estimate the prevalence of various child health issues. NSCH was sponsored by the Maternal and Child Health Bureau and the U.S. Department of Health and Human Services with a goal of >1,700 households per state. The National Center for Health Statistics conducted the study using the State and Local Area Integrated Telephone Survey program. The telephone numbers were chosen at random, followed by identification of the households with one or more children under the age of 18 and caregiver interview. Interviews were conducted in English, Spanish, and 4 Asian languages. Subsequently, caregivers were interviewed about a randomly selected child. The survey results were weighted by the NSCH to represent the population of non-institutionalized children nationally and in each state. Using the data from U.S. Bureau of the Census, sample weights were created that factored age, sex, race/ethnicity, household size, and educational attainment of the most educated household member using a multi-stage area probability sampling design by NSCH. These sample weights are needed to provide nationally representative prevalence estimates for each state's population of non-institutionalized children less than 18 years of age as previously described¹³. All frequency data are presented as raw values, whereas prevalence estimates presented reflect this complex weighting. The National Center for Health Statistics of Center for Diseases Control and Prevention oversaw sampling and telephone interviews. Approval by the institutional review board was waived.

Eczema prevalence and severity

Eczema and skin allergy prevalence was determined using the NSCH question, "During the past 12 months, have you been told by a doctor or other health professional that (child) had

eczema or any kind of skin allergy?” This is referred to as eczema throughout the manuscript. Since this question assessed healthcare diagnosed eczema, we excluded all subjects who responded “no” or “don’t know” to the question, “During the past 12 months, did (child) see a doctor, nurse, or other health care professional for any kind of medical care, including sick-child care, well-child check-ups, physical exams, and hospitalizations?” There were 91,642 children in the cohort; 79,667 of them had healthcare interaction in the previous year and were included in the final analysis. Severity of eczema was determined using the NSCH question, “Would you describe (child's) eczema or skin allergy as mild, moderate, or severe?” Responses were encoded as an ordinal variable, where 1=mild, 2=moderate and 3=severe.

Associations with eczema

A number of associations with eczema severity were examined, including age, sex, race/ethnicity, household income, family structure and size, highest level of maternal and paternal education, maternal and paternal birthplace, overall and mental health, primary language spoken in home, birthplace in the US, residence in a metropolitan area, smokers living in the home, smoking in the home, dilapidated housing, presence of garbage on the street, parks and sidewalks in the neighborhood. These covariates were selected for analysis based on a priori hypotheses and from the results of previous studies ^{1, 2, 14}.

Data processing and statistical methods

All data processing and statistical analyses were performed in SAS version 9.2. Analyses of survey responses were performed using SURVEY procedures. Univariate associations were tested by Rao-Scott chi-square tests (SURVEYFREQ). Multivariate logistic regression models were constructed with eczema severity dichotomized into moderate-severe vs. mild (SURVEYLOGISTIC). Models included predictors from bivariate analysis with P-values <0.05. This approach was used over ordinal logistic regressions because the data did not meet the proportional odds assumption (Score test, $P < 0.01$) and for parsimony. All variables were tested in the model using backward and stepwise selection with the same results. There were no differences between these approaches. Significant explanatory variables included in the final models are presented. Adjusted odds ratios and 95% confidence intervals (95% CI) were estimated for each covariate. Complete data analysis was performed, i.e. subjects with missing data were excluded.

Correction for multiple dependent tests ($k = 27$) was performed by minimizing the false discovery rate with the approach of Benjamini and Hochberg ¹⁵ and yielded a critical P-value of 0.026. Thus, uncorrected P-values are presented and P-value <0.026 was considered to be statistically significant.

Results

Eczema prevalence and severity

Eczema prevalence was 12.97% (95% CI = 12.42 – 13.53). Overall, sixty seven percent (95% CI: 64.8 – 69.2) of children with eczema reportedly had mild, 26.0% (95% CI: 23.9 –

28.1) moderate and 7.0% (95% CI: 5.8 – 8.3) severe disease. That is equivalent to 5.6, 2.2 and 0.6 million US children having mild, moderate and severe disease, respectively.

