Original Investigation

Association Between Eczema and Increased Fracture and Bone or Joint Injury in Adults
A US Population-Based Study

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IMPORTANCE Adults with eczema have multiple risk factors for accidental injury. However, little is known about the risk of injury in adult patients with eczema.

OBJECTIVE To determine whether adult eczema is associated with an increased risk of injury.

DESIGN, SETTING, AND PARTICIPANTS A prospective questionnaire-based study using the 2012 National Health Interview Survey among a nationally representative sample of 34 500 adults aged 18 to 85 years with a history of eczema in the past 12 months.

MAIN OUTCOMES AND MEASURES History of fracture and bone or joint injury (FBJI) and other injury causing limitation.

RESULTS The prevalences of eczema and any injury causing limitation were 7.2% (95% CI, 6.9%-7.6%) and 2.0% (95% CI, 1.9%-2.2%), respectively. An FBJI causing limitation was reported by 1.5% (95% CI, 1.3%-1.7%), while other types of injury causing limitation occurred in 0.6% (95% CI, 0.5%-0.7%). Adults with eczema had higher odds of any injury causing limitation (survey logistic regression adjusted odds ratio [aOR], 1.44; 95% CI, 1.07-1.94), particularly FBJI (aOR, 1.67; 95% CI, 1.21-2.33), in models controlling for sociodemographics, asthma, hay fever, food allergies, and psychiatric and behavioral disorders. The prevalence of FBJI causing limitation increased gradually with age, peaking at 50 to 69 years and decreasing thereafter. Significant interactions were observed between eczema and fatigue or sleep symptoms, such that adults with eczema and fatigue (aOR, 1.59; 95% CI, 1.16-2.19), daytime sleepiness (aOR, 1.81; 95% CI, 1.28-2.55), or insomnia (aOR, 1.74; 95% CI, 1.28-2.37) had higher rates of FBJI compared with those with sleep symptoms and no eczema. Adults with both eczema and psychiatric and behavioral disorders (aOR, 2.15; 95% CI, 1.57-2.93) had higher rates of FBJI compared with those with eczema (aOR, 1.39; 95% CI, 1.19-1.61) or psychiatric and behavioral disorders (aOR, 1.58; 95% CI, 1.36-1.83) alone.

CONCLUSIONS AND RELEVANCE The results of this study suggest that eczema in adulthood is a previously unrecognized risk factor for fracture and other injury causing limitation. Future studies are needed to confirm these associations. The findings may warrant the development of preventive measures for injury risk reduction in adult patients with eczema.

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Eczema is a chronic inflammatory disorder that causes significant morbidity related to itch, sleep impairment, and a wide range of comorbidities.[1-5] A recent study[6] of 27 556 children aged 0 to 5 years from the 2007-2008 National Survey of Children's Health found that children with eczema have higher odds of injuries requiring medical attention. Patients with eczema have multiple risk factors for injury, including sleep impairment,[7-11] sedating antihistamine use,[12] and psychological comorbidity.[3] Sleep impairment is a particularly well-known risk factor for increased injury risk[13-15] and affects a high percentage of patients with eczema.[16] However, little is known about the risk of injury in adult patients with eczema.

In particular, the risk of bone fracture and other injury causing limitation in adults with eczema has been largely unexplored. Fractures are a source of tremendous public health burden[17] and are projected to increase dramatically during the next few decades given increases in the elderly population.[18,19] Patients with eczema may be at risk of fracture given their use of systemic corticosteroids, which may decrease bone mineral density (BMD). In addition, the chronic inflammation associated with eczema may predispose toward bone loss, as described in patients with rheumatoid arthritis and inflammatory bowel disease.[20,21] A 2009 study[22] found low BMD in approximately one-third of patients with moderate to severe atopic dermatitis (AD). Therefore, studies describing the prevalence of fracture among adults with eczema are needed. We hypothesized that adults with eczema have higher odds of fracture and other injury. Furthermore, adults with eczema may be more prone to certain causes of injury, such as motor vehicle crashes or falls. In the present study, we assessed the burden of fracture and other types of injury causing limitation in adults with eczema.

Methods

This study was approved by the institutional review board at Northwestern University. We used the 2012 National Health Interview Survey, which is collected by the National Center for Health Statistics and is the principal source of information on the health of the civilian noninstitutionalized population of the United States. Waiver of informed consent was obtained by the National Center for Health Statistics because the survey posed minimal risk and respondents were not identifiable by the recorded data. The survey included a separate core module with questions to estimate the prevalence of various health issues among adults. 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. Questions used in this study are presented in the eMethods in the Supplement.

