

Eczema and cardiovascular risk factors in 2 US adult population studies

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Background: Eczema is associated with high rates of sleep disturbance and quality-of-life impairment. These factors might have a negative impact on psychosocial development and behavior and could increase cardiovascular risk.

Objective: We sought to determine whether adults with eczema have increased cardiovascular risk factors.

Methods: We analyzed data for 27,157 and 34,525 adults aged 18 to 85 years from the 2010 and 2012 National Health Interview Survey.

Results: Adults with eczema had higher odds of ever smoking 100 cigarettes in their lifetime (survey logistic regression; adjusted odds ratio [aOR], 1.32; 95% CI, 1.18-1.47) and current smoking history (aOR, 1.28; 95% CI, 1.12-1.45), with significantly younger age of onset (survey linear regression; adjusted β , -0.58; 95% CI, -0.95 to -0.21). Eczema was also associated with greater odds of ever drinking 12 or more alcoholic beverages annually (aOR, 1.16; 95% CI, 1.03-1.31), including current intake of moderate (aOR, 1.33; 95% CI, 1.09-1.62) and heavier (aOR, 1.58; 95% CI, 1.23-2.03) amounts. Adults with a history of eczema had lower odds of daily vigorous activity (aOR, 0.79; 95% CI, 0.63-0.99) and lower frequency of vigorous activity in the past week (adjusted β , -0.46; 95% CI, -0.72 to -0.21) than did adults without a history of eczema. Those with eczema had a higher body mass index than did those without eczema (adjusted β , 0.86; 95% CI, 0.37-1.36), particularly a body mass index of 35 or more (aOR, 1.54; 95% CI, 1.16-2.05), and higher odds of hypertension (aOR, 1.48; 95% CI, 1.18-1.85), hypertension on 2 visits (aOR, 1.56; 1.22-1.99), and lifetime prediabetes (aOR, 1.71; 95% CI, 1.19-2.45). Finally, there were significant interactions between eczema and sleep disturbances such that eczema associated with fatigue, daytime sleepiness, or insomnia was associated with even higher odds of obesity, hypertension, hypertension on 2 visits, prediabetes, diabetes, and high cholesterol than eczema alone.

Conclusions: We found that eczema in adults is a marker for cardiovascular risk, emphasizing the importance of behavioral modification and perhaps more aggressive interventions to better manage eczema. (J Allergy Clin Immunol 2014;■■■■:■■■■-■■■■.)

Key words: Atopic dermatitis, eczema, obesity, body mass index, BMI, hypertension, diabetes, prediabetes, insulin resistance, high cholesterol, smoking, alcohol, physical activity, fatigue, sleepiness, insomnia

Atopic dermatitis (AD) is a chronic inflammatory disorder that causes significant morbidity and has a wide range of allergic and nonallergic comorbid disorders.¹⁻³ Most cases of AD begin in childhood or adolescence, with more than 80% of pediatric patients having persistent symptoms of itch and dry skin in adulthood.^{4,5} The early age of onset and disease chronicity, plus impaired quality of life, secondary to AD weigh heavily on a child's psychological and behavioral development, with delayed social development throughout life and very high rates of psychological and behavioral disorders⁶ and quality-of-life impairment.⁷ Previous studies found associations between AD and smoking.⁸⁻¹³ Little is known about associations between other unhealthy behaviors and AD. We hypothesized that adults with AD are more likely to smoke cigarettes, drink alcohol, and have a sedentary lifestyle.

Recent studies demonstrated associations of higher body mass index (BMI) and obesity with eczema in early childhood¹⁴⁻¹⁷ and adolescents,^{18,19} suggesting that obesity may persist into adulthood. However, little is known about the relationship between adiposity and eczema in adulthood, or whether adults with eczema are at a higher risk for other disorders related to obesity. We hypothesized that adults with eczema have higher rates of obesity, hypertension, insulin resistance, type 2 diabetes, and hypercholesterolemia. In the present study, we analyzed data from 2 US-population studies to determine whether adults with eczema have increased rates of prevalent cardiovascular risk factors.

METHODS

National Health Interview Survey

The institutional review board at Northwestern University approved this study, and the protocol is consistent with the principles of the Declaration of Helsinki. We used data from the 2010 and 2012 National Health Interview Survey (NHIS), which are conducted by the National Center for Health Statistics and are the principal source of information on the health of the civilian noninstitutionalized population of the United States. The survey was administered in-person to selected households by approximately 400 trained interviewers of the US Census Bureau using computer-assisted personal interviewing in English and Spanish. Subsequently, 1 adult per household was randomly selected for the sample adult questionnaire. Using data from the US Census Bureau, weights were adjusted for age, sex, race, ethnicity, household size, and educational attainment of the most educated household member to provide a data set that was more representative of each state's population of noninstitutionalized adults older than 17 years. The questions used to assess for history of eczema and cardiovascular risk factors are given in Table E1 in this article's Online Repository available at www.jacionline.org.

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Abbreviations used

AD: Atopic dermatitis
 aOR: Adjusted odds ratio
 BMI: Body mass index
 BP: Blood pressure
 NHIS: National Health Interview Survey
 OR: Odds ratio

Statistical analyses

All data processing and statistical analyses were performed with SAS (version 9.4) software (SAS institute, Cary, NC). Analyses of survey responses were performed with SURVEY procedures. Bivariable survey logistic regression models were used to determine the associations of eczema, hypertension, or diabetes (dependent variables) with sociodemographic variables, including age (18-29, 30-49, 50-69, ≥ 70 years), sex (male/female), race (white, black, American Indian, Asian, Multiracial/other), Hispanic origin (yes/no), household income (\$0-34K, \$35-74K, \$75-99K, $\geq \$100K$), and highest level of household education (<high school, high school or GED, >high school) (independent variables). Crude odds ratios (ORs) and 95% CIs were estimated.

Binary survey logistic regression models were constructed as follows: (1) Measures of smoking and alcohol intake and vigorous activity, hypertension, hypertension on 2 visits, prediabetes and diabetes, and ever and 1-year history of high cholesterol as the binary dependent variables and AD as the independent variable. (2) The distribution of BMI was significantly skewed and neither met assumptions of normality (Kolmogorov-Smirnov test, $P < .01$) nor goodness of fit for logistic regression models (Hosmer-Lemeshow, $P \leq .01$). Therefore, BMI was treated as an ordinal variable for all analysis and divided into bins (<18.5, 18.5-24, 25-29, 30-34, ≥ 35). For parsimony, AD was modeled as the binary dependent variable and BMI as the ordinal independent variable. Crude ORs and 95% CI were estimated.

The NHIS did not directly assess AD severity. We used reports of fatigue, daytime sleepiness, and insomnia as proxy measures of more severe disease that has a negative impact on sleep efficiency. Logistic regression models that included AD and fatigue, sleepiness, or insomnia and a statistical interaction term between them as the independent variables were constructed for hypertension, hypertension on 2 visits, prediabetes and diabetes, and ever and 1-year history of high cholesterol (dependent variables). In models of BMI, AD was the dependent variable and BMI and either fatigue, sleepiness or insomnia and a statistical interaction term were the independent variables. Contrast statements were used to estimate the adjusted odds ratio (aOR) and 95% CI for eczema with and without sleep disturbances.

Survey linear regression models were constructed for continuous outcomes as follows: age of smoking onset, average number of cigarettes smoked, frequency and duration of vigorous activity, and BMI as the dependent variables and AD as the independent variable. Crude β and 95% CI were estimated.

Covariates included in multivariable models were selected from significant sociodemographic variables in bivariable models ($P < .1$) or variables that resulted in modification of estimates of effect size for AD by more than 20% when included as covariates. Inclusion of all potential confounding variables into a single model would decrease the power of the models. Therefore, 2 different multivariable models were constructed for BMI, hypertension, hypertension on 2 visits, prediabetes and diabetes, and ever and 1-year history of high cholesterol. The first model included age, highest level of education in the household, race, ethnicity, sex, history of smoking, current working status, BMI (included in all models except in those in which BMI was the dependent variable), ever history of smoking, ever history of alcohol consumption, and frequency of vigorous activity as covariates. The second model included history of asthma and hay fever as covariates. aORs (logistic regression) and β (linear regression) and 95% CI for each of the models were determined.

Two- and 3-way statistical interactions between covariates were tested and included in the above models if P value was less than .01, cell

frequencies were more than 5 for each level of interaction, and estimates were modified by more than 20%. In models of binary outcomes with significant statistical interactions, we constructed generalized linear models using a logit (binary outcomes) and identity (continuous outcomes) link function in PROC GLIMMIX. aORs and 95% CI were estimated for each combination of factors included in the interaction effects. The best model was selected by using the Bayesian information criterion, which penalizes for extra parameters and takes into account the large sample size. Complete data analysis was performed; that is, subjects with missing data were excluded.