There was a significant variation of the distribution of eczema severity nationwide (Rao-Scott chi square, $P = 0.004$). Rates of severe eczema ranged from 2.0 – 12.9% across states and districts (Figure 1). The highest rates of severe eczema occurred predominantly located in Northeastern and Midwestern states.

Univariate analyses

Eczema severity was associated with older age ($P = 0.0003$), African-American and Hispanic race/ethnicity ($P < 0.0001$) but not sex ($P = 0.12$) (Table 2). Several household factors were associated with increased eczema severity, including lower household income ($P < 0.0001$), being the oldest child in the family ($P = 0.02$), home with a single mother and no father present ($P < 0.0001$), but not number of children in the household ($P = 0.03$) or primary language spoken in home ($P = 0.27$).

Several parental factors were associated with more severe eczema, including paternal and maternal education level ($P = 0.001$ and < 0.0001 , respectively), maternal general health ($P < 0.0001$) and maternal and paternal emotional health ($P < 0.0001$ and 0.02 , respectively). However, paternal, maternal and child birthplace inside the US were not associated with eczema severity ($P = 0.04$).

Finally, several local environmental factors were associated with more severe eczema, including dilapidated housing ($P = 0.0009$) and garbage on the streets ($P = 0.001$). However, eczema severity was not associated with residence in a metropolitan area ($P = 0.26$), smokers living at home ($P = 0.03$), indoor smoking ($P = 0.29$) or the presence of a park ($P = 0.53$) or sidewalk ($P = 0.94$) in the neighborhood (Table 3).

Multivariate analysis

Multivariate survey logistic regression models were constructed using backward and stepwise selection from all significant variables from univariate analyses. Moderate – severe eczema was associated with older age (adjusted odds ratio [95% confidence interval], P -value; 1.05 [1.03 – 1.07], $P < 0.0001$), lower household income (0-99% FPL: 1.91 [1.39 – 2.63], $P < 0.0001$; 100-199% FPL: 1.60 [1.20 – 2.12], $P = 0.001$; 200-399% FPL: 1.39 [1.06 – 1.83], $P = 0.01$) and fair or poor maternal health (2.16 [1.47 – 3.16], $P < 0.0001$), but inversely associated with birthplace outside the US (0.44 [0.22 – 0.89], $P = 0.02$).

Discussion

Using a population-based sample, we present the distribution and associations of eczema severity in the US. The findings of this study suggest a multifactorial role of genetic, environmental and lifestyle factors on eczema severity. First, we found significant statewide variation of eczema severity, with severe eczema occurring predominantly in Northeastern and Midwest states. Further, eczema severity was associated with household income, family structure, parental education and health, dilapidated housing and the presence of garbage on local streets and inversely associated with birthplace in the US. Previous international

studies found only weak associations^{5-7, 9, 10} or no associations^{4, 8} between filaggrin mutations and AD severity. Together, these suggest that environmental and/or lifestyle factors drive disease severity in the US and play as much, or even more important role than genetics.

The present study assessed self-reported eczema severity over a 1 year period. This measure provides an overall assessment of eczema severity over a relatively broad time period and is distinct from disease prevalence or incidence. This approach is quite useful because assessment of eczema severity at a single time point may not capture the true disease severity given the waxing and waning nature of the disease. We found that the distribution of eczema severity was 67% mild, 26% moderate and 7% severe. This is a slightly more severe disease distribution than the distribution of 82% mild, 12% moderate and 6% severe found in a previous study in the United Kingdom using a novel eczema severity score¹⁶. Another UK study using clinician assessment of severity found 84% mild, 14% moderate and 2% severe¹⁷. The different distributions may reflect population-based differences of eczema severity between the US and UK. Alternatively, caregiver-report of AD severity may differ from that of the Nottingham Eczema Severity Score or clinician assessment used in those studies^{16, 17}. Nevertheless, we previously demonstrated that caregiver-report of eczema severity strongly correlated with quality-of-life reporting and healthcare utilization in the US¹². Thus, the distribution of eczema severity found in this study appears to be a good indicator of the public health burden of eczema in the US.