All data processing and statistical analyses were performed with a software program (SAS, version 9.4; SAS Institute Inc). Bivariate and multivariable analyses of survey responses were performed with SURVEY procedures. Bivariate associations between eczema or injury causing limitation and other sociodemographic variables (eg, age, sex, race/ethnicity, or household income) were tested via logistic regression models. All other bivariate associations were tested using Rao-Scott χ^2 test. Significant predictors from bivariate analyses were included as covariates in multivariable logistic regression models. Adjusted odds ratios (aORs) and 95% CIs were determined. Complete data analysis was performed (ie, individuals with missing data were excluded). Only types of injury with at least 5 responses were statistically analyzed in models. Our a priori hypothesis was that adults with eczema and different combinations of fatigue or sleep symptoms might have an increased risk of injury compared with those with fatigue or sleep symptoms alone. Therefore, models were constructed that tested interaction terms between eczema and different combinations of fatigue and sleep symptoms. Two-way interaction terms between other covariates were also tested. Interactions were included in final models only in cases of $P < .01$ and modification of estimates greater than 20%. In models of binary outcomes with significant statistical interactions, we constructed generalized linear models using a logit link function in PROC GLIMMIX; aORs (95% CIs) were estimated for each combination of factors included in the interaction effects. The best model was selected using the Bayesian information criterion, which penalizes for extra parameters and takes into account the large sample size.

Results

Determinants of Eczema and Fracture and Bone or Joint Injury Causing Limitation

In total, 34 500 adults aged 18 to 85 years were included in the analysis. The US prevalence of self-reported eczema or skin allergy in the past 12 months among adults was 7.2% (95% CI, 6.9%-7.6%). The prevalence of eczema was significantly associated with female sex and post-high school education but inversely associated with African American race/ethnicity, Hispanic origin, household income of $75 000 to $99 999, families with children, either a single parent or both parents living in the household compared with those without children, birthplace outside the United States, and lack of health insurance coverage (**Table 1**).

The prevalence of any injury causing limitation was 2.0% (95% CI, 1.9%-2.2%). A fracture and bone or joint injury (FBJI) causing limitation was reported by 1.5% (95% CI, 1.3%-1.7%), while 0.6% (95% CI, 0.5%-0.7%) reported having other types of injury causing limitation. The prevalence of FBJI causing limitation was significantly associated with increasing age and decreasing household income but inversely associated with Asian race/ethnicity, Hispanic origin, high school or General Education Development or post-high school education, families with

Table 1. Association Between Sociodemographic Factors and Eczema and FBJI Causing Limitation in 34 500 Adults[a]

	Eczema				FBJI Causing Limitation			
	% Prevalence (95% CI)				% Prevalence (95% CI)			
Variable	No	Yes	OR (95% CI)	*P* Value	No	Yes	OR (95% CI)	*P* Value
Age, y								<.001
18-29	93.4 (92.6-94.2)	6.6 (5.8-7.4)	1 [Reference]	NA	99.6 (99.4-99.8)	0.4 (0.2-0.6)	1 [Reference]	NA
30-49	92.6 (92.0-93.3)	7.4 (6.7-8.0)	1.12 (0.96-1.31)	.14	99.2 (99.0-99.4)	0.8 (0.6-1.0)	2.11 (1.18-3.76)	.01
50-69	92.4 (91.7-93.0)	7.6 (7.0-8.3)	1.17 (1.00-1.37)	.05	97.7 (97.4-98.0)	2.3 (2.0-2.6)	5.98 (3.44-10.39)	<.001
≥70	93.1 (92.2-94.0)	6.9 (6.0-7.8)	1.05 (0.87-1.27)	.61	96.3 (95.7-97.0)	3.7 (3.0-4.3)	9.60 (5.48-16.84)	<.001
Sex								
Male	94.2 (93.7-94.7)	5.8 (5.3-6.3)	1 [Reference]	NA	98.4 (98.2-98.7)	1.6 (1.4-1.8)	1 [Reference]	NA
Female	91.5 (90.9-92.0)	8.5 (8.0-9.1)	1.52 (1.36-1.70)	<.001	98.5 (98.3-98.7)	1.5 (1.3-1.7)	0.97 (0.79-1.19)	.75
Race/ethnicity								
White	92.5 (92.0-92.9)	7.5 (7.1-8.0)	1 [Reference]	NA	98.3 (98.1-98.5)	1.7 (1.5-1.9)	1 [Reference]	NA
African American	93.9 (93.1-94.8)	6.1 (5.2-6.9)	0.79 (0.64-0.93)	.01	98.7 (98.3-99.0)	1.3 (1.0-1.7)	0.79 (0.61-1.04)	.09
American Indian	90.8 (87.2-94.5)	9.2 (5.5-12.8)	1.24 (0.80-1.92)	.34	98.1 (96.4-99.7)	1.9 (0.3-3.6)	1.15 (0.48-2.77)	.76
Asian	93.4 (91.6-95.2)	6.6 (4.8-8.4)	0.86 (0.64-1.17)	.34	99.6 (99.3-99.9)	0.4 (0.1-0.7)	0.22 (0.09-0.49)	<.001
Multiracial or other	93.9 (92.9-95.0)	6.1 (5.0-7.1)	0.80 (0.66-0.97)	.02	99.0 (98.6-99.4)	1.0 (0.6-1.4)	0.58 (0.38-0.88)	.01
Hispanic origin								
No	92.5 (92.1-92.9)	7.5 (7.1-7.9)	1 [Reference]	NA	98.4 (98.2-98.5)	1.6 (1.5-1.8)	1 [Reference]	NA
Yes	94.4 (93.7-95.2)	5.6 (4.8-6.3)	0.73 (0.62-0.85)	<.001	99.0 (98.8-99.3)	1.0 (0.7-1.2)	0.59 (0.44-0.80)	<.001
Household income, $								
0-34 999	92.7 (92.1-93.2)	7.3 (6.8-7.9)	0.96 (0.83-1.12)	.63	97.4 (97.0-97.7)	2.6 (2.3-3.0)	6.37 (4.05-10.03)	<.001
35 000-74 999	92.2 (91.5-92.9)	7.8 (7.1-8.5)	1.03 (0.88-1.21)	.72	98.7 (98.4-99.0)	1.3 (1.0-1.6)	3.04 (1.88-4.94)	<.001
75 000-99 999	94.2 (93.2-95.1)	5.8 (4.9-6.8)	0.76 (0.61-0.94)	.01	99.1 (98.7-99.4)	0.9 (0.6-1.3)	2.23 (1.22-4.08)	.01
≥100 000	92.4 (91.5-93.3)	7.6 (6.7-8.5)	1 [Reference]	NA	99.6 (99.4-99.8)	0.4 (0.2-0.6)	1 [Reference]	NA
Highest level of household education								
<High school	94.2 (93.3-95.2)	5.8 (4.8-6.7)	1 [Reference]	NA	97.1 (96.3-97.8)	2.9 (2.2-3.7)	1 [Reference]	NA
High school or GED	94.3 (93.7-95.0)	5.7 (5.0-6.3)	0.98 (0.79-1.22)	.87	97.9 (97.5-98.3)	2.1 (1.7-2.5)	0.72 (0.52-0.99)	.04
>High school	92.2 (91.7-92.6)	7.8 (7.4-8.3)	1.39 (1.15-1.68)	<.001	98.8 (98.6-98.9)	1.2 (1.1-1.4)	0.42 (0.31-0.56)	<.001
Family structure								
No children	92.2 (91.8-92.7)	7.8 (7.3-8.2)	1 [Reference]	NA	98.1 (97.9-98.3)	1.9 (1.7-2.1)	1 [Reference]	NA
Single parent	93.8 (92.9-94.7)	6.2 (5.3-7.1)	0.79 (0.67-0.94)	.006	99.1 (98.8-99.4)	0.9 (0.6-1.2)	0.46 (0.32-0.67)	<.001
Both parents	7.5 (4.6-10.4)	6.0 (5.2-6.8)	0.76 (0.65-0.89)	<.001	99.4 (99.2-99.6)	0.6 (0.4-0.8)	0.31 (0.21-0.47)	<.001
Other adult, no parents	92.2 (89.1-95.4)	7.8 (4.6-10.9)	1.00 (0.64-1.56)	.99	97.8 (96.2-99.5)	2.2 (0.5-3.8)	1.12 (0.50-2.51)	.78
Birthplace in the United States								
No	95.0 (94.4-95.7)	5.0 (4.3-5.6)	0.63 (0.54-0.73)	<.001	99.1 (98.8-99.3)	0.9 (0.7-1.2)	0.55 (0.40-0.73)	<.001
Yes	92.3 (91.9-92.7)	7.7 (7.3-8.1)	1 [Reference]	NA	98.3 (98.1-98.5)	1.7 (1.5-1.9)	1 [Reference]	NA

