Association between childhood eczema and headaches: An analysis of 19 US population-based studies

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Background: Atopic dermatitis (or eczema) is a chronic inflammatory disorder associated with sleep disturbances and quality-of-life impairment. Sleep disturbances have been shown to cause headaches in childhood. However, an association between eczema and headaches is not well established.
Objectives: We sought to determine whether childhood eczema is associated with increased headaches and whether such association is related to fatigue or sleep disturbance.
Methods: We analyzed data from 401,002 children and adolescents in 19 US population-based cross-sectional studies from the National Survey of Children's Health 2003/2004 and 2007/2008 and the National Health Interview Survey 1997-2013.
Results: In multivariate models controlling for age, sex, race/ethnicity, household income, highest level of education in the family, insurance coverage, number of persons in the household, birthplace in the United States, ever history of asthma, hay fever, and food allergy, eczema was found to be associated with headaches in 14 of 19 studies. In a pooled analysis of all 19 studies, children with eczema compared with those without eczema had a significantly higher prevalence (10.7% [95% CI, 10.3% to 11.0%] vs 5.4% [95% CI, 5.3% to 5.5%]) and odds (1.52 [95% CI, 1.45-1.59]) of headaches. Mild (1.79 [95% CI, 1.07-2.98]) and severe (2.72 [95% CI, 1.33-5.57]) eczema were associated with significantly higher odds of headaches. In particular, eczema associated with atopy, fatigue, excessive daytime sleepiness, insomnia, and only 0 to 3 nights of sufficient sleep had even higher odds of headache than eczema alone.
Conclusions: Eczema is associated with increased headaches in childhood, particularly in patients with severe disease accompanied by atopy, fatigue, and sleep disturbances. (J Allergy Clin Immunol 2015;■■■:■■■-■■■.)

Key words: Atopic dermatitis, eczema, headaches, atopy, sleep disturbance, sleepiness, insomnia, fatigue

Atopic dermatitis (AD; or eczema) is the most common chronic inflammatory skin disorder of childhood, affecting approximately 10% to 12% of children in the United States.[1] The intense itch and skin manifestations of eczema can be devastating, with impaired

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Abbreviations used
AD: Atopic dermatitis
aOR: Adjusted odds ratio
NHIS: National Health Interview Survey
NSCH: National Survey of Children's Health
OR: Odds ratio

quality of life,[2] fatigue and sleep disturbance,[3] mental health comorbidity,[4] and comorbid allergic disorders, including asthma, hay fever, and food allergy.[5,6]

Headaches are also a common problem in children. A study of 10,198 US children from the National Health and Nutrition Examination Survey found a 1-year prevalence of 17.1%.[7] Childhood headaches have been found to cause significant quality-of-life impairment similar to that seen in patients with arthritis and cancer.[8,9] Given the commonality and large patient and familial burden of disease, it is important to identify potentially modifiable risk factors.

Headaches are a common symptom of a number of chronic diseases. Previous studies have demonstrated that headaches occur more frequently in children with allergic disease,[7,10,11] sleep disturbances,[12-17] and psychological and behavioral disorders,[18] all of which occur more frequently in children with eczema.[4,5,19] However, the association of eczema *per se* and headaches has not been well established.

I hypothesized that childhood eczema is associated with increased headaches, especially in patients with more severe disease. In particular, I hypothesized that fatigue and sleep disturbances occurring in patients with severe eczema further predispose to headaches. The present study analyzed data from 19 different large-scale studies to determine whether childhood eczema is associated with headaches and what role fatigue and sleep disturbances play in this association.

METHODS
Study sources
After approval by Northwestern University's Institutional Review Board, data were assessed from the following cross-sectional studies: 1997-2013 National Health Interview Survey (NHIS) child and adult health surveys and the 2003-2004 and 2007-2008 National Survey of Children's Health (NSCH). These studies were selected because of their rigorous methodology and available data for history of both eczema and headaches. Data were obtained from the National Center for Health Statistics of the Centers for Disease Control and Prevention, which oversaw sampling and interviews. No other studies with valid data available on history of eczema and headaches were excluded. The characteristics of these studies are summarized in Table E1 in this article's Online Repository at www.jacionline.org. By using data from the US Census Bureau, sample weights were created for each study by their sponsors that factored age, sex, race, ethnicity, household size, and educational attainment of the most educated household member by using a multistage area probability sampling design. These sample weights are needed to provide

nationally representative prevalence estimates for each state's population of noninstitutionalized adults. All prevalence estimates for individual studies presented reflect this complex weighting. Each study year included a different cohort of subjects than previous years. The sample designs and methodology were consistent across all years of the NHIS and NSCH, allowing for pooling of data from each year of the respective studies. Pooled analyses were performed by merging the data sets and dividing the sampling weights by the number of years for the respective study (17 for the NHIS and 2 for the NSCH). Weighted prevalence estimates are presented for pooled analysis. However, the sampling designs of the NHIS and NSCH were not comparable, which precluded combination of sampling weights. Therefore unweighted prevalence estimates are presented for pooled analysis of NSCH and NHIS results. The questions used in this study for the assessment of eczema, headaches, and potentially confounding variables are presented in Table E2 in this article's Online Repository at www.jacionline.org.

Statistics

All data processing and statistical analyses were performed in SAS version 9.4 software (SAS Institute, Cary, NC). Frequencies of missing values are presented in Table E3 in this article's Online Repository at www.jacionline.org. There were low frequencies of missing values for the history of eczema and headaches and other covariates. Complete data analysis was performed for all variables (ie, subjects with missing data were excluded), with 3 exceptions in which missing values were greater than 5% of respondents: household income in the 1997-2013 NHIS and 2003-2004 and 2007-2008 NSCH. Therefore I used the multiple imputation of missing household income levels that were generated by the National Center for Health Statistics. The National Center for Health Statistics previously evaluated the nonresponse rates for the NSCH and found minimal or no response bias for multiple questions, including measures of health use.[20] Multivariate survey logistic regression models were constructed for individual studies by using procedures that accounted for the surveys' complex weighting factors (proc surveylogistic). The dependent variable was a history of headaches in the past year, and the independent variables were history of eczema (yes/no) and eczema severity (mild/moderate/severe). The complex weighting factors for the NHIS and NSCH could not be combined given the varied sampling and study designs and therefore were not included in pooled analyses. Multivariate models included age, sex, race/ethnicity, household income, highest level of education in the family, insurance coverage, number of persons in the household, birthplace in the United States, ever history of asthma, hay fever, and food allergy as categorical variables; additional models were created that also included parental history of eczema and headaches (NHIS 1998-2013). Adjusted odds ratios (aORs) and 95% CIs were estimated.