The distribution of eczema severity found in this study is also distinct from that of the distribution of US prevalence of eczema previously demonstrated, where peak prevalences occurred on the East coast and Pacific Northwest¹. Many of the states with higher rates of severe eczema have large population-densities with different racial/ethnic distributions¹⁸, more air pollution¹⁹ and colder climates. It is unknown what role, if any, these factors have on eczema severity. We previously found that climate conditions influence the prevalence of pediatric eczema in the US, with disease risk increasing in areas of lower relative humidity, lower UV index, lower temperatures and more precipitation and increased days needing indoor heating³. The Northeastern states generally have lower UV index and relative humidity, which suggests that climate may influence disease severity as well. It may be that low indoor humidity during the winter months in Northeastern and Midwest states causes xerotic or irritant contact dermatitis in at risk individuals, thereby predisposing to the development of ESA. Further studies are needed to determine whether climatic or other factors further drive eczema severity in the US.

We found that severe eczema was associated with Black race and Hispanic ethnicity. No studies have examined the role of racial/ethnic disparities in determining eczema severity. Previous studies found that eczema prevalence was higher in children of African descent compared with Caucasians^{1, 20-22}. Studies of racial/ethnic disparities in asthma found that African-Americans have significantly worse asthma outcomes, while Hispanics have lower quality of life secondary to asthma²³. African American children are less likely to use preventive medications for asthma than White or Hispanic children²⁴ and to have lower health literacy²³. Together, there appear to be significant racial/ethnic disparities for AD and other allergic disease.

Severe eczema was also associated with lower socioeconomic status, including lower household income, single-parent households, lower parental education, dilapidated housing and garbage on the street. Hanifin and Reed found that the US prevalence of AD and eczema decreased significantly with higher household income, but did not compare AD severity by household income²⁵. However, Shaw et al. found that eczema prevalence in the US increased with higher household incomes¹. Several other studies in the US and internationally found that markers of atopy such as skin-prick test positivity and immunoglobulin E levels were increased with higher socioeconomic status²⁶⁻²⁸. Future studies are needed to elucidate these points and to determine the cause(s) of racial/ethnic and perhaps socioeconomic disparities.

Eczema severity was significantly associated with being the oldest child in the household. This may be due to parental inexperience dealing with eczema skin care in their children, which would improve with subsequent children. This emphasizes the importance of education of parents about proper use of emollients and medications by dermatologists and other providers. Alternatively, there may be different exposures in children with older siblings living in the home, such as earlier introduction of certain foods that might result in tolerance or greater exposure to allergens in the physical environment. Flohr et al. recently demonstrated increased sensitization to a variety of food allergens in children that were exclusively breastfed, suggesting that sensitization occurs via transcutaneous sensitization²⁹. Family size and structure, household dietary and cultural practices may contribute to such transcutaneous sensitization. Future studies are needed to better understand the role of these factors on eczema.

Moderate - severe eczema was also associated with older age, which remained significant in multivariate models. Previous studies found lower prevalence of childhood eczema and eczema with increasing age^{1, 12, 25}. Together, these findings suggest that mild to moderate eczema generally becomes more quiescent with age and that children whose eczema persists are likely to have more severe disease. It is therefore important to study this group in the future to better understand the determinants of severe eczema in the population.