(continued)

Table 1. Association Between Sociodemographic Factors and Eczema and FBJI Causing Limitation in 34 500 Adults[a] (continued)

Variable	Eczema				FBJI Causing Limitation			
	% Prevalence (95% CI)				% Prevalence (95% CI)			
	No	Yes	OR (95% CI)	*P* Value	No	Yes	OR (95% CI)	*P* Value
Health insurance coverage								
No	93.6 (92.8-94.4)	6.4 (5.6-7.2)	0.85 (0.74-0.99)	.04	99.0 (98.7-99.2)	1.0 (0.8-1.3)	0.63 (0.48-0.84)	.002
Yes	92.6 (92.2-93.0)	7.4 (7.0-7.8)	1 [Reference]	NA	98.4 (98.2-98.5)	1.6 (1.5-1.8)	1 [Reference]	NA

Abbreviations: FBJI, fracture and bone or joint injury; GED, General Education Development; NA, not available; OR, odds ratio.

[a] Refusal to answer a particular question or response of "don't know" occurred for the questions pertaining to eczema in 25, FBJI causing limitation in 45, other injury causing limitation in 45, any injury causing limitation in 0, fatigue in 20, daytime sleepiness in 14, insomnia in 9, current asthma in 37, hay fever in 25, respiratory allergies in 48, digestive allergies in 37, age in 0, sex in 0, race/ethnicity in 0, Hispanic origin in 0, household income in 1926, highest level of household education in 68, family structure in 4, birthplace in the United States in 10, and health insurance coverage in 112.