A 2-sided P value of less than .05 was taken to indicate statistical significance for all estimates. However, the multiple dependent tests performed in this study increase the risk of falsely rejecting the null hypothesis.

RESULTS**Determinants of eczema, diabetes, and hypertension**

A total of 34,525 adults aged 18 to 85 years was included in the analysis of the 2012 NHIS. The US prevalence (95% CI) of eczema in adults was estimated to be 7.2% (6.9 to 7.6%). The prevalence of eczema was significantly associated with female sex (logistic regression; OR, 1.52; 95% CI, 1.36-1.70; $P < .001$) and post-high school education (OR, 1.39; 95% CI, 1.15-1.68; $P < .001$) but inversely associated with black race (OR, 0.79; 95% CI, 0.64-0.93; $P = .01$), Hispanic origin (OR, 0.73; 95% CI, 0.62-0.85; $P < .001$), household income of \$75,000 to \$99,999 (OR, 0.76; 95% CI, 0.61-0.94; $P = .01$), families with children and either a single parent (OR, 0.79; 95% CI, 0.67-0.94; $P = .006$) or both parents living in the household (OR, 0.76; 95% CI, 0.65-0.89; $P < .001$) compared with those with no children, birthplace outside the United States (OR, 0.63; 95% CI, 0.54-0.73; $P < .001$), and lack of insurance coverage (OR, 0.85; 95% CI, 0.74-0.99; $P = .04$). Prevalence was not associated with age (see Table E2 in this article's [Online Repository](http://www.jacionline.org) available at www.jacionline.org).

The prevalence (95% CI) of hypertension and diabetes was 29.9% (29.3% to 30.5%) and 9.2% (8.8% to 9.6%), respectively. The prevalence of hypertension was significantly associated with older age (30-49 years: OR, 3.38; 95% CI, 2.94-3.89; $P < .001$; 50-69 years: OR, 12.03; 95% CI, 10.50-13.79; $P < .001$; ≥ 70 years: OR, 25.51; 95% CI, 22.02-29.55; $P < .001$), lower household income (\$75,000-\$99,999: OR, 1.21; 95% CI, 1.07-1.37; $P = .002$; \$35,000-\$74,999: OR, 1.40; 95% CI, 1.28-1.54; $P < .001$; and \$0-\$34,999: OR, 1.73; 95% CI, 1.58-1.90; $P < .001$), and black race (OR, 1.41; 95% CI, 1.30-1.52; $P < .001$) but inversely associated with Asian race (OR, 0.69; 95% CI, 0.61-0.79; $P < .001$), Hispanic origin (OR, 0.54; 95% CI, 0.50-0.59; $P < .001$) and post-high school education (OR, 0.65; 95% CI, 0.60-0.72; $P < .001$).

The prevalence of diabetes was associated with higher age (30-49 years: OR, 4.94; 95% CI, 3.51-6.94; $P < .001$; 50-69 years: OR, 16.83; 95% CI, 12.09-23.43; $P < .001$; ≥ 70 years: OR, 24.39; 95% CI, 17.44-34.11; $P < .001$), lower household income (\$75,000-\$99,999: OR, 1.30; 95% CI, 1.05-1.60; $P = .02$; \$35,000-\$74,999: OR, 1.78; 95% CI, 1.51-2.10; $P < .001$; and \$0-\$34,999: OR, 2.45; 95% CI, 2.10-2.86; $P < .001$), and black race (OR, 1.49; 95% CI, 1.34-1.67; $P < .001$) but inversely associated with Asian race (OR, 0.90; 95% CI, 0.75-1.10; $P < .001$) and post-high school education (OR, 0.52; 95% CI, 0.46-0.60; $P < .001$).

Associations between eczema and cigarette smoking, alcohol consumption, and vigorous activity

In multivariable models, adults with eczema compared with those without eczema had higher odds of ever smoking 100 cigarettes in their lifetime (aOR, 1.32; 95% CI, 1.18-1.47; $P < .001$) and current smoking history (aOR, 1.28; 95% CI, 1.12-1.45; $P < .001$). Furthermore, adults with eczema started smoking at a significantly younger age than did those without eczema (adjusted β , -0.58 ; 95% CI, -0.95 to -0.21 ; $P = .002$) (Table I). However, there was no association of eczema with the number of cigarettes smoked. Eczema was also associated with greater odds of ever drinking 12 or more alcoholic beverages annually (aOR, 1.16; 95% CI, 1.03-1.31; $P = .02$), including former and current, with light to heavier amounts. There was a significant 2-way interaction between race and eczema in models of alcohol consumption, such that eczema was associated with higher odds of ever drinking 12 or more alcoholic beverages in whites (aOR, 1.15; 95% CI, 1.14-1.15), blacks (aOR, 1.46; 95% CI, 1.46-1.47), and American Indians (aOR, 5.92; 95% CI, 5.83-6.01) but not in Asian-Americans (aOR, 1.00; 95% CI, 0.99-1.00). Current heavier drinking was associated with eczema in all racial groups compared with lifetime abstaining from or current light drinking ($P < .001$ for all).

Adults with a history of eczema had lower odds of daily vigorous activity (aOR, 0.79; 95% CI, 0.63-0.99; $P = .04$) and lower frequency of vigorous activity in the past week (adjusted β , -0.46 ; 95% CI, -0.72 to -0.21 ; $P < .001$) than did adults without a history of eczema. Eczema was associated with a shorter duration of vigorous activity in univariable models (β , -3.50 ; 95% CI, -6.83 to -0.16 ; $P = .04$), but the association was not significant in multivariable models ($P = .65$).

Associations of eczema with obesity, hypertension, diabetes, and high cholesterol

In multivariable models of data from 2012 NHIS, those with eczema had a significantly higher BMI than did those without eczema (adjusted β , 0.86; 95% CI, 0.37-1.36; $P < .001$). In particular, eczema was associated with class II/III obesity even after controlling for sociodemographic factors (aOR, 1.54; 95% CI, 1.16-2.05; $P = .003$) and comorbid asthma and hay fever (aOR, 1.22; 95% CI, 1.03-1.46; $P = .02$).

Similarly, eczema was associated with higher odds of hypertension (aOR, 1.48; 95% CI, 1.18-1.85; $P < .001$), hypertension on 2 visits (aOR, 1.56; 95% CI, 1.22-1.99; $P = .0003$), and lifetime prediabetes (aOR, 1.71; 95% CI, 1.19-2.45; $P = .004$) in multivariable models that controlled for sociodemographic characteristics, history of smoking, alcohol consumption, and vigorous activity. Eczema was also associated with higher odds of hypertension (aOR, 1.31; 95% CI, 1.17-1.47; $P < .001$), hypertension on 2 visits (aOR, 1.37; 95% CI, 1.22-1.53; $P < .001$), prediabetes (aOR, 1.77; 95% CI, 1.42-2.22; $P < .001$) and diabetes (aOR, 1.37; 95% CI, 1.16-1.63; $P < .001$), particularly adult-onset diabetes (aOR, 1.35; 95% CI, 1.13-1.62; $P < .001$), and ever history (aOR, 1.29; 95% CI, 1.15-1.45; $P < .0001$) and 1-year history (aOR, 1.33; 95% CI, 1.17-1.52; $P < .0001$) of high cholesterol in models that controlled for comorbid asthma and/or hay fever (Table II). There were no significant interactions between these outcomes and age ($P \geq .44$); that is, the odds of hypertension, hypertension on 2

visits, prediabetes and diabetes, and ever and 1-year history of high cholesterol were consistently higher at all age strata (data not shown). Similar results were found in the 2010 NHIS (see Table E3 in this article's Online Repository at www.jacionline.org).

Association between eczema, sleep disturbance, and cardiovascular risk

There were significant 2-way interactions between eczema and fatigue and eczema and regular daytime sleepiness or insomnia as predictors of cardiovascular risk factors. In models of interaction between eczema and fatigue, eczema alone was associated with hypertension, hypertension on 2 visits, adult-onset diabetes, and ever and 1-year history of high cholesterol, whereas those with both eczema and fatigue had even higher odds of these cardiovascular risk factors (see Table E4 in this article's Online Repository at www.jacionline.org). Being underweight, having class I or II/III obesity, and childhood-onset diabetes were associated only with eczema and fatigue.

Similarly, in models of interaction between eczema and regular daytime sleepiness or insomnia, regular daytime sleepiness or insomnia and eczema were associated with higher odds of cardiovascular risk factors (see Table E4).