We found that birthplace outside the US was associated with decreased eczema severity. This is consistent with previous studies of Silverberg et al. that showed children born outside the US had significantly lower odds of atopic disease compared with those born in the US, including asthma, eczema, hay fever and food allergies¹⁴. Interestingly, children born outside the US who lived in the US for >10 years when compared with only 0-2 years had significantly higher odds of developing eczema and other atopic disorders. Shaw et al. found that the prevalence of childhood eczema was lower in children who were born outside the US or whose parents were born outside the US¹. Similarly, Silverberg and Hanifin found that the prevalence of eczema in US adults was lower in those born outside the US compared with those born in the US². Several other studies found that birthplace outside the US was associated with lower prevalence of asthma³⁰⁻³³. The results of this study suggest that birthplace outside the US may also have a protective effect for eczema severity.

The strengths of this study include being large-scale, US population-based and using backward and stepwise selection approaches in multivariate survey logistic regression

models. However, the study also has some limitations. The NSCH question encompassed both eczema and skin allergy. We were therefore unable to distinguish between these two entities. However, the preponderant etiology of eczema in children is related to AD. Is it possible that responses are skewed by inclusion of allergic or irritant contact dermatitis, which may increase with older age. However, this is less likely because the population we have categorized as eczema demonstrate a disease prevalence, comorbidity profile, and a natural history course consistent with AD¹². This group of children has a prevalence of eczema similar to two other studies of the prevalence of AD in the US using more strict criteria³⁴. A lower prevalence of affirmative responses to this question with age is consistent with the natural course of the disease. Lastly, children with a “yes” response to this question have a higher risk of asthma, food allergy and hay fever with odds ratios very similar to previously published numbers for AD populations. History and severity of eczema were defined by caregiver report. Previous studies using parental recall of history of physician-diagnosed eczema^{34, 35} and severity of disease³⁶ have been validated and found to correlate well with physician exam. Moreover, the perception of severe eczema by parents and children is likely a better determinant of quality of life impairment and healthcare utilization than physician assessment. We reported that caregiver-report of severe eczema was associated with poorer overall health and greater healthcare utilization¹². Caregiver-report of severe eczema was associated with increased mental health comorbidity, including attention deficit hyperactivity disorder, depression, anxiety, conduct disorder and autism³⁷. Thus, the results of this survey based approach using a patient / caregiver centered outcome are likely meaningful and accurate. The study is cross-sectional and therefore provides a snapshot view of eczema severity nationwide. Of course, eczema has a waxing and waning course, which may not be accurately represented in a cross-sectional study. However, the measure used in the study was report of overall severity of eczema over a 1 year period, which better describes the variable disease course than current severity. Nevertheless, future longitudinal studies are needed to identify risk factors for disease severity and flares.

In conclusion, childhood eczema severity varies widely nationwide and is associated with older age, African and Hispanic descent and lower socioeconomic status. Future studies are needed to verify these associations and to further identify the environmental factors that drive eczema severity in the US.

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Abbreviations used

CI	confidence interval
OR	odds ratio
aOR	adjusted odds ratio
AD	atopic dermatitis

NSCH National Survey of Children's Health

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Severe eczema - Tertile (min-max):
 ■ 1ST (2.0 - 5.5%)
 ■ 2ND (5.6 - 6.8%)
 ■ 3RD (7.1 - 12.9%)