Table 2. Association Between Eczema and Injury in 34 500 Adults[a]

Injury Causing Limitation	No Eczema (n = 32 023)			Eczema (n = 2477)						
	Frequency of Injury	Weighted Frequency	% Prevalence (95% CI)	Frequency of Injury	Weighted Frequency	% Prevalence (95% CI)	OR (95% CI)	*P* Value	aOR (95% CI)	*P* Value
Any injury	763	4 140 008	1.9 (1.7-2.1)	113	629 626	3.72 (2.81-4.63)	1.99 (1.52-2.61)	<.001	2.06 (1.56-2.72)	<.001
FBJI	580	3 073 705	1.5 (1.3-1.6)	93	532 963	3.15 (2.29-4.01)	2.27 (1.68-3.07)	<.001	2.32 (1.71-3.15)	<.001
Other injury	210	1 226 439	0.6 (0.5-0.7)	32	181 775	1.07 (0.61-1.54)	1.92 (1.19-3.07)	.006	2.09 (1.28-3.40)	.003

Abbreviations: aOR, adjusted odds ratio; FBJI, fracture and bone or joint injury; OR, odds ratio.

[a] Binary survey logistic regression models were constructed with 1-year history of eczema as the independent variable and any injury causing limitation, FBJI causing limitation, or other injury causing limitation as the dependent variables. The ORs and aORs (95% CIs) were estimated. Multivariable logistic regression models were constructed that included age, sex, race/ethnicity, Hispanic origin, household income, highest level of household education, family structure, birthplace in the United States, and health insurance coverage. Refusal to answer a particular question or response of "don't know" occurred for the questions pertaining to eczema in 25, FBJI causing limitation in 45, other injury causing limitation in 45, any injury causing limitation in 0, fatigue in 20, daytime sleepiness in 14, insomnia in 9, current asthma in 37, hay fever in 25, respiratory allergies in 48, digestive allergies in 37, age in 0, sex in 0, race/ethnicity in 0, Hispanic origin in 0, household income in 1926, highest level of household education in 68, family structure in 4, birthplace in the United States in 10, and health insurance coverage in 112.

children, either a single parent or both parents living in the household compared with those without children, birthplace outside the United States, and lack of health insurance coverage.

Association Between Eczema and Injury

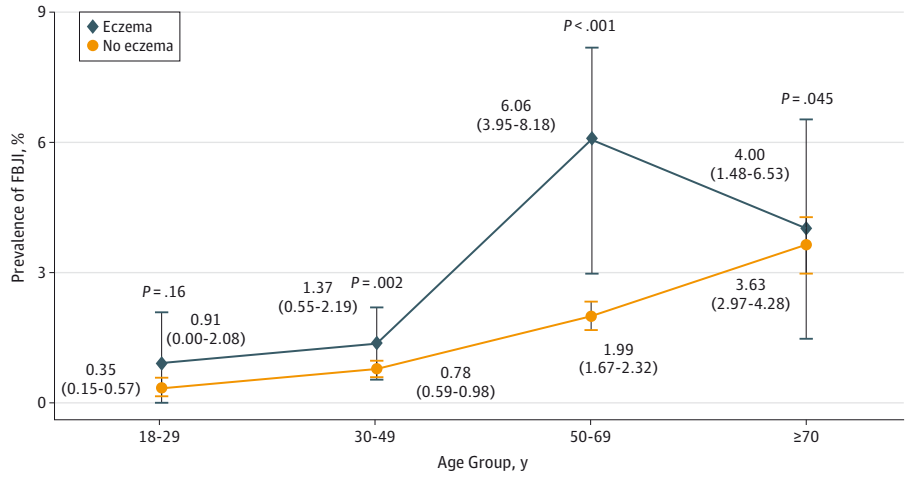
Adults with eczema had higher odds of any injury (odds ratio [OR], 1.99; 95% CI, 1.52-2.61; $P < .001$), including FBJI (OR, 2.27; 95% CI, 1.68-3.07; $P < .001$) and other injury (OR, 1.92; 95% CI, 1.19-3.07; $P = .006$) causing limitation, compared with adults without eczema. These associations remained significant in multivariable models that included age, sex, race/ethnicity, household income, family structure, highest level of household education, birthplace in the United States, and health insurance coverage (**Table 2**). In addition, the associations between eczema and any injury (OR, 1.67; 95% CI, 1.24-2.25; $P < .001$), FBJI (OR, 1.90; 95% CI, 1.36-2.65; $P < .001$), and other injury types (OR, 1.74; 95% CI, 1.05-2.88; $P = .03$) remained significant in multivariable models controlling for asthma, hay fever, and food allergies. In models controlling for psychiatric and behavioral disorders (PBDs), the associations remained significant for any injury (aOR, 1.44; 95% CI, 1.07-1.94; $P = .02$) and FBJI (aOR, 1.67; 95% CI, 1.21-2.33; $P = .002$).

Association Between Eczema and FBJI as Modified by Age

Because many injuries are age related, the prevalence of FBJI was examined separately for ages 18 to 29, 30 to 49, 50 to 69, and 70 years or older. Among adults without eczema, the prevalence of injuries increased gradually with age. However, among adults with eczema, the prevalence of injuries increased initially, peaked at ages 50 to 69 years, and then decreased substantially in the age group 70 years or older (**Figure**).