My *a priori* hypothesis was that having both eczema and atopic disorders is associated with even higher odds of headaches than either disorder alone. Therefore models were constructed that included eczema, atopic disorders (asthma, hay fever, and/or food allergy), and an interaction term between them. In addition, I hypothesized that fatigue and sleep disturbance in eczema are associated with headaches. Two studies assessed for caregiver-reported history of fatigue or insomnia (NHIS 2007 and 2012) and one for excessive daytime sleepiness (NHIS 2012). Two studies assessed for caregiver report of the number of nights per week with sufficient sleep (NSCH 2003-2004 and 2007-2008). However, the distribution of this variable was bimodal and highly skewed, and therefore it was dichotomized into 0 to 3 versus 4 to 7 nights of sufficient sleep, which was similar to a previous study.[5] Separate bivariate and multivariate logistic regression models were constructed that included each of the abovementioned sleep-related variables, history of eczema, and a statistical interaction term between them. Estimates of effect size for significant interactions between eczema and a sleep-related variable were conducted for each level of the covariate by using contrast statements.

RESULTS

Prevalence of eczema and headaches

Data were collected on 401,002 children and adolescents, representing all age, sex, racial/ethnic, household education, and income groups. The pooled US prevalence of eczema in childhood was 10.4% (95% CI, 10.3% to 10.4%), although the prevalence of eczema steadily increased in the NHIS from 7.6% (95% CI, 7.2% to 8.1%) in 1997 to 12.0% (95% CI, 11.4% to 12.5%) in 2013. In pooled bivariate logistic regression models, the prevalence of eczema was significantly associated with female sex, black and multiracial race, maternal and paternal history of eczema, and headaches (Table I). However, eczema was inversely associated with older age, Hispanic ethnicity, lower household income, higher number of persons in the household, birthplace outside the United States, lack of insurance coverage, and paternal smoking every day.

The pooled US prevalence of headaches in childhood was 5.9% (95% CI, 5.8% to 6.0%), with relatively stable prevalence between 1997 (5.8% [95% CI, 5.3% to 6.2%]) and 2013 (6.1% [95% CI, 5.7% to 6.6%]). In pooled bivariate logistic regression models, headaches were significantly associated with female sex, older age, black race, lower household income and education, maternal history of eczema, maternal and paternal history of headaches, and maternal and paternal history of smoking every day (Table I). However, headaches were inversely associated with Hispanic and multiracial race/ethnicity, higher number of persons in the household, and birthplace outside the United States.

Association between headaches and eczema

In bivariate models eczema was associated with significantly higher odds of headaches in 19 of 19 studies (P <.0001 for all, data not shown). In multivariate models controlling for age, sex, race/ethnicity, household income, highest level of education in the family, insurance coverage, number of persons in the household, birthplace in the United States, ever history of asthma, hay fever, and food allergy, association between eczema and increased headaches remained significant in 15 of 19 studies (Table II).

In pooled weighted analysis of NHIS studies, 11.1% (95% CI, 10.5% to 11.7%) of children with eczema were reported to also have headaches compared with only 5.4% (95% CI, 5.3% to 5.5%) of those without eczema. Conversely, nearly 1 in 5 children with a history of headaches were reported to have eczema (17.6% [95% CI, 17.0% to 18.1%]) compared with only 9.2% (95% CI, 9.1% to 9.3%) of those without headaches. In pooled multivariate models of NHIS studies controlling for sociodemographics and comorbid asthma, hay fever, and food allergy, eczema was associated with a significantly increased odds of headache (aOR, 1.51 [95% CI, 1.34-1.71]; P < .0001). Similar results were found in pooled weighted analysis of NSCH studies and pooled unweighted analysis of NHIS and NSCH studies (P <.0001, Table I). These results remained significant in models that also controlled for parental history of eczema, headaches, and current smoking (aOR, 1.76 [95% CI, 1.25-2.49]; P <.0001).

Given that both headaches and eczema activity can vary at different ages, logistic regression models of data from all studies were stratified by age. Eczema was associated with significantly higher prevalences of headaches at all ages in childhood and adolescence (Fig 1).

Association between eczema severity and headaches

NSCH 2007 assessed for self-reported eczema severity in those children and adolescents who were reported to have eczema.

TABLE I. Associations of eczema and headaches in children (n = 401,002)

