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**Title:** Association of people with atopic dermatitis and household income among US adults in the 1999-2006 National Health and Nutrition Examination Survey

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**Conflicts of Interest:**

Dr. Wu is or has been an investigator, consultant, or speaker for AbbVie, Almirall, Amgen, Arcutis, Aristeia Therapeutics, Bausch Health, Boehringer Ingelheim, Bristol-Myers Squibb, Dermavant, DermTech, Dr. Reddy's Laboratories, Eli Lilly, EPI Health, Galderma, Janssen, LEO Pharma, Mindera, Novartis, Pfizer, Regeneron, Samsung Bioepis, Sanofi Genzyme, Solius, Sun Pharmaceutical, UCB, and Zerigo Health. Dr. Han is or has been an investigator, consultant/advisor, or speaker for AbbVie, Athenex, Boehringer Ingelheim, Bond Avillion, Bristol-Myers Squibb, Celgene Corporation, Dermavant, Eli Lilly, Janssen, LEO Pharma, MC2, Novartis, Ortho Dermatologics, PellePharm, Pfizer, Regeneron, Sanofi/Genzyme, SUN Pharmaceutical, and UCB. Authors Devjani, Vedula, Smith, and Collier have no conflicts of interest to declare.

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**Body of manuscript:**

Atopic dermatitis (AD) is a common inflammatory dermatological condition characterized by the presence of pruritic, erythematous lesions on the skin. Affecting between 7-11% of adults nationwide, AD inflicts uncomfortable, debilitating symptoms that significantly impact patients' quality of life [1]. As a result, direct costs from medical management as well as indirect costs from lost wages, productivity, and home care contribute to financial insecurity among AD patients [2]. Lost work productivity and wages may impact income, thus leaving patients in even worse financial positions to support themselves and their families. Nonetheless, the association between atopic dermatitis and household income has yet to be explored in a large U.S. adult population. We studied the relationship between atopic dermatitis and income in U.S. adults ages 18 and older using the 1999-2006 National Health and Nutrition Examination Survey (NHANES).

NHANES participants are randomly selected by a statistical process using U.S. Census information. There were 12,809 patients between the ages of 18 and 60 that answered survey questions that assessed atopic dermatitis status and household income. Statistical analysis and multivariate logistic regressions were performed using STATA/MP 17.0 to explore the relationship between atopic dermatitis and household income as well as sociodemographic characteristics of adult atopic dermatitis patients with a household income of  $< \$45,000$ . This income level of  $\$45,000$  was chosen as it most closely resembles the median income of U.S. households from 1999-2006 [3]. We controlled for age, race, education, sex, marital status, U.S. citizenship status, health insurance, and tobacco usage in our models.

There were 1,343 survey participants who endorsed having atopic dermatitis, 731 with an income of  $\geq \$45,000$  and 612 with an income of  $< \$45,000$ . The association between variables atopic dermatitis and income was statistically significant ( $p=0.05$ ), however the significance was lost ( $p=0.55$ ) when controlling for other factors. Age, race, education, health insurance, marital status, and smoking status were significantly associated with household income amongst those with atopic dermatitis. Atopic dermatitis patients with  $< \$45,000$  annual household income were more likely to be younger in age, non-white, unmarried, uninsured, and smokers. These patients were also less likely to be educated (Table

1). Within the atopic dermatitis population, the odds of having income less than \$45,000 was nearly 2 times higher amongst Black (AOR 2.29, p=0.000) and Hispanic (AOR 2.46, p=0.000) patients compared to White patients. Smokers with atopic dermatitis had significantly higher odds of having lower income than non-smokers (AOR 1.46, p=0.011). Alternatively, married individuals (AOR 0.43, p=0.000) and insured patients (AOR 0.34, p=0.000) with atopic dermatitis had lower odds of having lower income (Table 2). These findings are relatively consistent with those who do not have atopic dermatitis.

Our study has limitations, such as lack of temporality, sample size, and subjective interpretation of questions, similar to other survey-based studies. Nonetheless, our results indicate that within AD, lower-than-median household incomes are disproportionately represented within certain socio-demographic populations. Evaluating indirect and direct costs may be important in further understanding these inequalities. While some of these imbalances hold true amongst patients with other health conditions, it is nonetheless important to note these risk factors when considering the increased availability of novel treatments for AD. Considering and addressing these inequities are important as we formulate holistic plans of care for our patients.