DISCUSSION

Using 2 US population-based cohorts, we found that adults with eczema had higher rates of cigarette smoking and consumption of alcoholic beverages, lower rates of vigorous activity, and higher prevalence of class II/III obesity, hypertension, prediabetes, diabetes, and high cholesterol. These results could have major clinical and public health ramifications because smoking, alcohol intake, and sedentary lifestyle are all modifiable risk factors. Patients with AD may be candidates for aggressive interventions aimed at lifestyle modification, including smoking and alcohol cessation and increasing physical activity. Nevertheless, the associations of AD and obesity, hypertension, and prediabetes remained significant in multivariable models that controlled for these behaviors, suggesting that there is an additional risk conferred by AD. Furthermore, AD associated with fatigue, daytime sleepiness, and/or insomnia had even higher odds of cardiovascular risk factors than did AD alone, suggesting that more severe AD confers even greater cardiovascular risk.

The nature of the association of eczema and cardiovascular risk factors is not immediately clear because previous studies suggest possible pathways or confounders including hay fever and asthma. Adults with eczema commonly have comorbid asthma and hay fever,² which raises questions about whether these comorbidities or eczema are confounding factors. Indeed, previous studies found increased cardiovascular risk factors and metabolic syndrome in adults with asthma.^{20,21} We therefore created multivariable models that controlled for history of asthma and hay fever and still found that eczema was associated with increased cardiovascular risk factors. Thus, it appears that factors related to eczema *per se*, such as chronic inflammation, itch, and sleep disturbance, are associated with a higher risk for cardiovascular disease. There are other factors related to AD that may contribute toward cardiovascular risk that warrant exploration in future studies, including socioeconomic status differences, depression, and other psychological comorbidities.

TABLE I. Associations between eczema and cigarette smoking and alcohol consumption and inverse association with vigorous activity in adults from the 2012 NHIS (N = 34,525)

Variable	No eczema (n = 32,100)		Eczema (n = 2,488)			
	% Prevalence (95% CI)	% Prevalence (95% CI)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Ever smoked 100 cigarettes						
No	60.1 (59.4-60.8)	54.5 (51.9-57.1)	1.00	—	1.00	—
Yes	39.9 (39.2-40.6)	45.5 (42.9-48.1)	1.26 (1.13-1.40)	<.001	1.32 (1.18-1.47)	<.001
Currently smoke cigarettes						
No	78.1 (77.6-78.7)	74.1 (71.8-76.4)	1.00	—	1.00	—
Yes	21.9 (21.3-22.4)	25.9 (23.6-28.2)	1.25 (1.10-1.41)	<.001	1.28 (1.12-1.45)	<.001
	Mean (95% CI)	Mean (95% CI)	Crude β (95% CI)	P value	Adjusted β (95% CI)	P value
Age first smoked cigarettes (y)	17.8 (17.7-18.0)	17.3 (17.0-17.7)	-0.51 (-0.89 to -0.12)	.009	-0.58 (-0.95 to -0.21)	.002
No. of cigarettes smoked	14.6 (14.3-14.9)	14.7 (13.9-15.5)	0.12 (-0.77 to 1.01)	.79	0.17 (-0.70 to 1.05)	.70
	% Prevalence (95% CI)	% Prevalence (95% CI)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Ever had ≥ 12 drinks of alcoholic beverage in 1 y						
No	35.9 (35.2-36.6)	33.8 (31.3-36.2)	1.00	—	1.00	—
Yes	64.1 (63.4-64.8)	66.2 (63.8-68.9)	1.10 (0.98-1.23)	.10	1.16 (1.03-1.31)	.02
Drinking status*						
Lifetime abstainer	21.4 (20.8-22.0)	16.6 (14.7-18.5)	1.00	—	1.00	—
Former infrequent	8.2 (7.9-8.6)	8.8 (7.2-10.5)	1.38 (1.09-1.75)	.007	1.40 (1.10-1.78)	.006
Former regular	6.1 (5.8-6.5)	7.8 (6.4-9.2)	1.64 (1.31-2.06)	<.001	1.75 (1.38-2.20)	<.001
Current infrequent	12.8 (12.3-13.3)	14.9 (13.0-16.7)	1.50 (1.24-1.80)	<.001	1.48 (1.22-1.78)	<.001
Current light	31.0 (30.3-31.7)	31.9 (29.5-34.3)	1.32 (1.13-1.55)	<.001	1.37 (1.17-1.62)	<.001
Current moderate	15.5 (15.0-16.0)	14.1 (12.3-16.0)	1.17 (0.97-1.42)	.11	1.33 (1.09-1.62)	.005
Current heavier	4.9 (4.6-5.2)	5.9 (4.7-7.0)	1.54 (1.20-1.96)	<.001	1.58 (1.23-2.03)	<.001
Vigorous activity for at least 10 min						
Never/unable	53.1 (52.4-53.9)	55.5 (52.9-58.1)	1.00	—	1.00	—
Daily	7.2 (6.8-7.6)	5.8 (4.7-7.0)	0.78 (0.62-0.96)	.02	0.79 (0.63-0.99)	.04
Weekly to annually	39.7 (39.0-40.4)	38.7 (36.1-41.2)	0.93 (0.83-1.04)	.23	0.92 (0.81-1.04)	.17
	Mean (95% CI)	Mean (95% CI)	Crude β (95% CI)	P value	Adjusted β (95% CI)	P value
Frequency of vigorous activity (past week)	4.1 (4.0-4.2)	3.6 (3.4-3.8)	-0.51 (-0.76 to -0.25)	<.001	-0.46 (-0.72 to -0.21)	<.001
Duration of vigorous activity	57.8 (56.8-58.9)	54.3 (51.2-57.5)	-3.50 (-6.83 to -0.16)	.04	-0.76 (-4.04 to 2.51)	.65

Multivariable logistic and linear regression models were constructed with self-reported history of smoking, age of smoking onset, number of cigarettes smoked, history and frequency of alcohol consumption, and history, frequency, and duration of vigorous activity for at least 10 minutes modeled as the dependent variables and AD/eczema as the independent variable. Crude OR, β , and 95% CI were estimated. Adjusted OR, β , and 95% CI were estimated in multivariable models, including age, highest level of education in the household, race, ethnicity, and sex.

Refusal to answer a particular question or response of "don't know" occurred for the questions pertaining to eczema in 25 (0.07%), ever history of smoking in 262 (0.8%), current smoking history in 11 (0.03%), age first started smoking cigarettes in 444 (3.1%), number of cigarettes smoked in 34 (0.6%), ever history of drinking alcohol in 345 (1.0%), former or current alcohol history in 629 (1.8%), frequency of vigorous activities in the past week in 496 (1.4%), duration of vigorous activity in 61 (0.4%), age in 0 (0.0%), sex in 0 (0.0%), race in 0 (0.0%), Hispanic/Spanish origin in 0 (0.0%), household income in 1928 (5.6%), current working status in 25 (0.07%), and highest level of education in the household in 69 (0.2%) respondents, respectively.

Former infrequent: 12+ drinks in lifetime but never as many as 12 in 1 y and none in past year.

Former regular: 12+ drinks in lifetime, 12+ drinks in 1 y, but none in past year.

Current infrequent: 12+ drinks in lifetime, and 1 to 11 drinks in past year.

Current light: 12+ drinks in lifetime, and ≤ 3 drinks per week in past year.

Current moderate: 12+ drinks in lifetime, and (male) >3 drinks per week up to 14 drinks per week or (female) >3 drinks per week up to 7 drinks per week.

Current heavier: 12+ drinks in lifetime, and (male) >14 drinks per week in past year or (female) >7 drinks per week in past year.

*Lifetime abstainer: <12 drinks in lifetime.

Regardless of the actual mechanisms, this study highlights important cardiovascular risk factors in patients with AD that are potentially modifiable with clinical and public health interventions.

Previous studies similarly found increased smoking,²² alcohol consumption,²³ obesity,²⁴ hypertension,²⁵ insulin resistance, and type 2 diabetes²⁶ in psoriasis, another inflammatory skin disease. The present study suggests that such associations are not specific to psoriasis and that adults with eczema may similarly be at a higher risk for cardiovascular disease owing to their greater risk

factor burden. Increased cardiovascular risk in psoriasis is thought to be mediated in part by increased levels of TNF- α , IL-17, and IL22.^{27,28} AD is also associated with increased production of IL17 and IL22,^{29,30} suggesting that AD may be associated with a similar profile of cardiovascular and other comorbidities as psoriasis.