Significant 2-way interactions were observed between eczema and age as predictors of FBJI. Generalized linear models with binary distributions were constructed that tested pairwise differences of rows from the coefficient matrix for each level of interaction. This approach allowed comparison of the effects of eczema vs no eczema on FBJI at each individual age group. Eczema was associated with significantly higher odds of FBJI at ages 30 to 49 years (aOR, 2.25; 95% CI, 1.35-3.78; $P = .002$), 50 to 69 years (aOR, 2.29; 95% CI, 1.68-3.14; $P < .001$), and 70 years or older (aOR, 1.66; 95% CI, 1.01-2.73; $P = .045$) but not at ages 18 to 29 years (aOR, 2.14; 95% CI, 0.74-6.20; $P = .16$).

Figure. Prevalence of FBJI Causing Limitation as Modified by Age



The prevalence of fracture and bone or joint injury (FBJI) causing limitation was stratified into age groups. Multivariable generalized linear models were constructed with FBJI causing limitation as the dependent variable. The independent variables were 1-year history of eczema and age and a 2-way interaction between them. Included as covariates were age, sex, race/ethnicity, Hispanic origin, household income, highest level of household education, family structure, birthplace in the United States, and health insurance coverage. Data are given as percentage prevalences (95% CIs).

Table 3. Association Between Sleep Disturbance and FBJI Causing Limitation in 34 500 Adults as Modified by Eczema[a]

	No Sleep Disturbance		Sleep Disturbance					
			No Eczema		Eczema			
Variable	Frequency of Injury	% Prevalence (95% CI)	Frequency of Injury	% Prevalence (95% CI)	Frequency of Injury	% Prevalence (95% CI)	aOR (95% CI)	*P* Value
Fatigue	404	1.10 (0.95-1.24)	216	3.6 (3.0-4.2)	54	6.29 (4.02-8.56)	1.59 (1.16-2.19)	.004
Daytime sleepiness	460	1.23 (1.08-1.38)	165	3.3 (2.6-3.9)	47	5.93 (3.77-8.10)	1.81 (1.28-2.55)	.001
Insomnia	372	1.07 (0.93-1.22)	246	3.1 (2.6-3.6)	56	6.04 (3.94-8.14)	1.74 (1.28-2.37)	<.001

Abbreviations: aOR, adjusted odds ratio; FBJI, fracture and bone or joint injury.

[a] Generalized linear models were constructed with any injury causing limitation, FBJI causing limitation, or other injury causing limitation as the dependent variables. The independent variables were sleep disturbance (fatigue, daytime sleepiness, or insomnia) and 1-year history of eczema and an interaction term between them. The aORs (95% CIs) were estimated. Multivariable logistic regression models were constructed that included age, sex, race/ethnicity, Hispanic origin, household income, highest level of household education, family structure, birthplace in the United States, and health insurance coverage. Refusal to answer a particular question or response of "don't know" occurred for the questions pertaining to eczema in 25, FBJI causing limitation in 45, other injury causing limitation in 45, any injury causing limitation in 0, fatigue in 20, daytime sleepiness in 14, insomnia in 9, current asthma in 37, hay fever in 25, respiratory allergies in 48, digestive allergies in 37, age in 0, sex in 0, race/ethnicity in 0, Hispanic origin in 0, household income in 1926, highest level of household education in 68, family structure in 4, birthplace in the United States in 10, and health insurance coverage in 112.

Associations Among Eczema, Fatigue, Sleep Disturbance, and Injury

In univariate models, eczema (OR, 1.99; 95% CI, 1.52-2.61), fatigue (OR, 4.19; 95% CI, 3.49-5.03), daytime sleepiness (OR, 3.41; 95% CI, 2.80-4.15), and insomnia (OR, 3.74; 95% CI, 3.12-4.49) ($P < .001$ for all) were significant predictors of any injury. However, significant 2-way interactions were observed between eczema and fatigue or sleep symptoms as predictors of FBJI. In models of interaction between eczema and fatigue, eczema alone was associated with FBJI (OR, 1.29; 95% CI, 1.12-1.50; $P < .001$), whereas fatigue without eczema was associated with higher odds of FBJI (OR, 1.93; 95% CI, 1.67-2.24; $P < .001$); those with both eczema and fatigue had higher odds of FBJI (OR, 2.61; 95% CI, 1.91-3.55; $P < .001$). Similar interactions were found between eczema and daytime sleepiness or insomnia. These interactions remained significant in multivariable models (eTable 1 in the Supplement).

Generalized linear models with binary distributions were constructed that allowed comparison of the effects of each sleep symptom with vs without eczema on FBJI. Adults with fatigue and eczema had higher odds of FBJI compared with those with fatigue alone (aOR, 1.59; 95% CI, 1.16-2.19; $P = .004$). Similarly, the odds of FBJI were higher in adults with eczema and daytime sleepiness or insomnia compared with those with daytime sleepiness or insomnia alone (**Table 3**).