Variable, no. (%)	Eczema		Headaches	
	Prevalence (% [95% CI])	Pooled OR (95% CI)	Prevalence (% [95% CI])	Pooled OR (95% CI)
Sex				
Male	10.1 (10.0-10.2)	1.00 (reference)	5.4 (5.3-5.5)	1.00 (reference)
Female	10.6 (10.5-10.8)	1.06 (1.04-1.08)	6.4 (6.3-6.5)	1.19 (1.5-1.22)
Age (y)				
0-5	12.3 (12.1-12.4)	1.00 (reference)	0.9 (0.8-1.0)	1.00 (reference)
6-10	10.6 (10.5-10.8)	0.85 (0.83-0.87)	4.0 (3.9-4.2)	4.64 (4.21-5.12)
11-17	8.7 (8.5-8.8)	0.68 (0.66-0.70)	8.5 (8.4-8.6)	10.32 (9.13-11.24)
Race				
White	9.9 (9.8-10.1)	1.00 (reference)	6.0 (5.9-6.1)	1.00 (reference)
Black/African American	14.6 (14.2-14.9)	1.54 (1.50-1.59)	6.8 (6.6-7.1)	1.15 (1.10-1.20)
Hispanic	8.2 (8.0-8.3)	0.81 (0.78-0.83)	5.3 (5.2-5.5)	0.88 (0.85-0.92)
Multiracial/other	11.6 (11.1-12.1)	1.19 (1.14-1.25)	4.4 (4.1-4.8)	0.72 (0.67-0.79)
Household income (% FPL)				
0% to 99%	10.7 (10.4-10.9)	0.94 (0.91-0.97)	8.3 (8.0-8.6)	1.77 (1.69-1.85)
100% to 199%	10.4 (10.1-10.6)	0.91 (0.89-0.94)	6.8 (6.6-7.0)	1.43 (1.36-1.49)
200% to 399%	10.6 (10.5-10.8)	0.94 (0.92-0.97)	5.6 (5.5-5.8)	1.17 (1.12-1.22)
≥400%	11.2 (11.0-11.4)	1.00 (reference)	4.9 (4.7-5.0)	1.00 (reference)
No. of persons in household				
1-2	11.4 (11.2-11.5)	1.00 (reference)	6.0 (5.9-6.2)	1.00 (reference)
3-4	9.9 (9.8-10.1)	0.86 (0.84-0.88)	5.8 (5.7-6.0)	0.97 (0.94-1.01)
≥5	8.6 (8.4-8.9)	0.74 (0.71-0.76)	5.7 (5.5-5.9)	0.94 (0.89-0.98)
Highest level of household education				
Less than high school	6.4 (6.1-6.7)	0.77 (0.75-0.80)	6.6 (6.2-7.0)	1.10 (1.05-1.15)
High school or GED	8.4 (8.2-8.7)	0.57 (0.54-0.61)	6.4 (6.2-6.7)	1.12 (1.05-1.20)
More than high school	10.6 (10.5-10.7)	1.00 (reference)	5.9 (5.8-6.0)	1.00 (reference)
Birthplace in the United States				
No	10.6 (10.5-10.6)	0.56 (0.53-0.59)	6.0 (5.9-6.0)	0.81 (0.75-0.87)
Yes	6.2 (5.8-6.5)	1.00 (reference)	4.9 (4.6-5.2)	1.00 (reference)
Insurance coverage				
No	7.4 (7.2-7.7)	0.67 (0.65-0.70)	6.0 (5.7-6.3)	1.02 (0.98-1.08)
Yes	10.7 (10.6-10.8)	1.00 (reference)	5.9 (5.8-6.0)	1.00 (reference)
Maternal history of eczema				
No	12.2 (11.6-12.9)	1.00 (reference)	6.6 (6.1-7.2)	1.00 (reference)
Yes	27.4 (24.4-30.4)	2.71 (2.30-3.18)	11.7 (9.3-14.1)	1.87 (1.46-2.40)
Paternal history of eczema				
No	10.4 (9.6-11.2)	1.00 (reference)	4.7 (4.1-5.3)	1.00 (reference)
Yes	19.8 (15.7-23.9)	2.12 (1.61-2.79)	6.7 (3.9-9.6)	1.47 (0.92-2.37)
Maternal history of headaches				
No	8.9 (8.7-9.1)	1.00 (reference)	4.5 (4.3-4.7)	1.00 (reference)
Yes	15.2 (14.7-15.7)	1.84 (1.76-1.92)	13.3 (12.8-13.8)	3.25 (3.07-3.45)
Paternal history of headaches				
No	8.5 (8.3-8.8)	1.00 (reference)	4.5 (4.3-4.7)	1.00 (reference)
Yes	12.3 (11.4-13.2)	1.50 (1.37-1.64)	11.1 (10.2-12.0)	2.64 (2.38-2.94)
Maternal history of smoking				
Not at all	11.7 (11.1-12.2)	1.00 (reference)	7.5 (7.0-8.0)	1.00 (reference)
Some days	12.6 (11.5-13.6)	1.09 (0.97-1.22)	8.6 (7.6-9.6)	1.16 (0.99-1.34)
Every day	10.9 (10.4-11.4)	0.93 (0.86-1.00)	10.0 (9.5-10.5)	1.37 (1.24-1.51)
Paternal history of smoking				
Not at all	9.9 (9.3-10.5)	1.00 (reference)	6.0 (5.5-6.5)	1.00 (reference)
Some days	9.5 (8.4-10.6)	0.96 (0.83-1.11)	4.8 (3.8-5.7)	0.79 (0.63-0.99)
Every day	8.5 (7.9-9.1)	0.85 (0.77-0.94)	7.4 (6.8-8.0)	1.27 (1.11-1.44)

Pooled prevalences of eczema or headaches were estimated for NHIS 1997-2013 and NSCH 2003-2004 and 2007-2008. Binary logistic regression models were constructed with eczema or headaches as the binary dependent variables and sociodemographics and family history of eczema or headaches as the independent variables. The complex sample weights in the NHIS and NSCH could not be combined given differences in sampling methodology between these studies. Therefore unweighted estimates of prevalence and effect size are presented. *FPL,* Family poverty level.

Higher prevalences of headaches occurred in children with mild (8.4% [95% CI, 6.0% to 10.8%]) and moderate (9.7% [95% CI, 7.1% to 12.2%]) eczema compared with those with no eczema (4.8% [95% CI, 4.3% to 5.2%], Table III). However, children with severe eczema had an even higher prevalence of headaches (19.7% [95% CI, 11.4% to 27.9%]). In multivariate models mild (aOR, 1.79 [95% CI, 1.07-2.98]) and severe (aOR, 2.72 [95% CI, 1.33-5.57]) eczema were associated with significantly higher odds of headaches. We tested each covariate individually with eczema severity and found that moderate eczema remained

TABLE II. Association between eczema and frequent or severe headaches in children and adolescents