Smoking

The association between eczema and smoking is consistent with previous studies.⁸⁻¹³ A case-control study of 83 Taiwanese

TABLE II. Logistic regression models of the associations between eczema and obesity, hypertension, diabetes, and high cholesterol in adults in the 2012 NHIS (N = 34,525)

	No eczema (n = 32,100)	Eczema (n = 2,488)						
					Model 1 (sociodemographic characteristics)		Model 2 (asthma, hay fever)	
Value	% Prevalence (95% CI)	% Prevalence (95% CI)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
BMI								
Underweight: <18.5	1.7 (1.5-1.9)	1.9 (1.2-2.6)	1.11 (0.74-1.67)	.62	1.15 (0.57-2.29)	.70	1.01 (0.67-1.53)	.95
Normal weight: 18.5-24	35.1 (34.4-35.8)	34.2 (31.8-36.7)	1.00	—	1.00	—	1.00	—
Overweight: 25-29	35.0 (34.3-35.7)	31.8 (29.3-34.2)	0.93 (0.81-1.06)	.29	1.20 (0.98-1.49)	.08	0.93 (0.81-1.07)	.30
Class I obesity: 30-34	17.2 (16.7-17.8)	17.5 (15.5-19.4)	1.04 (0.89-1.22)	.63	1.16 (0.90-1.50)	.24	0.99 (0.85-1.16)	.91
Class II/III obesity: ≥35	10.9 (10.5-11.4)	14.6 (12.7-16.6)	1.38 (1.15-1.64)	<.001	1.54 (1.16-2.05)	.003	1.22 (1.03-1.46)	.02
Lifetime prevalence of hypertension								
No	70.6 (70.0-71.3)	63.2 (60.7-65.7)	1.00	—	1.00	—	1.00	—
Yes	29.4 (28.7-30.0)	36.8 (34.3-39.3)	1.40 (1.25-1.56)	<.001	1.48 (1.18-1.85)	<.001	1.31 (1.17-1.47)	<.001
Lifetime prevalence of hypertension on 2 visits								
No	75.0 (74.4-75.6)	67.1 (64.7-69.6)	1.00	—	1.00	—	1.00	—
Yes	25.0 (24.4-26.6)	32.9 (30.4-35.3)	1.47 (1.31-1.65)	<.001	1.56 (1.22-1.99)	<.001	1.37 (1.22-1.53)	<.001
Lifetime prevalence of prediabetes								
No	95.9 (95.6-96.2)	93.4 (92.2-94.6)	1.00	—	1.00	—	1.00	—
Yes	4.1 (3.8-4.4)	6.6 (5.4-7.8)	1.93 (1.55-2.40)	<.001	1.71 (1.19-2.45)	.004	1.77 (1.42-2.22)	<.001
Lifetime prevalence of diabetes								
No	90.9 (90.4-91.3)	87.4 (85.9-89.0)	1.00	—	1.00	—	1.00	—
Yes	9.1 (8.7-9.6)	12.6 (11.0-14.1)	1.42 (1.20-1.69)	<.001	1.17 (0.83-1.66)	.37	1.37 (1.16-1.63)	<.001
Childhood-onset diabetes								
No	99.4 (99.3-99.5)	99.1 (98.6-99.6)	1.00	—	1.00	—	1.00	—
Yes	0.6 (0.5-0.7)	0.9 (0.4-1.4)	1.45 (0.82-2.55)	.20	2.04 (0.64-6.53)	.23	1.48 (0.83-2.64)	.18
Adult-onset diabetes								
No	91.5 (91.2-91.9)	88.5 (86.7-90.3)	1.00	—	1.00	—	1.00	—
Yes	8.5 (8.1-8.8)	11.5 (9.7-13.3)	1.41 (1.18-1.68)	<.001	1.11 (0.78-1.56)	.57	1.35 (1.13-1.62)	<.001
Lifetime prevalence of high cholesterol								
No	74.0 (73.4-74.6)	67.7 (65.3-70.1)	1.00	—	1.00	—	1.00	—
Yes	26.0 (25.4-26.6)	32.3 (29.9-34.7)	1.36 (1.21-1.52)	<.0001	1.14 (0.92-1.43)	.24	1.29 (1.15-1.45)	<.0001
1-y prevalence of high cholesterol								
No	82.1 (81.6-82.6)	76.4 (74.6-78.6)	1.00	—	1.00	—	1.00	—
Yes	17.9 (17.4-18.4)	23.6 (21.4-25.8)	1.41 (1.24-1.61)	<.0001	1.14 (0.89-1.46)	.30	1.33 (1.17-1.52)	<.0001

Multivariable logistic regression models were constructed with self-reported BMI classification, hypertension, prediabetes/diabetes, and high cholesterol modeled as the dependent variables and AD/eczema as the independent variable. Crude OR and 95% CI were estimated. Adjusted OR and 95% CI were estimated in 2 different multivariable models, including (1) age, highest level of education in the household, race, ethnicity, sex, history of smoking, current working status, BMI (included in all models except in which BMI was the outcome), history of ever smoking, history of ever alcohol consumption, and frequency of vigorous activity as covariates and (2) history of asthma and hay fever as covariates.

Refusal to answer a particular question or response of “don’t know” occurred for the questions pertaining to eczema in 25 (0.07%), BMI in 1635 (4.2%), ever history of hypertension in 32 (0.08%), hypertension on 2 visits in 27 (0.08%), prediabetes in 30 (0.09%), diabetes in 25 (0.05%), age of onset of diabetes in 60 (1.7%), ever history of smoking in 262 (0.8%), ever history of drinking alcohol in 345 (1.0%), history of vigorous activity for at least 10 minutes in 496 (1.4%), age in 0 (0.0%), sex in 0 (0.0%), race in 0 (0.0%), Hispanic/Spanish origin in 0 (0.0%), current working status in 25 (0.07%), and highest level of education in the household in 69 (0.2%) respondents, respectively.

patients with AD and 142 age- and sex-matched controls found that adult-onset AD was associated with ever and current history of smoking and number of packs per year.⁸ A French population-based study of 14,578 adults found that active smoking was associated with current eczema, as well as asthma and hay fever.⁹ Similarly, a Swedish population-based study of 18,087 adults found that ex and current smoking were associated with self-reported current history of eczema, whereas ex smoking was associated with ever having eczema.¹⁰ In contrast, several smaller studies found no significant

associations between smoking and AD/eczema in adults.^{31,32} In addition, multiple studies found strong associations between smoking and hand eczema in particular.¹¹⁻¹³ It is not clear from the results of the present study or from the above-mentioned studies whether smoking predisposes to eczema or whether people with eczema are more inclined to smoke. Regardless of the direction of association, the present study demonstrates that adults with eczema have higher rates of smoking, which is a well-established risk factor for hypertension and cardiovascular disease.

Alcohol

The present study found an association between eczema and consumption of alcoholic beverages, with the largest effect size occurring in former-regular and current-heavier amounts. Although an association between alcohol consumption and AD flares has previously been noted,³³ there is a dearth of studies on the matter. A recent analysis of data from the Nurses' Health Study II revealed no association between alcohol consumption and incident self-reported physician diagnosis of eczema.³⁴ However, that study was limited to female nurses, which is not representative of the entire US population. Furthermore, people with eczema may be more inclined to drink alcoholic beverages, even if alcohol is not a risk factor for developing eczema. Further studies are much needed to better understand the relationship between alcohol consumption and AD.

Vigorous activity

The present study found that adults with eczema were less likely to perform vigorous activities on a daily basis, with lower frequency and duration of activities in the past week. Sedentary lifestyle along with weight gain and other unhealthy behaviors may be risk factors for developing eczema. Perhaps a more likely explanation is that people with eczema are less likely to perform vigorous activities to avoid sweating. Previous studies in humans and animal models found that sweating and exercise are common exacerbating factors for AD.³⁵⁻³⁸ A recent study of 110 Swedish adults with AD and 196 healthy controls found no significant differences in the frequency of physical activity.³⁹ Everyday exercise was lower in women and regular hard training or competition was lower in men, though statistical analysis of individual types of exercise was not performed. The differences in findings between the present study and that study may be due to smaller sample size, lack of information about actual frequency and duration of the physical activities, and/or regional differences in attitudes toward exercise and fitness. In-depth interviews from that study revealed an avoidance of swimming and preference to exercise outdoors to minimize sweating.³⁹ Further studies are needed to confirm that adults with eczema are more likely to have a sedentary lifestyle and to determine the direction of this association.