Associations Among Eczema, PBDs, and Injury

In univariate models, eczema (OR, 1.99; 95% CI, 1.52-2.61) and at least 1 PBD (OR, 3.16; 95% CI, 2.63-3.79) ($P < .001$ for both) were significant predictors of any injury. In models of interaction among eczema and at least 1 PBD, eczema (OR, 1.27; 95% CI, 1.11-1.46; $P < .001$) and PBDs (OR, 1.72; 95% CI, 1.50-1.98; $P < .001$) alone were associated with any injury; those with both eczema and PBDs had higher odds of any injury (OR, 2.15; 95% CI, 1.63-2.84; $P < .001$). Similar interactions were found between eczema and PBDs when FBJI was the outcome. In contrast, eczema alone was not associated with other injury (OR, 1.13; 95% CI, 0.86-1.50; $P = .38$). Psychiatric and behavioral disorders with

Table 4. Lack of Association Between Eczema and Cause of Injury Among 1189 Adults[a]

	No Eczema		Eczema					
Cause of Injury	Frequency	% Prevalence (95% CI)	Frequency	% Prevalence (95% CI)	OR (95% CI)	*P* Value	aOR (95% CI)	*P* Value
Motor vehicle crash	67	6.4 (4.5-8.3)	14	11.1 (3.9-18.3)	1.82 (0.82-4.02)	.13	1.74 (0.77-3.95)	.18
Fall	433	37.8 (34.0-41.6)	55	32.9 (23.7-42.0)	0.80 (0.52-1.26)	.34	0.68 (0.41-1.12)	.13
Overexertion or strenuous movement	159	15.9 (13.0-18.9)	14	7.3 (2.9-11.6)	0.41 (0.21-0.82)	.01	0.47 (0.23-0.99)	.05
Struck by object or person	97	9.6 (7.1-12.0)	13	11.6 (4.0-19.2)	1.24 (0.56-2.74)	.60	1.23 (0.53-2.81)	.63
Animal or insect bite	35	3.5 (1.9-5.0)	6	5.4 (0.4-10.5)	1.59 (0.54-4.69)	.40	1.48 (0.54-4.10)	.45
Cut or pierce	80	8.1 (5.9-10.3)	6	4.23 (0.4-8.0)	0.50 (0.19-1.34)	.16	0.51 (0.18-1.45)	.20

Abbreviations: aOR, adjusted odds ratio; OR, odds ratio.

[a] Binary survey logistic regression models were constructed with 1-year history of eczema as the independent variable and motor vehicle crash, fall, overexertion or strenuous movement, struck by object or person, animal or insect bite, and cut or pierce as the dependent variables. The ORs and aORs (95% CIs) were estimated. Multivariable logistic regression models were constructed that included age, sex, race/ethnicity, Hispanic origin, household income, highest level of household education, family structure, birthplace in the United States, and health insurance coverage. Refusal to answer a particular question or response of "don't know" occurred for the questions pertaining to eczema in 0 and cause of injury in 28.

eczema (OR, 2.88; 95% CI, 1.84-4.52) and without eczema (OR, 2.40; 95% CI, 1.81-3.17) ($P < .001$ for both) were associated with other injury. These interactions remained significant in multivariable models (eTable 2 in the Supplement). Of note, in multivariable models, adults with both eczema and PBDs (aOR, 2.15; 95% CI, 1.57-2.93; $P < .001$) had higher rates of FBJI compared with those with eczema (aOR, 1.39; 95% CI, 1.19-1.61; $P < .001$) or PBDs (aOR, 1.58; 95% CI, 1.36-1.83; $P < .001$) alone.

Association Between Other Skin Problems and Injury

Because associations with injury may be present in other skin diseases and not specific to eczema, we tested the association between other skin problems and injury. Other skin problems were not associated with any injury (OR, 1.37; 95% CI, 0.96-1.93; $P = .08$), FBJI (OR, 1.29; 95% CI, 0.91-1.83; $P = .15$), or other injury (OR, 1.74; 95% CI, 0.87-3.49; $P = .12$) in multivariable models.

Association Between Eczema and Cause of Injury

We examined the association between eczema and various causes of injury as determined by a separate questionnaire focusing on medically attended injuries in the past 3 months. In multivariable models, eczema was not significantly associated with specific causes of injury (**Table 4**).

Discussion

Using a US population-based cohort, we demonstrated higher prevalences of FBJI and other types of injury causing limitation among adults with eczema. These associations remained significant after controlling for the effects of comorbid atopic disease and PBDs, suggesting a specific association between adult eczema and an increased risk of injury. Eczema was associated with higher odds of FBJI for all individuals 30 years or older, with the largest effect at ages 50 to 69 years. Significant interactions were observed between eczema and fatigue or sleep symptoms, such that adults with eczema had an increased risk of injury above and beyond the presence of concurrent sleep disturbance or fatigue. In addition, adults with both eczema and fatigue or sleep symptoms had higher rates of FBJI compared with those with eczema or fatigue or sleep symptoms alone. Similarly, adults with both eczema and PBDs had higher rates of FBJI compared with those with eczema or PBDs alone. These interactions suggest that adults with more severe eczema accompanied by sleep and PBD comorbidities are at particularly higher odds of FBJI.

The results of this study are consistent with a recent study[6] from the National Survey of Children's Health among 27 556 individuals aged 0 to 5 years, which found that children with eczema, asthma, hay fever, and food allergies have a higher risk of injury requiring medical attention. Other studies have demonstrated an association between adult asthma and injury risk. A large population-based cohort study[23] of individuals with asthma aged 6 to 30 years demonstrated that adults in the cohort had increased odds of injury compared with those without asthma. A study[24] of the 2001 and 2004 Australian National Health Survey among 37 419 adults similarly found a higher prevalence of injury among adults with a history of asthma. However, our study is the first to our knowledge to demonstrate an increased risk of injury, particularly FBJI, in adults with eczema.