History of eczema	No headaches		Headaches			
	Frequency	Prevalence (% [95% CI])	Frequency	Prevalence (% [95% CI])	aOR (95% CI)	P value
NHIS 1997						
No eczema	10,193	94.8 (94.3-95.2)	576	5.2 (4.8-5.7)	1 (reference)	—
Eczema	784	89.7 (87.4-92.0)	95	10.3 (8.0-12.6)	1.43 (1.05-1.96)	.02
NHIS 1998						
No eczema	9,658	94.3 (93.7-94.8)	585	5.7 (5.2-6.3)	1 (reference)	—
Eczema	716	90.3 (88.0-92.6)	89	9.7 (7.4-12.0)	1.22 (0.88-1.69)	.24
NHIS 1999						
No eczema	9,326	94.0 (93.4-94.6)	570	6.0 (5.4-6.6)	1 (reference)	—
Eczema	608	87.9 (85.2-90.7)	92	12.1 (9.3-14.8)	1.50 (1.11-2.03)	.009
NHIS 2000						
No eczema	9,629	94.8 (94.3-95.3)	539	5.2 (4.7-5.7)	1 (reference)	—
Eczema	666	88.1 (85.4-90.8)	103	11.9 (9.2-14.6)	1.64 (1.19-2.27)	.003
NHIS 2001						
No eczema	9,669	94.4 (93.8-94.9)	591	5.6 (5.1-6.2)	1 (reference)	—
Eczema	765	86.3 (83.3-89.3)	116	13.7 (10.7-16.7)	1.73 (1.27-2.35)	.0005
NHIS 2002						
No eczema	8,775	94.5 (94.0-95.1)	551	5.5 (4.9-6.0)	1 (reference)	—
Eczema	761	87.4 (85.0-89.9)	116	12.6 (10.1-15.0)	1.73 (1.29-2.33)	.0003
NHIS 2003						
No eczema	8,670	94.2 (93.7-94.8)	541	5.8 (5.2-6.3)	1 (reference)	—
Eczema	774	88.4 (85.9-90.9)	109	11.6 (9.1-14.1)	1.22 (0.85-1.74)	.28
NHIS 2004						
No eczema	8,715	94.5 (93.9-95.0)	549	5.5 (5.0-6.1)	1 (reference)	—
Eczema	793	87.3 (84.8-89.8)	127	12.7 (10.2-15.2)	1.65 (1.23-2.21)	.0008
NHIS 2005						
No eczema	8,808	94.5 (94.0-95.1)	522	5.5 (4.9-6.0)	1 (reference)	—
Eczema	852	87.8 (85.2-90.4)	119	12.2 (9.6-14.8)	1.69 (1.25-2.27)	.0006
NHIS 2006						
No eczema	6,851	95.0 (94.4-95.6)	394	5.0 (4.4-5.6)	1 (reference)	—
Eczema	689	87.1 (83.7-90.4)	99	12.9 (9.6-16.3)	1.90 (1.31-2.76)	.0008
NHIS 2007						
No eczema	6,646	95.0 (94.3-95.6)	338	5.0 (4.4-5.7)	1 (reference)	—
Eczema	618	91.7 (89.3-94.2)	58	8.3 (5.8-10.7)	1.11 (0.74-1.67)	.62
NHIS 2008						
No eczema	6,169	94.8 (94.2-95.5)	357	5.2 (4.5-5.8)	1 (reference)	—
Eczema	674	89.0 (86.4-91.7)	94	11.0 (8.3-13.6)	1.39 (0.97-2.01)	.07
NHIS 2009						
No eczema	7,676	95.1 (94.5-95.7)	444	4.9 (4.3-5.5)	1 (reference)	—
Eczema	933	91.0 (88.8-93.2)	109	9.0 (6.8-11.2)	1.43 (1.04-1.96)	.03
NHIS 2010						
No eczema	7,663	94.6 (94.0-95.2)	455	5.4 (4.8-6.0)	1 (reference)	—
Eczema	976	89.5 (87.3-91.7)	120	10.5 (8.3-12.7)	1.40 (1.04-1.90)	.03
NHIS 2011						
No eczema	8,726	94.6 (94.1-95.2)	523	5.4 (4.8-5.9)	1 (reference)	—
Eczema	1,148	89.0 (87.0-91.1)	139	11.0 (8.9-13.0)	1.56 (1.19-2.05)	.002
NHIS 2012						
No eczema	9,093	94.6 (94.0-95.1)	555	5.4 (4.9-6.0)	1 (reference)	—
Eczema	1,145	90.2 (88.3-92.1)	145	9.8 (7.9-11.7)	1.34 (1.01-1.77)	.04
NHIS 2013						
No eczema	8,904	94.7 (94.1-95.2)	513	5.3 (4.8-5.9)	1 (reference)	—
Eczema	1,112	89.7 (87.7-91.8)	139	10.3 (8.2-12.3)	1.41 (1.06-1.88)	.02
NSCH 2003-2004						
No eczema	73,188	94.9 (94.6-95.2)	3,930	5.1 (4.8-5.4)	1 (reference)	—
Eczema	7,270	89.6 (88.3-90.9)	774	10.4 (9.1-11.7)	1.65 (1.40-1.94)	<.0001
NSCH 2007-2008						
No eczema	54,066	94.9 (94.7-95.1)	2,922	5.1 (4.9-5.3)	1 (reference)	—
Eczema	6,319	90.6 (90.0-91.3)	653	9.4 (8.7-10.1)	1.56 (1.09-2.23)	.01
Pooled NHIS*						
No eczema	145,171	94.6 (94.5-94.7)	8,603	5.4 (5.3-5.5)	1 (reference)	—
Eczema	14,014	88.9 (88.3-89.5)	1,869	11.1 (10.5-11.7)	1.51 (1.34-1.71)	<.0001

(Continued)

TABLE II. *(Continued)*

History of eczema	No headaches		Headaches			
	Frequency	Prevalence (% [95% CI])	Frequency	Prevalence (% [95% CI])	aOR (95% CI)	*P* value
Pooled NSCH†						
No eczema	127,254	95.1 (94.8-95.3)	6,852	4.9 (4.7-5.2)	1 (reference)	—
Eczema	13,589	90.0 (88.9-91.1)	1,427	10.0 (8.9-11.1)	1.62 (1.38-1.90)	<.0001
Pooled NHIS and NSCH‡						
No eczema	272,425	94.6 (94.5-94.7)	15,455	5.4 (5.3-5.5)	1 (reference)	—
Eczema	27,603	89.3 (89.0-89.7)	3,296	10.7 (10.3-11.0)	1.52 (1.45-1.59)	<.0001

Binary survey logistic regression models were constructed with headache as the binary dependent variable and history of eczema as the binary independent variable. Multivariate models were constructed that included age, sex, race/ethnicity, household income, highest level of education in the family, insurance coverage, number of persons in the household, birthplace in the United States, ever history of asthma, hay fever, and food allergy. aORs and 95% CIs were estimated.
*The complex sample weights in the NHIS were combined across all years. Pooled weighted estimates of prevalence and effect size are presented.
†The complex sample weights in the NSCH were combined across all years. Pooled weighted estimates of prevalence and effect size are presented.
‡The complex sample weights in the NHIS and NSCH could not be combined given differences in sampling methodology between these studies. Therefore pooled unweighted estimates of prevalence and effect size are presented.
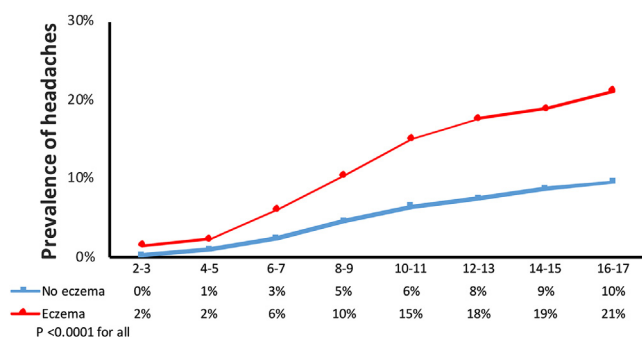

	2-3	4-5	6-7	8-9	10-11	12-13	14-15	16-17
No eczema	0%	1%	3%	5%	6%	8%	9%	10%
Eczema	2%	2%	6%	10%	15%	18%	19%	21%

P <0.0001 for all

FIG 1. Association between history of eczema and headaches occurs at any age during childhood and adolescence. Logistic regression models were constructed, with history of headaches as the dependent variable and history of eczema as the independent variable. Models were stratified by age. The association between eczema and headaches remained significant (*P* < .0001) at all ages in multivariate models that included history of asthma, hay fever and food allergy, race/ethnicity, household income, highest level of education in the household, US birthplace, number of persons in the home, and insurance coverage.

significant with inclusion of each covariate by itself. This suggests that the loss of significance in multivariate models was due to insufficient power because of the relatively lower frequency of children with moderate eczema and headaches.