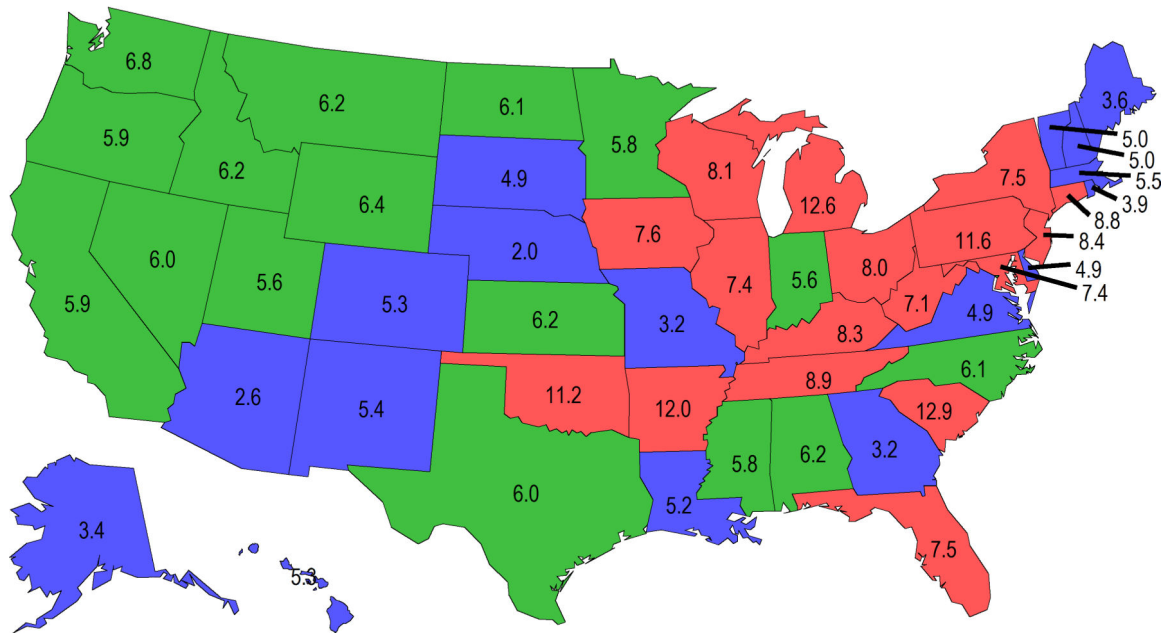


Figure 1. Rates of severe eczema in the United States are highest in Northeastern and Midwestern states

Data are presented as % per state. Severe eczema rates were divided into tertiles and color-coded: tertile-1 = blue, tertile-2 = green, tertile-3 = red.

Table 1

Personal and household associations of childhood atopic dermatitis severity (n=79,667).