Obesity and hypertension

The present study found increased BMI, particularly class II/III obesity, in adults with eczema than in those without eczema. The associations between eczema and self-reported hypertension and hypertension on 2 visits were not age-dependent and remained significant in both the 2010 and 2012 NHIS, even after controlling for sedentary lifestyle, smoking, alcohol consumption, and BMI. Blood pressure (BP) elevation in AD may be multifactorial, including chronic cutaneous and/or systemic inflammation, sleep disturbance, quality-of-life impairment and psychological comorbidity secondary to AD, and use of treatments such as cyclosporine and systemic corticosteroids that can increase BP and/or additional unhealthy lifestyle factors. Silverberg et al¹⁹ recently examined adiposity and BP in a multicenter pediatric dermatology case-control study of 132 children and adolescents with active moderate to severe AD and 143 healthy controls. They found that AD was associated with significantly higher systolic BP, even after controlling for sociodemographic factors, BMI, waist circumference, and use of systemic corticosteroids

and cyclosporine.¹⁹ A previous US claims-based study including 89,381 patients with AD found the prevalence of hypertension to be higher in those with a history of AD than in those without AD.^{40,41} In contrast, a clinical study of 521 Japanese adults with active AD and 87 with "healed" AD found very low incidence of hypertension.⁴² The results of the latter study may differ due to patient ethnicity, demographic characteristics and health behaviors, region, smaller sample sizes, and potential sampling bias.⁴²

Diabetes and high cholesterol

In the present study, eczema was associated with adult-onset diabetes. Given the self-reported nature of the diabetes outcome, we were unable to determine whether the subjects had type 1 or 2 diabetes. These results are consistent with a recent study that demonstrated a higher rate of Filaggrin null mutations that are found in AD in adults with established type 2 diabetes.⁴³ Previous studies mostly found an inverse association of AD (and atopic diseases) with type 1 diabetes, which may be related to mutually exclusive genetics and/or a protective effect of T_H2 inflammation from AD against T_H1-mediated inflammation in diabetes,⁴⁴⁻⁴⁸ a single study finding a positive association.⁴⁹ The present study demonstrates an increased risk of diabetes in adulthood, along with increased smoking, alcohol intake, sedentary lifestyle, obesity, and hypertension. It is intriguing that eczema was associated with higher odds of high cholesterol. We are not aware of any previous studies that examined this association for comparison. Together, it appears that adults with AD have an increased risk for metabolic syndrome and cardiovascular disease.

Strengths and limitations

The strengths of this study include prospective data collection, US population-based cohort, large scale with a diverse sample, and complex sample weighting that allows for generalization of results to the entire US population and controlling for multiple confounding variables in multivariable models. However, this study has limitations. All exposures and outcomes in the study were assessed by self-report and not verified by physical examination and may be subject to misclassification. We were unable to assess the distribution of skin lesions. Self-report of eczema has been previously validated and shown to have good correlation with clinical examination.^{50,51} Nevertheless, prospective studies, with actual clinical confirmation of AD, are needed to confirm the results of this study and determine whether there are differences in AD phenotype and disease course that might be predictive of cardiovascular risk.

Conclusions

Adult eczema was found to be associated with increased odds of obesity, hypertension, prediabetes, diabetes, and high cholesterol, which are in part related to increased cigarette smoking, alcohol intake, and sedentary lifestyle. Together, these data suggest that adult eczema is a marker for cardiovascular risk, emphasizing the importance of behavioral modification and perhaps more aggressive interventions to better manage eczema. Future studies using clinical examination and objective measures of adiposity and metabolic syndrome are needed to confirm these associations.

Key messages

- This study found that US adults with eczema were more likely to smoke cigarettes, drink more alcohol, and perform less vigorous activity.
- Adults with eczema had higher odds of obesity, high blood pressure, prediabetes and diabetes, and high cholesterol.
- Eczema associated with sleep disturbances was associated with even higher cardiovascular risk than eczema alone.

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TABLE E1. Questions used in this study

Variable	Question	Years asked
Eczema	During the past 12 mo, have you been told by a doctor or other health professional that (child) had eczema or any kind of skin allergy?	2012
Eczema	During the past 12 mo, have you had dermatitis, eczema, or any other red, inflamed skin rash?	2010
Ever asthma history	Have you ever been told by a doctor or other health professional that you had asthma?	2010, 2012
Hay fever	During the past 12 mo, have you been told by a doctor or other health professional that you had hay fever?	2010, 2012
Height	How tall are you without shoes?	2010, 2012
Weight	How much do you weigh without shoes?	2010, 2012
Hypertension	Have you ever been told by a doctor or other health professional that you had hypertension, also called high blood pressure?	2010, 2012
Hypertension on 2 visits	Were you told on 2 or more different visits that you had hypertension, also called high blood pressure?	2010, 2012
Prediabetes	Have you ever been told by a doctor or other health professional that you have any of the following: prediabetes, impaired fasting glucose, impaired glucose tolerance, borderline diabetes, or high blood sugar?	2010, 2012
Diabetes	[If female, other than during pregnancy] Have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?	2010, 2012
Ever high cholesterol	Have you ever been told by a doctor or other health professional that you had high cholesterol?	2012
1-y high cholesterol	During the past 12 mo have you had high cholesterol?	2012
Age of diabetes onset	How old were you when a doctor first told you that you had diabetes or sugar diabetes?	2010, 2012
Ever smoking history	Have you smoked at least 100 cigarettes in your entire life?	2010, 2012
Current smoking history	Do you now smoke cigarettes every day, some days, or not at all?	2010, 2012
Age of smoking onset	How old were you when you first started to smoke fairly regularly?	2010, 2012
Number of cigarettes	On the average, how many cigarettes do you now smoke a day?	2010, 2012
History of alcohol	In any 1 y, have you had at least 12 drinks of any type of alcoholic beverage?	2010, 2012
Amount of alcohol	In the past year, how often did you drink any type of alcoholic beverage? In the past year on those days that you drank alcoholic beverages, on the average, how many drinks did you have?	2010, 2012
Vigorous activity	How often do you do vigorous leisure-time physical activities for at least 10 min that cause heavy sweating or large increases in breathing or heart rate?	2010, 2012
Duration of activities	About how long do you do these vigorous leisure-time physical activities each time?	2010, 2012
Fatigue	During the past 12 mo, have you had fatigue or lack of energy more than 3 d?	2012
Sleepiness	During the past 12 mo, have you regularly had excessive sleepiness during the day?	2012
Insomnia	During the past 12 mo, have you regularly had insomnia or trouble sleeping?	2012

TABLE E2. ORs for the associations of eczema, hypertension, and diabetes in adults from the 2012 NHIS (N = 34,525)

Variable, n (%)	Eczema (n = 2,488)			Hypertension (n = 11,340)			Diabetes (n = 3,544)		
	% Prevalence (95% CI)	Crude OR (95% CI)	P value	% Prevalence (95% CI)	Crude OR (95% CI)	P value	% Prevalence (95% CI)	Crude OR (95% CI)	P value
Age (y)									
18-29	6.6 (5.8-7.4)	1.00	—	6.4 (5.7-7.2)	1.00	—	1.1 (0.7-1.4)	1.00	—
30-49	7.4 (6.7-8.0)	1.12 (0.96-1.31)	.14	18.9 (18.0-19.8)	3.38 (2.94-3.89)	<.001	5.0 (4.5-5.5)	4.94 (3.51-6.94)	<.001
50-69	7.6 (7.0-8.3)	1.17 (1.00-1.37)	.005	45.3 (44.1-46.5)	12.03 (10.50-13.79)	<.001	15.2 (14.4-16.1)	16.83 (12.09-23.43)	<.001
≥70	6.9 (6.0-7.8)	1.05 (0.87-1.27)	.059	63.7 (62.0-65.4)	25.51 (22.02-29.55)	<.001	20.7 (19.2-22.1)	24.39 (17.44-34.11)	<.001
Sex									
Male	5.8 (5.3-6.3)	1.00	—	30.5 (29.6-31.4)	1.00	—	9.3 (8.7-9.8)	1.00	—
Female	8.6 (8.0-9.1)	1.52 (1.36-1.70)	<.001	29.3 (28.5-30.2)	0.95 (0.89-1.00)	.06	9.1 (8.6-9.6)	0.98 (0.90-1.08)	.72
Race									
White	7.4 (7.0-7.8)	1.00	—	29.4 (28.7-30.1)	1.00	—	8.7 (8.3-9.2)	1.00	—
Black	6.1 (5.3-7.0)	0.82 (0.70-0.96)	.01	36.9 (35.3-38.5)	1.41 (1.30-1.52)	<.001	12.5 (11.4-13.6)	1.49 (1.34-1.67)	<.001
American Indian	8.2 (5.0-11.4)	1.12 (0.73-1.72)	.59	29.0 (23.3-34.8)	0.98 (0.74-1.30)	.91	13.6 (9.4-17.7)	1.64 (1.14-2.35)	.007
Asian	6.6 (5.3-8.0)	0.89 (0.71-1.11)	.31	22.4 (20.2-24.5)	0.69 (0.61-0.79)	<.001	8.0 (6.6-9.3)	0.90 (0.75-1.10)	.31
Multiracial/other	13.3 (6.7-20.0)	1.93 (1.08-3.44)	.03	26.0 (18.4-33.6)	0.84 (0.57-1.25)	.40	7.8 (4.0-11.5)	0.88 (0.52-1.49)	.63
Hispanic origin									
No	7.5 (7.1-7.9)	1.00	—	31.6 (30.9-32.3)	1.00	—	9.2 (8.8-9.6)	1.00	—
Yes	5.6 (4.8-6.3)	0.73 (0.62-0.85)	<.001	20.1 (18.9-21.3)	0.54 (0.50-0.59)	<.001	9.2 (8.3-10.1)	1.00 (0.89-1.13)	.98
Household income (×\$1000)									
0-34	7.3 (6.8-7.9)	0.97 (0.83-1.12)	.65	34.6 (33.6-35.6)	1.73 (1.58-1.90)	<.001	12.3 (11.6-13.0)	2.45 (2.10-2.86)	<.001
35-74	7.8 (7.1-8.5)	1.03 (0.88-1.21)	.72	30.0 (28.8-31.1)	1.40 (1.28-1.54)	<.001	9.2 (8.5-10.0)	1.78 (1.51-2.10)	<.001
75-99	5.9 (4.9-6.8)	0.76 (0.61-0.95)	.01	27.0 (25.2-28.9)	1.21 (1.07-1.37)	.002	6.9 (5.9-7.9)	1.30 (1.05-1.60)	.02
≥100	7.6 (6.7-8.5)	1.00	—	23.4 (22.0-24.8)	1.00	—	5.4 (4.7-6.1)	1.00	—
Highest level of household education									
<High school	5.8 (4.8-6.7)	1.00	—	37.2 (35.3-39.2)	1.00	—	14.3 (12.8-15.7)	1.00	—
High school or GED	5.7 (5.0-6.3)	0.98 (0.79-1.22)	.85	36.6 (35.2-38.0)	0.97 (0.88-1.08)	.57	12.8 (11.9-13.8)	0.88 (0.76-1.02)	.10
>High school	7.7 (7.2-8.2)	1.37 (1.13-1.66)	.001	27.9 (27.1-28.7)	0.65 (0.60-0.72)	<.001	8.0 (7.5-8.5)	0.52 (0.46-0.60)	<.001