Association of eczema, atopy, and headaches

There were significant interactions between eczema and atopy as predictors of headache. In bivariate models of NHIS 1997-2013, eczema (odds ratio [OR], 1.78 [95% CI, 1.48-2.14]) and atopy (OR, 2.64 [95% CI, 2.44-2.87]) alone were associated with significantly higher odds of headaches (see Table E4 in this article's Online Repository at www.jacionline.org). However, children with eczema and atopy had even higher odds of headaches (OR, 4.27 [95% CI, 3.73-4.88]). Similar results were found in multivariate models and in bivariate models for NSCH 2003-2004 and NSCH 2007-2008.

Association of eczema, fatigue, sleep disturbances, and headaches

NHIS 2007 and 2012 assessed for fatigue in children. In bivariate models eczema alone was associated with significantly

higher odds of headaches (OR for 2007: 1.65 [95% CI, 1.10-2.47]; 2012: 1.77 [95% CI, 1.34-2.35]). However, children with fatigue both with and without eczema had higher odds of headaches (OR for 2007: 5.75 [95% CI, 3.67-9.00] and 5.93 [95% CI, 2.64-13.29], respectively; 2012: 5.56 [95% CI, 4.15-7.44] and 7.42 [95% CI, 4.71-11.69], respectively; Table IV). Similar results were found in bivariate models of daytime sleepiness (NHIS 2012) and insomnia (NHIS 2007 and 2012) and in multivariate models for fatigue, sleepiness, and insomnia.

NSCH 2003-2004 and 2007-2008 assessed number of nights with sufficient sleep. Children and adolescents with eczema, only 0 to 3 nights of sufficient sleep per week, or both had significantly higher odds of headaches than those with either eczema or inadequate sleep (Table IV).

Association between parental and child headaches is not modified by eczema

NHIS 1997-2013 assessed for migraine headaches in other members of the child's household, including the mother (n = 87,422) and father (n = 50,277). Pediatric headaches were significantly associated with maternal (survey logistic regression: OR, 3.25 [95% CI, 3.07-3.45]) and paternal (OR, 2.64 [95% CI, 2.38-2.94]) headaches (Table I). Maternal but not paternal headaches were associated with the child having eczema (maternal: 1.87 [95% CI, 1.46-2.40]; paternal: 1.47 [95% CI, 0.92-2.37]). There were significant interactions between history of eczema and maternal/paternal headaches, such that children with eczema and a parental history of eczema had higher odds of headaches than those with either eczema or a parental history alone (see Table E5 in this article's Online Repository at www.jacionline.org). However, there were no significant interactions between parental and child history of eczema or smoking as predictors of headaches.

DISCUSSION

In the present study we analyzed data from 19 US population-based cross-sectional studies and found that pediatric eczema is associated with increased odds of headaches at all ages throughout childhood and adolescence. In a single study that assessed for eczema severity, albeit self-reported, severe eczema was associated with even higher odds of headaches than mild or moderate disease, although mild-to-moderate disease was also

TABLE III. Association between headaches and eczema severity in NSCH 2007-2008

	Headaches							
	No (n = 60,374)		Yes (n = 3,573)					
Eczema severity	Frequency	Percent (95% CI)	Frequency	Percent (95% CI)	OR (95% CI)	P value	aOR (95% CI)	P value
None	54,066	95.2 (94.8-95.7)	2,922	4.8 (4.3-5.2)	1.00 (reference)	—	1.00 (reference)	—
Mild	4,297	91.6 (89.2-94.0)	372	8.4 (6.0-10.8)	1.83 (1.33-2.53)	.0002	1.79 (1.07-2.98)	.03
Moderate	1,649	90.3 (87.8-92.9)	198	9.7 (7.1-12.2)	2.14 (1.57-2.92)	<.0001	1.32 (0.83-2.09)	.24
Severe	362	80.3 (72.1-88.6)	81	19.7 (11.4-27.9)	4.91 (2.90-8.34)	<.0001	2.72 (1.33-5.57)	.006

Binomial logistic regression models were constructed with history of headaches as the binary dependent (outcome) variable and eczema severity (none, mild, moderate, or severe) as the independent variable. OR and 95% CIs were determined. aORs were determined from multivariate models by including age, sex, race/ethnicity, household income, highest level of education in the family, insurance coverage, number of persons in the household, birthplace in the United States, ever history of asthma, hay fever, and food allergy as categorical variables.

TABLE IV. Association between eczema, fatigue, and sleep disturbances and headaches