Variable	Subgroup	Atopic dermatitis severity						P-value *
		Mild (n = 7198)		Moderate (n = 2612)		Severe (n = 576)		
		Freq	Percent (95% CI)	Freq	Percent (95% CI)	Freq	Percent (95% CI)	
Age (yr)	<1	392	76.9 (69.9 – 84.0)	93	17.7 (11.2 – 24.2)	25	5.4 (2.0 – 8.7)	0.0003
	1-3	1182	76.2 (72.2 – 80.2)	352	18.6 (15.2 – 22.0)	61	5.2 (2.8 – 7.6)	
	3-7	1890	67.7 (63.3 – 72.2)	648	27.1 (22.9 – 31.3)	123	5.2 (2.9 – 7.4)	
	7-13	2003	63.1 (59.0 – 67.3)	784	27.8 (24.0 – 31.5)	196	9.1 (6.4 – 11.9)	
	13-17	1731	62.6 (57.4 – 67.7)	735	29.5 (24.3 – 34.6)	171	8.0 (5.7 – 10.3)	
Sex	Male	3725	65.0 (61.9 – 68.1)	1354	26.9 (24.1 – 29.8)	295	8.1 (6.0 – 10.1)	0.12
	Female	3466	68.9 (65.8 – 72.1)	1258	25.1 (22.0 – 28.2)	281	6.0 (4.7 – 7.3)	
Race/ethnicity	Hispanic	801	61.8 (54.2 – 69.4)	324	30.2 (22.7 – 37.7)	85	8.0 (3.9 – 12.2)	<0.00001
	White, non-Hispanic	4500	71.8 (69.2 – 74.3)	1530	23.1 (20.8 – 25.4)	285	5.1 (3.8 – 6.5)	
	African American, non-Hispanic	1045	60.5 (55.5 – 65.4)	435	28.4 (23.6 – 33.2)	135	11.2 (8.1 – 14.3)	
	Multi/Other, non-Hispanic	741	66.5 (60.3 – 72.8)	282	29.8 (23.6 – 36.0)	54	3.6 (2.0 – 5.3)	
Child's birthplace in the US	No	123	78.4 (68.6 – 88.3)	40	13.4 (6.5 – 20.2)	11	8.2 (1.6 – 14.9)	0.04
	Yes	7004	66.7 (64.5 – 69.0)	2548	26.3 (24.2 – 28.4)	570	7.0 (5.7 – 8.2)	
Household income	0-99% FPL	779	58.3 (52.8 – 63.8)	339	27.5 (22.7 – 32.3)	128	14.2 (10.1 – 18.3)	<0.0001
	100-199% FPL	1137	64.2 (59.2 – 69.1)	470	27.4 (22.6 – 32.2)	146	8.4 (6.0 – 10.9)	
	200-399% FPL	2395	66.9 (62.8 – 71.0)	897	27.8 (24.0 – 31.7)	131	5.3 (3.0 – 7.5)	
	400% FPL	7198	74.0 (70.3 – 77.8)	2612	22.2 (18.6 – 25.8)	576	3.7 (2.2 – 5.3)	
Primary language spoken in home	English	6843	66.7 (64.4 – 69.0)	2478	26.1 (24.0 – 28.3)	550	7.2 (5.9 – 8.5)	0.27
	Not English	352	71.3 (63.4 – 79.2)	133	24.4 (16.9 – 31.9)	25	4.3 (2.1 – 6.6)	
Number of children in household	1	2950	67.5 (64.1 – 70.8)	1041	24.8 (22.0 – 27.6)	229	7.8 (5.2 – 10.3)	0.03
	2	2783	67.4 (63.9 – 80.8)	1008	26.7 (23.4 – 30.0)	206	5.9 (4.2 – 7.7)	
	3	1027	64.2 (59.0 – 69.4)	415	29.4 (24.2 – 34.6)	95	6.4 (4.2 – 8.6)	
	4	438	71.2 (64.4 – 78.0)	148	17.7 (12.9 – 22.4)	46	11.1 (5.8 – 16.4)	
Birth order in families with 2 or more children	Oldest child	2950	67.5 (64.1 – 70.8)	1041	24.8 (22.0 – 27.6)	229	7.8 (5.2 – 10.3)	0.02
	2 nd oldest child	1644	63.5 (58.6 – 68.4)	606	29.8 (25.0 – 34.6)	134	6.7 (4.1 – 9.3)	
	3 rd oldest child	1935	65.2 (61.3 – 69.2)	730	27.8 (24.0 – 31.7)	157	6.9 (4.9 – 9.0)	
	4 th oldest child	502	75.8 (70.2 – 81.5)	185	17.5 (12.7 – 22.3)	41	6.6 (3.4 – 9.8)	
Family structure	Two parent biological/adopted	5084	70.5 (67.8 – 73.1)	1724	25.3 (22.8 – 27.8)	287	4.2 (3.0 – 5.5)	<0.0001
	Two parent stepfamily	415	64.7 (56.0 – 73.4)	194	26.4 (17.9 – 34.9)	58	8.9 (5.0 – 12.9)	
	Single mother/no father present	1295	57.4 (52.3 – 62.5)	535	28.5 (23.7 – 33.2)	189	14.1 (10.5 – 17.7)	
	Other	367	69.5 (62.9 – 76.2)	144	23.9 (17.9 – 30.0)	38	6.5 (3.2 – 9.9)	

* Rao-Scott chi-square tests comparing between mild, moderate and severe eczema.

Table 2

Parental associations of childhood atopic dermatitis severity.