Refusal to answer a particular question or response of “don’t know” occurred for the questions pertaining to eczema in 25 (0.07%), hypertension in 32 (0.08%), diabetes in 24 (0.05%), age in 0 (0.0%), sex in 0 (0.0%), race in 0 (0.0%), Hispanic/Spanish origin in 0 (0.0%), household income in 1928 (5.6%), current working status in 25 (0.07%), and highest level of education in the household in 69 (0.2%) respondents, respectively.

TABLE E3. Logistic regression models of the associations between eczema and obesity, hypertension, and diabetes in adults in the 2010 NHIS (N = 27,157)

	No eczema (n = 22,273)		Eczema (n = 2,408)					
					Model 1 (sociodemo- graphic characteristics)		Model 2 (asthma, hay fever)	
Variable	% Prevalence (95% CI)	% Prevalence (95% CI)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
BMI								
Underweight: <18.5	1.8 (1.6-2.1)	1.1 (0.7-1.5)	0.64 (0.42-0.97)	.04	0.80 (0.41-1.58)	.52	0.65 (0.42-0.99)	.04
Normal weight: 18.5-24	35.3 (34.6-36.1)	33.2 (30.9-35.6)	1.00	—	1.00	—	1.00	—
Overweight: 25-29	34.8 (34.1-35.6)	32.8 (30.5-35.0)	1.00 (0.88-1.35)	.99	1.20 (0.99-1.45)	.07	0.99 (0.87-1.13)	.90
Class I obesity: 30-34	17.3 (16.7-17.9)	19.0 (17.1-20.9)	1.17 (1.01-1.36)	.04	1.22 (0.95-1.56)	.13	1.15 (0.98-1.33)	.08
Class II/III obesity: ≥35	10.7 (10.2-11.2)	13.9 (12.3-15.5)	1.38 (1.17-1.63)	<.001	1.37 (1.03-1.83)	.03	1.30 (1.10-1.53)	.002
Lifetime prevalence of hypertension								
No	69.9 (69.2-70.6)	63.3 (61.0-65.6)	1.00	—	1.00	—	1.00	—
Yes	30.1 (29.4-30.8)	36.7 (34.4-39.0)	1.35 (1.21-1.49)	<.001	1.24 (1.01-1.53)	.04	1.30 (1.17-1.45)	<.001
Lifetime prevalence of hypertension on 2 visits								
No	74.4 (73.7-75.1)	67.1 (64.9-69.3)	1.00	—	1.00	—	1.00	—
Yes	25.6 (24.9-26.3)	32.9 (30.7-35.1)	1.43 (1.28-1.58)	<.001	1.32 (1.06-1.65)	.01	1.37 (1.23-1.53)	<.001
Lifetime prevalence of prediabetes								
No	95.9 (95.6-96.2)	93.4 (92.2-94.6)	1.00	—	1.00	—	1.00	—
Yes	4.1 (3.8-4.4)	6.6 (5.4-7.8)	1.64 (1.33-2.02)	<.001	1.57 (1.07-2.30)	.02	1.77 (1.42-2.22)	<.001
Lifetime prevalence of diabetes								
No	90.9 (90.4-91.3)	87.4 (85.9-89.0)	1.00	—	1.00	—	1.00	—
Yes	9.1 (8.7-9.6)	12.6 (11.0-14.1)	1.43 (1.23-1.67)	<.001	1.38 (0.94-2.02)	.10	1.40 (1.20-1.64)	<.001
Childhood-onset diabetes								
No	99.3 (99.2-99.5)	99.1 (98.5-99.6)	1.00	—	1.00	—	1.00	—
Yes	0.7 (0.5-0.8)	0.9 (0.4-1.5)	1.43 (0.76-2.67)	0.27	1.32 (0.77-2.45)	0.22	1.45 (0.78-2.70)	0.25
Adult-onset diabetes								
No	91.4 (91.0-91.8)	88.2 (86.8-89.7)	1.00	—	1.00	—	1.00	—
Yes	8.6 (8.2-9.0)	11.8 (10.3-13.2)	1.41 (1.21-1.65)	<.001	1.16 (0.79-1.71)	.45	1.38 (1.18-1.61)	<.001

Multivariable logistic regression models were constructed with self-reported BMI classification, hypertension, and prediabetes/diabetes (yes/no) modeled as the dependent variables and AD/eczema as the independent variable. Crude OR and 95% CI were estimated. Adjusted OR and 95% CI were estimated in 2 different multivariable models, including (1) age, highest level of education in the household, race, ethnicity, sex, history of smoking, current working status, BMI (included in all models except in those in which BMI was the outcome), ever history of smoking, ever history of alcohol consumption, and frequency of vigorous activity as covariates and (2) history of asthma and hay fever as covariates.

Refusal to answer a particular question or response of “don’t know” occurred for the questions pertaining to eczema in 16 (0.06%), BMI in 837 (3.4%), ever history of hypertension in 35 (0.1%), hypertension on 2 visits in 18 (0.07%), prediabetes in 23 (0.1%), diabetes in 12 (0.04%), age of onset of diabetes in 47 (1.8%), ever history of smoking in 145 (0.6%), ever history of drinking alcohol in 229 (0.9%), history of vigorous activity for at least 10 minutes in 268 (1.1%), age in 0 (0.0%), sex in 0 (0.0%), race in 0 (0.0%), Hispanic/Spanish origin in 0 (0.0%), current working status in 13 (0.05%), and highest level of education in the household in 46 (0.2%) respondents, respectively.

TABLE E4. Logistic regression models of the associations between eczema severity, sleep disturbance, and cardiovascular risk factors in adults in the 2012 NHIS