A 2009 study by Haeck et al[22] found that approximately one-third of adults with moderate to severe AD have low BMD as measured by dual-energy x-ray absorptiometry. Diseases characterized by chronic inflammatory states, including rheumatoid arthritis, systemic lupus erythematosus, and inflammatory bowel disease, are associated with bone loss and skeletal remodeling.[20,21] It is possible that the chronic inflammation in adult eczema similarly predisposes to bone loss and increased fracture risk, especially given that eczema cases persisting into adulthood are more likely to be severe. In addition, chronic systemic (and perhaps topical) corticosteroid use may contribute to impaired BMD and increased fracture risk.

Unfortunately, we were unable to examine the effects of corticosteroid use because it was not assessed in the National Health Interview Survey. Although systemic corticosteroid use is widely accepted as a risk factor for bone fractures, the effects of topical corticosteroids on bone mass are less clear. The results of 2 recent studies suggest that topical corticosteroid use has no effect on BMD of children[25] and adults[26] with moderate to severe AD, although low amounts of topical corticosteroids were used in both studies. Further studies are needed to clarify the effects of topical corticosteroid use on bone mass.

In addition, recent studies[27-31] have demonstrated an inverse relationship between serum vitamin D levels and AD. A study[27] of 15 212 Korean adults from the Korean National Health and Nutrition Examination Survey demonstrated significantly lower mean serum 25-hydroxyvitamin D levels in participants with AD compared with those without AD. It is likely that lower vitamin D levels in adults with AD contribute to low BMD and increased fracture risk. Future studies are needed to examine the association between vitamin D levels and fracture risk in adults with eczema, which may warrant the development of preventive measures in this high-risk group, such as routine calcium or vitamin D supplementation.

Atopic comorbidities, such as asthma, may further compound the increased risk of fracture in adults with eczema. Long-term corticosteroid therapy in individuals with asthma is associated with decreased bone density and an increased risk of rib and vertebral fracture.[32] Recent systematic reviews and meta-analyses of adult asthma demonstrated a slightly increased fracture risk associated with the use of high doses of inhaled corticosteroids.[33,34] We demonstrated an increased risk of FBJI after controlling for asthma, hay fever, and food allergies, suggesting that comorbid atopic disease does not fully account for the increased risk of fracture among adults with eczema.

In the present study, we demonstrated significant interactions among eczema, fatigue, and sleep symptoms, such that adults with both eczema and sleep disturbance had higher rates of FBJI than those with eczema or sleep disturbance alone. Furthermore, eczema conferred additional risk of FBJI compared with fatigue or sleep disturbance alone. Previous studies[7-11] demonstrated high rates of sleep disturbance in adults with eczema. In particular, eczema seems to result in lower sleep quality, decreased overall sleep efficiency, and increased daytime dysfunction.[7] Sleep deprivation leads to lapses in cognitive performance, motor function, working memory, and higher executive functions, and these neurocognitive deficits seem to accumulate over time in chronic sleep deprivation,[35] as may be experienced in adults with eczema. We found that sleep symptoms alone do not account for the increased risk of injury among adults with eczema; other factors, such as sedating antihistamine use or psychological comorbidity, likely have key roles.

We demonstrated significant interactions between eczema and psychological comorbidity, such that adults with eczema and PBDs had a higher risk of injury compared with those with eczema or PBDs alone. These data suggest that comorbid PBD modifies injury risk but does not completely account for the increased risk of fracture in adults with eczema. We recently found that the association between childhood allergic diseases (including eczema) and injury requiring medical attention was partially mediated by PBDs.[6] Psychiatric diseases in adults are characterized by prominent cognitive deficits, including impairments in attention, reaction times, short-term memory, and overall executive function,[36-38] all of which may predispose to injury.

The results of the present study demonstrated that the prevalence of FBJI among adults with eczema increases gradually with age, peaking at ages 50 to 69 years and decreasing thereafter. In comparison, the injury rate increased almost linearly with age in adults without eczema. Epidemiological studies[39-41] among general populations demonstrate that fracture risk increases steadily with age in female individuals and increases steadily after age 70 years in male individuals. This finding suggests that eczema may be particularly harmful for injury risk in middle age. Larger studies are needed to confirm these associations and more precisely identify risk factors.

The strengths of this study are several. These include that it is prospective, US population based, and large scale with a diverse sample controlling for multiple confounding demographic variables in multivariable models.