		Headaches							
		No		Yes					
Eczema	Other variables	Frequency	Percent (95% CI)	Frequency	Percent (95% CI)	OR (95% CI)	P value	aOR (95% CI)	P value
	Fatigue (NHIS 2007)								
No	No	6,482	96.0 (95.4-96.6)	271	4.0 (3.4-4.6)	1.00 (reference)	—	1.00 (reference)	—
No	Yes	162	70.3 (62.9-77.8)	67	29.7 (22.2-37.1)	10.11 (6.86-14.89)	<.0001	5.75 (3.67-9.00)	<.0001
Yes	No	579	93.6 (91.3-95.8)	43	6.5 (4.2-8.7)	1.65 (1.10-2.47)	.02	1.30 (0.80-2.10)	.29
Yes	Yes	39	71.1 (56.6-85.7)	15	28.9 (14.3-43.4)	9.72 (4.72-20.02)	<.0001	5.93 (2.64-13.29)	<.0001
	Fatigue (NHIS 2012)								
No	No	8,081	95.2 (94.7-95.8)	433	4.8 (4.2-5.3)	1.00 (reference)	—	1.00 (reference)	—
No	Yes	394	78.2 (73.7-82.7)	119	21.8 (17.3-26.3)	5.56 (4.15-7.44)	<.0001	4.28 (3.08-5.96)	<.0001
Yes	No	1,012	91.8 (89.9-93.7)	913	8.2 (6.3-10.1)	1.77 (1.34-2.35)	<.0001	1.64 (1.19-2.26)	.002
Yes	Yes	113	72.9 (64.2-81.5)	46	27.1 (18.5-35.8)	7.42 (4.71-11.69)	<.0001	4.23 (2.39-7.49)	<.0001
	Sleepiness (NHIS 2012)								
No	No	8,231	94.9 (94.3-95.5)	465	5.1 (4.5-5.7)	1.00 (reference)	—	1.00 (reference)	—
No	Yes	244	76.5 (71.0-81.9)	89	23.5 (18.1-29.0)	5.72 (4.12-7.93)	<.0001	3.53 (2.44-5.09)	<.0001
Yes	No	962	90.8 (88.8-92.8)	110	9.2 (7.2-11.2)	1.87 (1.43-2.45)	<.0001	1.64 (1.20-2.25)	.002
Yes	Yes	64	69.2 (57.8-80.7)	35	30.8 (19.3-42.2)	8.24 (4.77-14.25)	<.0001	3.58 (1.94-6.61)	<.0001
	Insomnia (NHIS 2007)								
No	No	6,392	95.7 (95.1-96.3)	274	4.3 (3.7-4.9)	1.00 (reference)	—	1.00 (reference)	—
No	Yes	252	80.6 (75.3-85.9)	63	19.4 (14.1-24.7)	5.36 (3.69-7.77)	<.0001	3.07 (2.02-4.67)	<.0001
Yes	No	566	93.3 (90.9-95.7)	40	6.7 (4.3-9.1)	1.60 (1.06-2.42)	.03	1.26 (0.77-2.07)	.36
Yes	Yes	52	76.9 (65.6-88.2)	18	23.1 (11.8-34.4)	6.71 (3.50-12.87)	<.0001	3.35 (1.50-7.47)	.003
	Insomnia (NHIS 2012)								
No	No	8,124	95.1 (94.6-95.7)	450	4.9 (4.3-5.4)	1.00 (reference)	—	1.00 (reference)	—
No	Yes	350	77.1 (72.1- 82.2)	103	22.9 (17.8-27.9)	5.77 (4.24-7.86)	<.0001	3.82 (2.67-5.47)	<.0001
Yes	No	935	91.0 (88.9-93.0)	106	9.0 (7.0-11.1)	1.93 (1.46-2.54)	<.0001	1.70 (1.24-2.32)	.0009
Yes	Yes	90	76.2 (67.7-84.7)	39	23.8 (15.3-32.3)	6.08 (3.75-9.86)	<.0001	3.10 (1.68-5.71)	.0003
	Nights of adequate sleep (NSCH 2003-2004)								
No	4-7	53,840	94.2 (93.9-94.6)	3,265	5.8 (5.4-6.1)	1.00 (reference)	—	1.00 (reference)	—
No	0-3	4,567	89.3 (87.7-90.8)	534	10.7 (9.2-12.3)	1.96 (1.64-2.33)	<.0001	1.57 (1.30-1.88)	<.0001
Yes	4-7	4,834	88.2 (86.7-89.8)	598	11.8 (10.2-13.3)	2.18 (1.85-2.56)	<.0001	1.82 (1.53-2.16)	<.0001
Yes	0-3	494	75.5 (67.7-83.3)	130	24.5 (16.7-32.3)	5.29 (3.46-8.09)	<.0001	3.75 (2.28-6.16)	<.0001
	Nights of adequate sleep (NSCH 2007-2008)								
No	4-7	49,016	95.8 (95.4-96.1)	2,430	4.2 (3.9-4.6)	1.00 (reference)	—	1.00 (reference)	—
No	0-3	4,535	89.5 (87.0-92.0)	450	10.5 (8.0-13.0)	2.66 (2.01-3.52)	<.0001	1.67 (1.03-2.72)	.04
Yes	4-7	5,646	91.6 (89.8-93.5)	514	8.4 (6.5-10.2)	2.06 (1.58-2.68)	<.0001	1.80 (1.18-2.74)	.007
Yes	0-3	612	82.7 (76.9-88.5)	129	17.3 (11.5-23.1)	4.73 (3.12-7.17)	<.0001	1.96 (1.14-3.36)	.02

Binomial survey logistic regression models were constructed with history of headaches as the binary dependent (outcome) variable. The independent variables were history of eczema, fatigue (NHIS 2007 and 2012), daytime sleepiness (NHIS 2012), insomnia (NHIS 2007 and 2012), or number of nights with adequate sleep (NSCH 2003-2004 and 2007-2008) and 2-way interaction terms between them. ORs and 95% CIs were determined. aORs were determined from multivariate models by including age, sex, race/ethnicity, household income, highest level of education in the family, insurance coverage, number of persons in the household, birthplace in the United States, ever history of asthma, hay fever, and food allergy as categorical variable.

associated with increased headaches compared with the odds in children without eczema. There was an additive effect, such that eczema combined with atopic disorders was associated with higher odds of headaches than either alone. Eczema without fatigue or sleep disturbances, including excessive sleepiness, insomnia, and only 0 to 3 nights of sufficient sleep, was associated with modestly increased odds of headaches. However, eczema accompanied by fatigue and these sleep disturbances was associated with even higher odds of headaches. Interestingly, eczema modified the association between child and parental headaches, such that children with a parental history of eczema had even higher rates of headaches than those with either or neither. Together, these results suggest that children with eczema, particularly those with concomitant atopy, fatigue, and sleep disturbances, have higher odds of headaches.

Few studies have examined the association between eczema and headaches.[10,11] A case-control study of the UK General Practice Research Database found that patients with migraines had higher rates of eczema, asthma, and hay fever.[10] Another study of 1077 British children from a suburban practice aged 3 to 11 years found that children with eczema, asthma, and hay fever had higher rates of headaches in general and migraines in particular.[11] The present study found that pediatric eczema *per se* was associated with headaches, even after controlling for multiple sociodemographic factors, comorbid asthma, hay fever and food allergy, parental history of smoking, eczema, and headaches.

Several authors have speculated about possible mechanisms for the association between eczema, allergic disease, and headaches, although no studies to date have demonstrated any causal factors. The present study demonstrates that children with eczema and sleep disturbances have dramatically higher rates of headaches than those with eczema alone, although eczema alone was still associated with modestly increased rates of headaches. Of note, sleep disturbances in children without eczema were also associated with increased headaches. Previous studies found that sleep disturbances are a risk factor for headaches, as reviewed in previous studies.[12-17] Sleep disturbances in patients with eczema have recently been found to be associated with shorter stature[21] and poor health-related quality of life[22-26] in children and poorer overall health,[3] increased fractures and other injuries,[27] and even cardiovascular disease[28] in adults.

Together, the present study suggests that fatigue and sleep disturbances that occur in patient with eczema (and other disorders) can increase the risk of or share a common pathomechanism with headaches. There might be other issues occurring in childhood eczema that also increase the risk for headaches, such as chronic inflammation, increased psychological and behavioral disorders,[4,19] and use of systemic medications. Future studies are needed to determine the mechanism or mechanisms of association between eczema and headaches.