	No eczema or fatigue (n = 35,873)	Eczema without fatigue (n = 2,660)						Eczema with fatigue (n = 1,005)					
			Model 1 (sociodemo- graphic characteristics)		Model 2 (asthma, hay fever)			Model 1 (sociodemo- graphic characteristics)		Model 2 (asthma, hay fever)			
Value	% Prevalence (95% CI)	% Prevalence (95% CI)	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value	% Prevalence (95% CI)	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value		
BMI													
Underweight: <18.5	74.6 (70.0-79.3)	4.4 (2.1-6.8)	0.90 (0.50-1.60)	.71	0.84 (0.47-1.50)	.55	3.3 (1.6-5.1)	1.68 (0.95-2.96)	.07	1.86 (1.06-3.26)	.03		
Normal weight: 18.5-24	81.7 (80.8-87.9)	5.1 (4.6-5.6)	1.00	—	1.00	—	1.9 (1.6-2.3)	1.00	—	1.00	—		
Overweight: 25-29	82.4 (81.5-83.3)	4.7 (4.2-5.2)	1.02 (0.87-1.21)	.79	0.91 (0.78-1.07)	.98	1.9 (1.6-2.2)	1.16 (0.91-1.47)	.23	0.98 (0.77-1.24)	.87		
Class I obesity: 30-34	78.2 (76.8-79.5)	4.7 (4.0-5.5)	1.09 (0.89-1.32)	.42	0.94 (0.77-1.14)	.54	2.6 (2.1-3.1)	1.58 (1.21-2.07)	.0007	1.29 (0.99-1.67)	.05		
Class II/III obesity: ≥35	69.3 (67.3-71.2)	4.7 (3.9-5.6)	1.18 (0.95-1.46)	.14	1.00 (0.81-1.24)	.98	4.7 (3.7-5.7)	3.05 (2.29-4.07)	<.0001	2.45 (1.84-3.25)	<.0001		
Lifetime prevalence of hypertension													
No	82.9 (82.3-93.6)	4.8 (4.4-5.1)	1.00	—	1.00	—	1.8 (1.6-2.0)	1.00	—	1.00	—		
Yes	91.1 (90.4-91.8)	5.1 (4.7-5.7)	1.13 (1.06-1.22)	.0005	1.07 (1.01-1.14)	.02	3.8 (3.3-4.3)	1.36 (1.16-1.60)	.0002	1.48 (1.29-1.71)	<.0001		
Lifetime prevalence of hypertension on 2 visits													
No	82.8 (82.2-83.4)	4.8 (4.4-5.1)	1.00	—	1.00	—	1.8 (1.6-2.0)	1.00	—	1.00	—		
Yes	70.7 (71.9-77.9)	5.2 (4.6-5.8)	1.16 (1.08-1.25)	<.0001	1.09 (1.03-1.16)	.006	4.1 (3.6-4.7)	1.45 (1.24-1.70)	<.0001	1.54 (1.34-1.78)	<.0001		
Lifetime prevalence of prediabetes													
No	81.7 (81.2-82.3)	4.7 (4.4-5.0)	1.00	—	1.00	—	2.0 (1.8-2.2)	1.00	—	1.00	—		
Yes	87.8 (85.5-90.0)	8.3 (6.3-10.3)	1.18 (1.05-1.33)	.007	1.17 (1.04-1.31)	.007	3.9 (2.7-5.1)	1.09 (0.82-1.43)	.56	1.18 (0.91-1.54)	.21		
Lifetime prevalence of diabetes													
No	81.2 (80.6-81.7)	4.9 (4.6-5.2)	1.00	—	1.00	—	2.0 (1.8-2.2)	1.00	—	1.00	—		
Yes	67.1 (65.1-69.2)	4.4 (3.5-5.3)	1.14 (1.03-1.25)	.01	1.08 (0.99-1.18)	.08	5.2 (4.0-6.3)	1.68 (1.35-2.09)	<.0001	1.80 (1.48-2.20)	<.0001		
Childhood-onset diabetes													
No	80.0 (79.4-80.5)	4.9 (4.6-5.2)	1.00	—	1.00	—	2.3 (2.1-2.5)	1.00	—	1.00	—		
Yes	66.6 (58.9-74.3)	2.9 (0.8-4.9)	1.11 (0.85-1.46)	.44	1.07 (0.81-1.40)	.62	7.2 (2.4-12.0)	2.16 (1.19-3.90)	.01	2.50 (1.42-4.43)	.002		
Adult-onset diabetes													
No	81.1 (80.5-81.7)	4.9 (4.6-5.2)	1.00	—	1.00	—	2.1 (1.9-2.3)	1.00	—	1.00	—		
Yes	67.0 (64.9-69.2)	4.5 (3.5-5.4)	1.13 (1.02-1.25)	.02	1.07 (0.98-1.18)	0.12	5.0 (3.8-6.2)	1.60 (1.28-2.01)	<.0001	1.73 (1.41-2.12)	<.0001		
Lifetime prevalence of high cholesterol													
No	82.5 (81.9-83.1)	4.8 (4.5-5.2)	1.00	—	1.00	—	1.8 (1.6-2.0)	1.00	—	1.00	—		
Yes	72.0 (70.9-73.2)	4.8 (4.3-5.4)	1.10 (1.03-1.18)	.005	1.08 (1.01-1.14)	.02	4.0 (3.4-4.5)	1.57 (1.34-1.83)	<.0001	1.58 (1.37-1.82)	<.0001		
1-y prevalence of high cholesterol													
No	81.9 (81.3-82.4)	4.8 (4.5-5.1)	1.00	—	1.00	—	1.9 (1.7-2.1)	1.00	—	1.00	—		
Yes	70.4 (68.9-71.8)	5.0 (4.4-5.7)	1.10 (1.02-1.18)	.01	1.08 (1.01-1.16)	.02	4.3 (3.6-5.0)	1.47 (1.24-1.75)	<.0001	1.54 (1.31-1.80)	<.0001		

(Continued)

TABLE E4. (Continued)

	No eczema or sleepiness (n = 36,869)	Eczema without sleepiness (n = 2,880)					Eczema with sleepiness (n = 786)				
			Model 1 (sociodemographic characteristics)		Model 2 (asthma, hay fever)			Model 1 (sociodemographic characteristics)		Model 2 (asthma, hay fever)	
Value	% Prevalence (95% CI)	% Prevalence (95% CI)	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value	% Prevalence (95% CI)	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
BMI											
Underweight: <18.5	74.4 (69.5-79.3)	5.2 (2.6-7.7)	0.98 (0.57-1.68)	.95	0.93 (0.54-1.59)	.80	2.6 (1.2-4.0)	1.78 (0.97-3.25)	.06	2.01 (1.10-3.69)	.02
Normal weight: 18.5-24	83.7 (82.9-84.6)	5.6 (5.1-6.2)	1.00	—	1.00	—	1.4 (1.2-1.7)	1.00	—	1.00	—
Overweight: 25-29	84.1 (83.2-85.0)	5.1 (4.5-5.6)	1.00 (0.85-1.17)	.98	0.90 (0.77-1.05)	.19	1.5 (1.3-1.8)	1.30 (1.00-1.69)	.05	1.06 (0.82-1.38)	.64
Class I obesity: 30-34	80.7 (79.6-82.2)	5.0 (4.3-5.8)	1.02 (0.84-1.24)	.83	0.90 (0.74-1.08)	.26	2.3 (1.8-2.8)	1.97 (1.48-2.64)	<.0001	1.54 (1.16-2.04)	.003
Class II/III obesity: ≥35	72.5 (70.6-74.4)	5.9 (4.9-6.8)	1.27 (1.04-1.56)	.02	1.09 (0.89-1.33)	.42	3.6 (2.7-4.6)	3.18 (2.29-4.43)	<.0001	2.50 (1.81-3.47)	<.0001
Lifetime prevalence of hypertension											
No	84.1 (83.5-84.8)	5.0 (4.7-5.4)	1.00	—	1.00	—	1.5 (1.3-1.7)	1.00	—	1.00	—
Yes	76.6 (75.6-77.7)	6.1 (5.5-6.7)	1.12 (1.04-1.21)	.003	1.09 (1.03-1.17)	.006	2.8 (2.4-3.2)	1.26 (1.05-1.52)	.01	1.32 (1.13-1.55)	.0005
Lifetime prevalence of hypertension on 2 visits											
No	84.0 (83.4-89.9)	5.0 (4.7-5.4)	1.00	—	1.00	—	1.5 (1.3-1.7)	1.00	—	1.00	—
Yes	75.7 (74.6-76.9)	6.3 (5.7-7.0)	1.16 (1.07-1.25)	.0003	1.12 (1.04-1.19)	.001	3.0 (2.5-3.5)	1.35 (1.12-1.64)	.002	1.37 (1.17-1.61)	.0001
Lifetime prevalence of prediabetes											
No	83.4 (82.9-84.0)	5.2 (4.8-5.5)	1.00	—	1.00	—	1.6 (1.4-1.8)	1.00	—	1.00	—
Yes	71.5 (68.5-74.5)	8.6 (6.7-10.6)	1.22 (1.08-1.39)	.002	1.24 (1.10-1.40)	.0006	3.6 (2.4-4.8)	1.32 (0.97-1.78)	.08	1.42 (1.07-1.89)	.02
Lifetime prevalence of diabetes											
No	83.0 (82.4-83.5)	5.3 (5.0-5.6)	1.00	—	1.00	—	1.6 (1.4-1.8)	1.00	—	1.00	—
Yes	72.1 (70.1-74.0)	5.6 (4.6-6.7)	1.16 (1.05-1.29)	.005	1.12 (1.02-1.23)	.01	4.0 (2.9-5.0)	1.67 (1.30-2.13)	<.0001	1.70 (1.35-2.12)	<.0001
Childhood-onset diabetes											
No	82.1 (81.5-82.6)	5.3 (5.0-5.7)	1.00	—	1.00	—	1.8 (1.6-2.0)	1.00	—	1.00	—
Yes	69.1 (61.3-76.9)	6.0 (2.6-9.5)	1.16 (0.85-1.60)	.35	1.13 (0.82-1.55)	.44	4.0 (0.01-8.0)	1.46 (0.66-3.24)	.35	1.60 (0.72-3.56)	.25
Adult-onset diabetes											
No	82.9 (82.4-83.5)	5.3 (5.0-5.7)	1.00	—	1.00	—	1.6 (1.5-1.8)	1.00	—	1.00	—
Yes	72.3 (70.3-74.3)	5.6 (4.5-7.6)	1.16 (1.04-1.29)	.008	1.12 (1.02-1.23)	.02	3.9 (2.8-5.0)	1.66 (1.28-2.14)	.0001	1.68 (1.33-2.11)	<.0001
Lifetime prevalence of high cholesterol											
No	83.6 (83.0-84.3)	5.2 (4.8-5.6)	1.00	—	1.00	—	1.5 (1.3-1.6)	1.00	—	1.00	—
Yes	77.2 (76.1-78.3)	5.7 (5.1-6.3)	1.15 (1.07-1.23)	.0002	1.13 (1.06-1.20)	.0003	3.1 (2.6-3.6)	1.62 (1.37-1.93)	<.0001	1.54 (1.31-1.80)	<.0001
1-y prevalence of high cholesterol											
No	83.3 (82.7-83.9)	5.1 (4.8-5.5)	1.00	—	1.00	—	1.6 (1.4-1.8)	1.00	—	1.00	—
Yes	75.9 (74.6-77.2)	6.2 (5.5-7.0)	1.11 (1.02-1.21)	.01	1.11 (1.03-1.20)	.004	3.1 (2.4-3.7)	1.34 (1.10-1.64)	.005	1.37 (1.15-1.64)	.0006