Highest level of education		Atopic dermatitis severity						P-value *
		Mild (n = 7198)		Moderate (n = 2612)		Severe (n = 576)		
		Freq	Percent (95% CI)	Freq	Percent (95% CI)	Freq	Percent (95% CI)	
Father	< HS	308	59.7 (51.1 – 68.3)	151	32.1 (23.6 – 40.5)	45	8.2 (4.6 – 11.9)	0.001
	HS	1100	64.9 (58.6 – 71.2)	423	28.1 (22.0 – 34.2)	89	7.0 (3.4 – 10.6)	
	> HS	4153	73.1 (70.4 – 75.8)	1373	23.5 (21.0 – 26.1)	210	3.3 (2.2 – 4.4)	
Mother	< HS	381	62.8 (55.0 – 70.5)	160	26.1 (19.2 – 33.1)	64	11.1 (6.8 – 15.4)	<0.0001
	HS	1158	59.7 (54.5 – 65.0)	461	27.9 (23.2 – 32.5)	135	12.4 (8.2 – 16.5)	
	> HS	5238	69.9 (67.2 – 72.6)	1836	25.5 (22.9 – 28.1)	332	4.6 (3.5 – 5.6)	
Birthplace in United States								
Father	No	635	68.3 (61.6 – 74.9)	219	26.1 (19.7 – 32.6)	38	5.6 (2.9 – 8.3)	0.72
	Yes	4952	70.4 (67.7 – 73.1)	1732	25.1 (22.6 – 27.7)	310	4.5 (3.2 – 5.8)	
Mother	No	734	66.3 (59.5 – 73.1)	280	27.1 (20.6 – 33.6)	56	6.6 (3.3 – 9.9)	0.94
	Yes	6060	67.0 (64.5 – 69.4)	2180	26.1 (23.8 – 28.4)	477	7.0 (5.6 – 8.4)	
Overall health								
Mother	Excellent	2015	72.3 (67.8 – 76.9)	567	22.7 (18.4 – 27.0)	104	5.0 (2.6 – 7.4)	<0.0001
	Very good	2724	70.7 (67.5 – 74.0)	979	25.6 (22.4 – 28.7)	159	3.7 (2.5 – 4.9)	
	Good	1503	66.0 (61.1 – 71.0)	575	25.9 (21.2 – 30.5)	153	8.1 (5.5 – 10.7)	
	Fair	459	46.6 (39.1 – 54.1)	259	35.9 (28.0 – 32.8)	84	17.5 (10.8 – 24.3)	
	Poor	117	57.1 (43.9 – 70.3)	88	30.6 (19.1 – 42.1)	32	12.3 (5.0 – 19.7)	
Father	Excellent	1779	74.2 (70.1 – 78.3)	537	20.6 (17.1 – 24.0)	90	5.2 (2.5 – 8.0)	0.15
	Very good	2394	69.5 (65.4 – 73.5)	849	26.2 (22.3 – 30.1)	144	4.3 (2.6 – 6.1)	
	Good	1131	67.6 (62.0 – 73.2)	428	28.9 (23.3 – 34.4)	68	3.5 (1.9 – 5.1)	
	Fair	246	63.1 (52.0 – 74.2)	110	30.9 (19.9 – 41.9)	32	6.1 (2.3 – 9.8)	
	Poor	56	69.9 (53.3 – 86.5)	34	21.1 (7.8 – 34.3)	15	9.0 (1.7 – 16.3)	
Mental / emotional health								
Mother	Excellent	2273	68.8 (64.7 – 72.9)	682	26.4 (22.4 – 30.4)	136	4.8 (2.9 – 6.6)	<0.0001
	Very good	2844	71.8 (68.4 – 75.1)	1009	24.5 (21.2 – 27.8)	171	3.7 (2.6 0 4.9)	
	Good	1262	64.5 (59.6 – 69.4)	541	27.3 (22.7 – 31.8)	139	8.2 (5.6 – 10.8)	
	Fair	371	46.9 (37.5 – 56.4)	192	31.5 (22.0 – 41.0)	65	21.6 (12.6 – 30.5)	
	Poor	63	47.5 (31.3 – 63.6)	32	19.0 (8.6 – 29.3)	23	33.6 (15.6 – 51.5)	
Father	Excellent	2189	71.5 (67.5 – 75.6)	656	23.0 (19.4 – 26.7)	117	5.5 (2.9 – 8.1)	0.02
	Very good	2371	71.7 (67.8 – 75.6)	839	24.6 (20.8 0 28.5)	133	3.7 (2.4 – 4.9)	
	Good	827	67.5 (61.2 – 73.8)	346	28.6 (22.4 – 34.8)	67	3.9 (2.2 – 5.6)	
	Fair	190	55.0 (42.1 – 67.8)	97	37.6 (24.8 – 50.5)	22	7.4 (1.2 – 13.7)	
	Poor	21	42.9 (3.6 – 82.2)	16	36.0 (5.1 – 67.0)	10	21.1 (0.8 – 41.3)	