However, the study has potential limitations. The survey question for FBJI was broad, including multiple causes of injury. Furthermore, we were unable to measure the prevalence of all injuries because the survey question in the National Health Interview Survey assessed injuries causing limitations. Nevertheless, we find this survey question to be a meaningful measure, preferentially selecting for injuries that interfere with daily functioning and affect quality of life. Despite the large number of participants in this study, the sample sizes for specific causes of injury analyses were small. Therefore, the nonsignificant association between eczema and various causes of injury may be owing to decreased statistical power. Larger studies are needed to confirm the increased risk of fracture and other injury. Eczema history was assessed by self-report on the questionnaire using a broad question that assessed for eczema and skin allergy and was not verified by physical examination. While self-report of eczema has been previously validated and shown to have good correlation with clinical examination,[42,43] those investigations used different wording to assess for self-report of eczema and were conducted in different patient populations. We believe that the question used in the National Health Interview Survey is a reasonable proxy of eczema in adults because the population we have categorized as having eczema demonstrates a disease prevalence and comorbidity profile consistent with AD. This group of adults has a prevalence of eczema similar to that in another study[10] of the prevalence of AD in the United States using more strict criteria. Adults with a yes response to this question have a higher risk of asthma, food allergy, and hay fever consistent with AD. Finally, physicians in the United States, including dermatologists and allergists, often refer to eczema as a skin allergy; therefore, a diagnosis of skin allergy likely identifies adults with actual AD. The prevalence of the remaining conditions identified as a skin allergy most likely includes a predominance of irritant or allergic contact dermatitis. However, these disorders have significant overlap with AD, which makes it difficult to distinguish clinically and epidemiologically. Therefore, we do not believe this broad

question to be so problematic. Nevertheless, multicenter validation studies are under way to address this issue.

It is also unclear whether associations with injury are specific to eczema or, rather, secondary to the wide range of comorbidities associated with eczema[5,44] or chronic skin disease in general. However, we found that other skin disease was not associated with injury in this population. Further studies are needed to examine the specificity of these associations. Sleep disturbance was also measured by means of self-report. Previous studies[8,45] found strong correlation between self-report of fatigue and daytime sleepiness and objective measures of sleep disturbance (ie, actigraphy and polysomnography). Furthermore, self-reported measures of sleep disturbance have been the mainstay of epidemiological study of sleep in cardiovascular disease,[46,47] diabetes mellitus,[48] chronic kidney disease,[49] and other disorders. We were also unable to control for systemic or topical corticosteroid and sedating antihistamine use. Finally, the cross-sectional nature of the study does not allow for determination of causality of association between eczema and fracture risk. For instance, it is possible that fractures lead to increased exposure to cleansing agents and irritants, which predispose to eczema. Further longitudinal studies are under way to address these potential limitations and verify the associations between eczema and injury in adults.

Conclusions

In conclusion, adult eczema is associated with an increased risk of injury, particularly FBJI, which is only partially related to the presence of sleep symptoms and PBDs. Taken together, these data suggest that adult eczema is a previously unrecognized risk factor for fracture and other injury, emphasizing the importance of developing safer and more effective clinical interventions for itch and sleep problems in eczema, as well as preventive measures for injury risk reduction in eczema. Future studies providing better measures of fracture risk are needed to confirm these associations.

ARTICLE INFORMATION

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NOTABLE NOTES

Josef Jadassohn
A Dermatologic Pioneer

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Josef Jadassohn was a dermatologist who was world-renowned not only for his devoted work and numerous contributions but also for the legacy of his coworkers and followers.[1,2] Born into a Jewish family on September 10, 1863, in Liegnitz, Silesia (now Poland), Jadassohn attended medical school at Göttingen, Breslau, Heidelberg, and Leipzig. During medical school, Jadassohn became fascinated by how the pathogenesis of diseases could be revealed by studying functional pathology. After medical school, he was offered a dermatology residency position at the University of Breslau by Albert Neisser (for whom *Neisseria gonorrhea* is named). Although he was interested in pathology, Jadassohn believed that general pathological questions could be fruitfully studied in the field of dermatology and chose to accept the position.

After residency, Jadassohn joined the staff at the University of Breslau. He took a particular interest in tuberculosis and in cutaneous changes observed with systemic illness. He studied and classified dermatologic disorders based on their etiology rather than on the morphologic characteristics or anatomic presentation. In 1917, Jadassohn assumed the role of chair of dermatology at the University of Breslau.

Jadassohn's contributions to dermatology are vast. He is considered the father of the patch test and was the first to describe nevus sebaceous, pityriasis lichenoides chronica, granulosis rubra nasi, incontinentia pigmenti, blue nevi, pachyonychia congenita (Jadassohn-Lewandowsky syndrome), as well as the Borst-Jadassohn phenomenon. Throughout his career, he was an active member and cofounder of many dermatologic societies and was part of the editorial board of many journals, including the most important dermatologic journal at the time, *Archiv für Dermatologie und Syphilis*. One of his greatest endeavors was the *Handbook of Skin and Venereal Diseases*, the most comprehensive dermatology book of its time. In 1930, he resigned as chair of dermatology but continued to see patients and provide guidance with research.

The rise of Nazi Germany in 1933 triggered a dramatic life change for Jadassohn. He and his Jewish colleagues were forced to resign several medical duties. In 1934, Jadassohn emigrated to Zurich, Switzerland. Sadly, during the last years of his life, Jadassohn suffered from depression and in 1936 was diagnosed as having colon cancer. Jadassohn died on March 24, 1936, from complications related to abdominal surgery.

Jadassohn's impact on and contributions to the advancement of the field of dermatology are nothing less than astounding. Nearly 80 years after his death, Jadassohn's patch test is still used in practice today, and his accurate descriptions of many dermatologic diseases make it hard not to run across his name in most of today's dermatology textbooks.

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