Value	No eczema or insomnia (n = 34,464)	Eczema without insomnia (n = 2,626)						Eczema with insomnia (n = 1,039)					
	% Prevalence (95% CI)	% Prevalence (95% CI)	Model 1 (sociodemo- graphic characteristics)		Model 2 (asthma, hay fever)		% Prevalence (95% CI)	Model 1 (sociodemo- graphic characteristics)		Model 2 (asthma, hay fever)		% Prevalence (95% CI)	% Prevalence (95% CI)
			Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value		Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value		
BMI													
Underweight: <18.5	75.2 (70.6-79.9)	4.2 (1.9-6.5)	0.82 (0.46-1.49)	.52	0.86 (0.48-1.55)	.62	3.6 (1.8-5.4)	1.56 (0.89-2.72)	.12	1.49 (0.86-2.57)	.15		
Normal weight: 18.5-24	77.9 (76.9-78.9)	5.0 (4.4-5.6)	1.00	—	1.00	—	2.1 (1.8-2.4)	1.00	—	1.00	—		
Overweight: 25-29	77.9 (76.9-78.9)	4.3 (3.8-4.8)	0.99 (0.83-1.17)	.87	0.87 (0.73-1.02)	.09	2.3 (2.0-2.7)	1.25 (1.00-1.57)	.05	1.11 (0.89-1.39)	.38		
Class I obesity: 30-34	73.9 (72.4-75.3)	4.9 (4.2-5.7)	1.19 (0.98-1.45)	.08	1.02 (0.84-1.24)	.83	2.4 (1.9-2.8)	1.30 (1.00-1.69)	.05	1.10 (0.86-1.43)	.45		
Class II/III obesity: ≥35	66.5 (64.6-68.5)	5.3 (4.3-6.3)	1.35 (1.07-1.70)	.01	1.15 (0.91-1.44)	.25	4.2 (3.3-5.0)	2.43 (1.85-3.19)	<.0001	1.97 (1.50-2.59)	<.0001		
Lifetime prevalence of hypertension													
No	79.2 (78.5-79.9)	4.6 (4.2-4.9)	1.00	—	1.00	—	1.9 (1.7-2.2)	1.00	—	1.00	—		
Yes	68.2 (67.1-69.3)	5.1 (4.5-5.7)	1.14 (1.07-1.23)	.0001	1.09 (1.03-1.16)	.003	3.8 (3.3-4.3)	1.35 (1.15-1.58)	.0003	1.43 (1.25-1.63)	<.0001		
Lifetime prevalence of hypertension on 2 visits													
No	79.0 (78.3-79.6)	4.6 (4.2-4.9)	1.00	—	1.00	—	2.0 (1.7-2.2)	1.00	—	1.00	—		
Yes	67.0 (65.8-68.2)	5.3 (4.6-5.9)	1.17 (1.09-1.26)	<.0001	1.11 (1.05-1.18)	.0004	4.0 (3.5-4.5)	1.40 (1.20-1.64)	<.0001	1.45 (1.27-1.66)	<.0001		
Lifetime prevalence of prediabetes													
No	77.9 (77.2-78.5)	4.6 (4.3-4.9)	1.00	—	1.00	—	2.1 (1.9-2.3)	1.00	—	1.00	—		
Yes	59.3 (56.1-62.6)	6.9 (5.1-8.7)	1.24 (1.10-1.39)	.0005	1.24 (1.11-1.39)	.0002	5.3 (3.8-6.8)	1.46 (1.12-1.91)	.006	1.56 (1.21-2.00)	.0006		
Lifetime prevalence of diabetes													
No	77.1 (76.5-77.7)	4.7 (4.4-5.0)	1.00	—	1.00	—	2.2 (2.0-2.4)	1.00	—	1.00	—		
Yes	65.3 (63.3-67.4)	5.0 (3.8-6.2)	1.16 (1.05-1.27)	.003	1.12 (1.03-1.23)	.009	4.6 (3.7-5.5)	1.44 (1.17-1.76)	.0005	1.57 (1.31-1.88)	<.0001		
Childhood-onset diabetes													
No	76.1 (75.5-76.7)	4.7 (4.4-5.0)	1.00	—	1.00	—	2.4 (2.2-2.6)	1.00	—	1.00	—		
Yes	63.0 (55.1-70.8)	4.0 (1.1-6.8)	1.17 (0.89-1.56)	.26	1.14 (0.86-1.51)	.36	6.1 (1.7-10.5)	1.77 (0.95-3.31)	.07	2.02 (1.11-3.70)	.02		
Adult-onset diabetes													
No	77.0 (76.4-77.6)	4.7 (4.4-5.0)	1.00	—	1.00	—	2.3 (2.0-2.5)	1.00	—	1.00	—		
Yes	65.6 (63.5-67.7)	5.0 (3.8-6.3)	1.15 (1.04-1.27)	.007	1.12 (1.02-1.22)	.02	4.5 (3.6-5.4)	1.38 (1.12-1.70)	.002	1.52 (1.26-1.82)	<.0001		
Lifetime prevalence of high cholesterol													
No	78.9 (78.2-79.6)	4.7 (4.4-5.1)	1.00	—	1.00	—	1.9 (1.7-2.1)	1.00	—	1.00	—		
Yes	67.8 (66.6-69.0)	4.8 (4.2-5.4)	1.11 (1.04-1.19)	.002	1.09 (1.03-1.16)	.003	4.0 (3.5-4.5)	1.52 (1.31-1.77)	<.0001	1.56 (1.36-1.78)	<.0001		
1-y prevalence of high cholesterol													
No	78.1 (77.5-78.7)	4.7 (4.3-5.0)	1.00	—	1.00	—	2.1 (1.9-2.3)	1.00	—	1.00	—		
Yes	66.7 (65.3-68.2)	5.1 (4.3-5.8)	1.11 (1.04-1.20)	.004	1.11 (1.04-1.18)	.002	4.2 (3.6-4.8)	1.41 (1.20-1.65)	<.0001	1.49 (1.29-1.72)	<.0001		

Multivariable logistic regression models were constructed with self-reported BMI classification, hypertension, prediabetes/diabetes, and high cholesterol modeled as the dependent variables. The independent variables were AD/eczema and either fatigue, sleepiness, or insomnia with a statistical interaction term between them. Adjusted OR and 95% CI were estimated for eczema with and without fatigue in 2 different multivariable models, including (1) age, highest level of education in the household, race, ethnicity, sex, history of smoking, current working status, BMI (included in all models except in those in which BMI was the outcome), history of ever smoking, and history of ever alcohol consumption as covariates and (2) history of asthma and hay fever as covariates.

Refusal to answer a particular question or response of "don't know" occurred for the questions pertaining to eczema in 25 (0.07%), BMI in 1635 (4.2%), ever history of hypertension in 32 (0.08%), hypertension on 2 visits in 27 (0.08%), prediabetes in 30 (0.09%), diabetes in 25 (0.05%), high cholesterol in 92 (0.3%), high cholesterol in the past year in 169 (0.5%), fatigue in 27 (0.06%), sleepiness in 19 (0.05%), insomnia in 17 (0.04%), age of onset of diabetes in 60 (1.7%), ever history of smoking in 262 (0.8%), ever history of drinking alcohol in 345 (1.0%), history of vigorous activity for at least 10 minutes in 496 (1.4%), age in 0 (0.0%), sex in 0 (0.0%), race in 0 (0.0%), Hispanic/Spanish origin in 0 (0.0%), current working status in 25 (0.07%), and highest level of education in the household in 69 (0.2%) respondents, respectively.