The mechanism of association between eczema and headaches is not known. Previous studies found increased histamine[29,30] and IgE[29,31] levels in patients with migraines. One study found increased IL-10 levels and decreased IL-4 and IL-5 levels during migraine attacks.[32] However, treatment with sumatriptan resulted in decreases of IL-10 and increases of IL-4 and IL-5 levels.[32] Another study found that 17% of patients with migraines and 15% of patients with tension headaches had increased IL-13 levels.[33] Together, it appears that patients with migraines have higher rates of T_H2 inflammation at baseline. Alternatively, treatment of migraines might contribute to the increased risk of eczema and atopy. Unfortunately, the NHIS and NSCH did not assess for migraine treatments, which precluded our ability to distinguish between migraines and migraine treatments. The interaction between sleep disturbances and eczema is intriguing. It might be that fatigue and sleep disturbances are merely a proxy measure of eczema severity. However, the results of the present study indicate that sleep disturbances *per se* are associated with headaches and might be the driver of headaches. Interestingly, a study of 254 healthy men found that insomnia and insufficient sleep were associated with lower IFN-γ and increased IL-4 levels, suggesting that sleep disturbance can either cause or be caused by T_H2 inflammation. Future studies are needed to elucidate the direction and mechanism of association among eczema, atopy, sleep disturbances, headaches, and their treatments.

It is intriguing that the prevalence of eczema steadily increased while the prevalence of headaches remained stable over a 17-year period. One might expect the US prevalence of headaches to increase secondary to the increasing prevalence of eczema. However, the prevalence of eczema only increased by 4.4%, with only approximately 10% of children with eczema experiencing headaches. Thus the overall contribution of eczema as a predictor of headache prevalence in the US population is relatively low. Nevertheless, this study demonstrates consistently increased rates of headaches in children with eczema.

This study has several strengths, including 19 different US population-based studies with very large random and diverse samples that allowed for subset analyses and controlling for a large number of potential confounding factors and demonstration of reproducibility. However, this study has potential limitations. The specific type of headache, such as migraines versus cluster or tension headaches, was not assessed. Eczema history was based on caregiver report in all studies and neither assessed clinically nor verified with any diagnostic testing. However, self-report and caregiver report of eczema using different instruments have been validated and found to have good correlation with clinical examination,[34,35] particularly single questions using parental recall of physician-diagnosed eczema.[36,37] Parental report of the severity of AD has previously been validated and was found to have moderate correlation with physician-assessed disease severity and a strong correlation with psychological comorbidity in patients with AD.[38] Thus the results of the survey with these questions are likely meaningful and accurate. Finally, these are cross-sectional studies that preclude any conclusions about the direction of association or causality between eczema and headaches. It is quite plausible that chronic sleep disturbance in patients with eczema causes headaches. On the other hand, frequent or severe headaches occurring at night would be expected to disrupt sleep. Future longitudinal studies with objective measures of eczema severity and more detailed assessment of headaches are needed to confirm these findings.

In conclusion, childhood eczema was associated with increased headaches at all ages, with severe eczema being associated with even higher rates of headaches than mild or moderate disease. In particular, sleep disturbances occurring in children with or without eczema were associated with dramatically higher odds of headaches. Future studies are warranted to better characterize sleep disturbances, other risk factors, and mechanisms of headaches in patients with eczema and to determine the ideal clinical interventions to prevent and treat such headaches.

Key messages

- This study found that US children with eczema, particularly those with severe disease, were more likely to have headaches.
- Eczema associated with atopy, fatigue, and sleep disturbance was associated with even higher odds of headaches than eczema alone.

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TABLE E1. Study characteristics*

Study	Size	Age (y)	Type	Languages
NSCH 2003-2004	102,353	0-17	Telephone	English Spanish Korean Mandarin Cantonese Vietnamese
NSCH 2007-2008	91,642	0-17	Telephone	English Spanish Korean Mandarin Cantonese Vietnamese
NHIS 1997	14,290 36,116	0-17 18-85	Household	English Spanish
NHIS 1998	13,645 32,440	0-17 18-85	Household	English Spanish
NHIS 1999	12,910 30,801	0-17 18-85	Household	English Spanish
NHIS 2000	13,376 32,374	0-17 18-85	Household	English Spanish
NHIS 2001	13,579 33,326	0-17 18-85	Household	English Spanish
NHIS 2002	12,524 31,044	0-17 18-85	Household	English Spanish
NHIS 2003	12,229 30,852	0-17 18-85	Household	English Spanish
NHIS 2004	12,424 31,326	0-17 18-85	Household	English Spanish
NHIS 2005	12,523 31,428	0-17 18-85	Household	English Spanish
NHIS 2006	9,837 24,275	0-17 18-85	Household	English Spanish
NHIS 2007	9,417 23,393	0-17 18-85	Household	English Spanish
NHIS 2008	8,815 21,781	0-17 18-85	Household	English Spanish
NHIS 2009	11,156 27,731	0-17 18-85	Household	English Spanish
NHIS 2010	11,277 27,157	0-17 18-85	Household	English Spanish
NHIS 2011	12,850 33,014	0-17 18-85	Household	English Spanish
NHIS 2012	13,275 34,525	0-17 18-85	Household	English Spanish
NHIS 2013	12,860 34,557	0-17 18-85	Household	English Spanish

*All studies used caregiver report for assessment of the child and self-report for assessment of the parent.

TABLE E2. Questions used for the exposure, outcomes, and covariates in this study

Variable	Question	Surveys asked
Eczema	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?	NHIS 1997-2013 NSCH 2003-2004, 2007-2008
Eczema (parents)	During the past 12 months, have you had dermatitis, eczema, or any other red inflamed skin rash?	NHIS 2010
Eczema (parents)	During the past 12 months, have you been told by a doctor or other health professional that you had eczema or any kind of skin allergy?	NHIS 2012
Eczema severity	Would you describe (his/her) eczema or skin allergy as mild, moderate, or severe?	NSCH 2007-2008
Ever asthma history	Have you ever been told by a doctor or other health professional that (child) had asthma?	NHIS 1997-2013 NSCH 2003-2004, 2007-2008
Headaches	During the past 12 months, has (child) had frequent or severe headaches, including migraines?	NHIS 1997-2013
Headaches	During the past 12 months, have you been told by a doctor or other health care provider that (child) had migraine headaches?	NSCH 2003-2004, 2007-2008
Headaches (parents)	During the past 3 months, did you have severe headache or migraine?	NHIS 1998-2013
Hay fever	During the past 12 months, have you been told by a doctor or other health professional that (child) had hay fever?	NHIS 1997-2013 NSCH 2003-2004, 2007-2008
Food allergy	During the past 12 months, have you been told by a doctor or other health professional that (child) had a food or digestive allergy?	NHIS 1997-2013 NSCH 2003-2004, 2007-2008
Fatigue	During the past 12 months, has (child) had fatigue or lack of energy more than 3 days?	NHIS 2007, 2012
Sleepiness	During the past 12 months, has (child) regularly had excessive sleepiness during the day?	NHIS 2012
Insomnia	During the past 12 months, has (child) regularly had insomnia or trouble sleeping?	NHIS 2007, 2012
Nights of sleep	During the past week, on how many nights did (child) get enough sleep for a child (his/her) age?	NSCH 2003-2004, 2007-2008