* Rao-Scott chi-square tests comparing between mild, moderate and severe eczema.

Table 3

Local environmental associations of childhood atopic dermatitis severity.

Variable	Subgroup	Atopic dermatitis severity						P-value *
		Mild (n = 7198)		Moderate (n = 2612)		Severe (n = 576)		
		Freq	Percent (95% CI)	Freq	Percent (95% CI)	Freq	Percent (95% CI)	
Residence in metropolitan area	Yes	4058	66.1 (63.4 – 68.8)	1483	26.7 (24.1 – 29.3)	342	7.2 (5.6 – 8.7)	0.26
	No	877	70.4 (66.2 – 74.6)	327	22.8 (19.1 – 26.5)	74	6.8 (4.2 – 9.4)	
Smokers living at home	No	5500	68.6 (66.0 – 71.2)	1922	25.2 (22.7 – 27.6)	358	6.2 (4.8 – 7.7)	0.03
	Yes	1651	62.6 (58.4 – 66.8)	672	28.5 (24.4 – 32.6)	213	8.9 (6.7 – 11.1)	
Smoking in home	No	1205	61.8 (56.7 – 66.9)	495	29.9 (24.9 – 24.9)	148	8.3 (5.7 – 10.9)	0.29
	Yes	445	64.8 (57.9 – 71.6)	177	24.4 (18.2 – 30.5)	65	10.9 (6.5 – 15.2)	
Dilapidated housing	No	6054	68.7 (66.3 – 71.1)	2110	25.3 (23.1 – 27.6)	434	6.0 (4.8 – 7.2)	0.0009
	Yes	1073	59.0 (52.9 – 65.0)	472	29.4 (23.7 – 35.2)	136	11.6 (7.6 – 15.6)	
Garbage on street	No	5839	69.0 (66.6 – 71.4)	2051	25.0 (22.7 – 27.3)	425	6.0 (4.8 – 7.2)	0.001
	Yes	1296	59.6 (54.4 – 64.8)	535	29.9 (24.8 – 34.9)	144	10.6 (6.9 – 14.3)	
Park in neighborhood	No	1265	64.7 (59.8 – 69.7)	525	27.1 (22.8 – 31.4)	117	8.2 (4.9 – 11.5)	0.53
	Yes	5870	67.5 (65.0 – 70.0)	2064	25.8 (23.4 – 28.2)	452	6.7 (5.4 – 8.0)	
Sidewalk in neighborhood	No	1771	67.4 (63.3 – 71.5)	669	26.0 (22.0 – 29.9)	166	6.6 (4.9 – 8.4)	0.94
	Yes	5366	66.9 (64.2 – 69.5)	1920	26.1 (23.6 – 28.5)	403	7.1 (5.5 – 8.6)	

* Rao-Scott chi-square tests comparing between mild, moderate and severe eczema.