TABLE E3. Frequency of missing values for variables used in the study

Study	Variable	Frequency (%)
NSCH 2003-2004	Migraines	
	Eczema	176 (0.2)
	Nights of sleep	623 (0.6)
	Asthma	218 (0.2)
	Hay fever	326 (0.3)
	Food allergy	187 (0.2)
	Age	0 (0.0)
	Race/ethnicity	1092 (1.0)
	Sex	80 (0.1)
	Household income	0 (0.0)*
	Highest level of education in the household	432 (0.4)
	US birthplace	959 (0.9)
	Number of persons in the home	13 (0.01)
	Insurance coverage	169 (0.2)
NSCH 2007-2008	Migraines	60 (0.1)
	Eczema	99 (0.1)
	Eczema severity	24 (0.03)
	Nights of sleep	634 (0.7)
	Asthma	117 (0.1)
	Hay fever	187 (0.2)
	Food allergy	140 (0.1)
	Age	0 (0.0)
	Race/ethnicity	1546 (1.7)
	Sex	110 (0.1)
	Household income	0 (0.0)*
	Highest level of education in the household	612 (0.9)
	US birthplace	961 (1.4)
	Number of persons in the home	325 (0.4)
	Insurance coverage	183 (0.2)
NHIS 1997-2013	Headaches	172 (0.1)
	Eczema	1029 (0.5)
	Asthma	348 (0.1)
	Hay fever	1484 (0.7)
	Food allergy	1140 (0.6)
	Fatigue	7 (0.003)
	Sleepiness	5 (0.001)
	Insomnia	8 (0.004)
	Age	0 (0.0)
	Race/ethnicity	301 (0.1)
	Sex	0 (0.0)
	Household income	0 (0.0)*
	Highest level of education in the household	976 (0.5)
	US birthplace	830 (0.4)
	Number of persons in the home	0 (0.0)
	Insurance coverage	1444 (0.7)
	Maternal history of headaches	46 (0.02)
	Paternal history of headaches	29 (0.004)

*Multiple imputation of missing values for household income was used.

TABLE E4. Association between eczema, atopy, and headaches

| | | Headaches | | | | | | | |
| | | No | | Yes | | | | | |
Eczema	Atopy	Frequency	Percent (95% CI)	Frequency	Percent (95% CI)	OR (95% CI)	P value	aOR (95% CI)	P value
NHIS 1997-2013									
No	No	108,822	96.2 (96.0-96.3)	4,483	3.8 (3.7-4.0)	1.00 (reference)	—	1.00 (reference)	—
No	Yes	36,349	90.1 (89.7-90.5)	4,120	9.9 (9.5-10.3)	2.64 (2.44-2.87)	<.0001	1.40 (1.18-1.67)	.0002
Yes	No	6,736	93.5 (92.8-94.1)	534	6.5 (5.9-7.2)	1.78 (1.48-2.14)	<.0001	1.73 (1.46-2.05)	<.0001
Yes	Yes	7,278	84.9 (84.0-85.9)	1,335	15.1 (14.1-16.0)	4.27 (3.73-4.88)	<.0001	2.30 (1.77-2.98)	<.0001
NSCH 2003-2004 and 2007-2008									
No	No	95,792	96.3 (96.1-96.6)	3,823	3.7 (3.4-3.9)	1.00 (reference)	—	1.00 (reference)	—
No	Yes	31,462	91.2 (90.6-91.8)	3,029	8.8 (8.2-9.4)	2.54 (2.29-2.81)	<.0001	1.52 (1.20-1.92)	<.0001
Yes	No	7,203	93.4 (92.1-94.7)	485	6.6 (5.3-7.9)	1.85 (1.48-2.31)	<.0001	1.99 (1.55-2.55)	<.0001
Yes	Yes	6,386	86.4 (84.6-88.2)	942	13.6 (11.8-15.4)	4.15 (3.51-4.91)	<.0001	2.47 (1.77-3.45)	<.0001

Binomial survey logistic regression models were constructed with history of headaches as the binary dependent (outcome) variable. The independent variables were history of eczema, atopy (asthma, hay fever, and/or food allergy) and 2-way interaction terms between them. ORs and 95% CIs were determined. Separate models were constructed for pooled analysis of NHIS 1997-2013 and NSCH 2003-2004 and 2007-2008 studies, which accounted for the complex sampling weights for each study. aORs were determined from multivariate models by including age, sex, race/ethnicity, household income, highest level of education in the family, insurance coverage, number of persons in the household, birthplace in the United States, ever history of asthma, hay fever, and food allergy as categorical variables.

TABLE E5. Association among eczema, parental history of headaches, and headaches in children

Eczema	Parental history of headaches	Headaches							
		No		Yes					
		Frequency	Percent (95% CI)	Frequency	Percent (95% CI)	OR (95% CI)	*P* value	aOR (95% CI)	*P* value
	Maternal								
No	No	46,370	96.0 (95.8-96.2)	2,003	4.0 (3.8-4.2)	1.00 (reference)	—	1.00 (reference)	—
No	Yes	13,850	88.2 (87.6-88.8)	1,975	11.8 (11.2-12.4)	2.54 (2.20-2.93)	<.0001	2.91 (2.65-3.19)	<.0001
Yes	No	4,242	91.9 (91.0-92.9)	394	8.1 (7.1-9.0)	2.05 (1.73-2.44)	<.0001	1.72 (1.46-2.03)	<.0001
Yes	Yes	2,278	83.1 (81.4-84.7)	510	16.9 (15.3-18.6)	5.01 (3.69-6.80)	<.0001	3.43 (2.94-4.01)	<.0001
	Paternal								
No	No	31,864	95.9 (95.6-96.1)	1,377	4.1 (3.9-4.4)	1.00 (reference)	—	1.00 (reference)	—
No	Yes	3,393	90.1 (89.0-91.3)	383	9.9 (8.7-11.0)	3.23 (2.98-3.50)	<.0001	2.09 (1.77-2.64)	<.0001
Yes	No	2,721	91.9 (90.7-93.1)	255	8.1 (6.9-9.3)	2.11 (1.84-2.43)	<.0001	1.68 (1.38-2.06)	<.0001
Yes	Yes	422	82.3 (77.9-86.6)	90	17.7 (13.4-22.1)	4.90 (4.30-5.58)	<.0001	4.13 (2.91-5.84)	<.0001

Binomial survey logistic regression models were constructed with history of headaches as the binary dependent (outcome) variable. The independent variables were history of eczema, maternal or paternal history of migraines (NHIS 1997-2013), and 2-way interaction terms between them. ORs and 95% CIs were determined. aORs were determined from multivariate models by including age, sex, race/ethnicity, household income, highest level of education in the family, insurance coverage, number of persons in the household, birthplace in the United States, ever history of asthma, hay fever, and food allergy as categorical variables.