## References:

1. *Eczema Stats*. National Eczema Association. (2022, September 27). Retrieved November 8, 2022
2. Smith Begolka W, Chovatiya R, Thibau IJ, Silverberg JI. Financial Burden of Atopic Dermatitis Out-of-Pocket Health Care Expenses in the United States. *Dermatitis*. 2021 Oct 1;32(1S):S62-S70. doi: 10.1097/DER.0000000000000715. PMID: 33323748; PMCID: PMC8560145.
3. *Digest of Education Statistics, 2010*. National Center for Education Statistics (NCES) Home Page, a part of the U.S. Department of Education. (n.d.).

**Table 1.** “Characteristics of U.S. adults with AD with income <45K and income ≥45K in NHANES 1999-2006”

Characteristic	Weighted %* (95% CI)	Weighted %* (95% CI)	P-value
<b>Outcome variables</b>	<b>Income &lt; 45K</b>	<b>Income ≥ 45K</b>	
<b>Age</b>			<b>0.0108</b>
18-30	47.55 (40.68-54.52)	52.45 (45.48-59.32)	
31-40	41.79 (36.11-47.69)	58.21 (60.75-72.58)	
41-50	33.07 (27.42-39.25)	66.93 (90.75-72.58)	
≥50	40.42 (34.30-46.85)	59.58 (53.15-65.70)	
<b>Race/Ethnicity<math>\Delta</math></b>			<b>0.0000</b>
Non-Hispanic White	35.75 (32.01-39.67)	64.25 (60.33-67.99)	
Non-Hispanic Black	57.10 (46.66-66.94)	39.57 (31.93-47.75)	
Hispanic	60.43 (52.25-68.07)	42.90 (33.06-53.34)	
<b>Sex</b>			0.9938
Female	40.28 (36.27-44.43)	59.72 (55.57-63.73)	
Male	40.26 (35.66-45.03)	59.74 (54.97-64.34)	
<b>Education</b>			<b>0.0000</b>
Some high school	69.26 (59.52-77.54)	30.74 (22.46-40.48)	
Highschool graduate	50.21 (44.05-56.36)	49.79 (43.64-55.95)	
Some college	43.57 (37.64-49.69)	56.43 (50.31-62.36)	
College graduate	17.75 (14.08-22.14)	82.25 (77.86-85.92)	
<b>Insurance<math>\dagger</math></b>			<b>0.0000</b>

No	67.91 (60.76-74.32)	32.09 (25.68-39.24)	
Yes	35.37 (31.89-39.02)	64.63 (60.98-68.11)	
<b>Married?</b>			<b>0.0000</b>
No	54.24 (48.71-59.66)	45.76 (40.34-51.29)	
Yes	29.52 (25.01-34.46)	70.48 (64.54-74.99)	
<b>U.S. Citizen?</b>			0.1330
No	48.54 (37.01-60.23)	51.46 (39.77-62.99)	
Yes	39.68 (36.10-43.37)	60.32 (56.63-63.90)	
<b>Tobacco use?<sup>§</sup></b>			<b>0.0002</b>
No	34.02 (29.95-38.34)	65.98 (61.66-70.05)	
Yes	45.17 (40.40-50.03)	54.83 (49.97-59.60)	

Values that are statistically significant (two-side P-value  $\leq .05$ ) are in bold.

\* Weighted percentage was calculated using NHANES survey design parameters

Δ Ethnicity was determined by patients self-identifying as Hispanic or Non-Hispanic. Race was also determined by patients self-identifying.

† Insurance status was assessed by the question “Are you covered by health insurance or some other kind of health care plan?”

§ Tobacco use was assessed by the question “Have you smoked at least 100 cigarettes in your entire life?”

**Table II.** “Multivariate logistic regression of household income amongst U.S. adults with vs. without AD<sup>††</sup>”

Outcome Variables	Household income <\$45,000 No AD (Adjusted Odds Ratio) ††	p-value	Household income < \$45,000 AD (Adjusted Odds Ratio) ††	p-value
Age				
18-30	1.00 (Reference)		1.00 (Reference)	
31-40	0.84 (0.69-1.00)	0.057	1.12 (0.73-1.7)	0.649
41-50	<b>0.75 (0.61-0.91)</b>	<b>0.004</b>	0.83 (0.53-1.29)	0.397
>50	<b>1.64 (1.36-1.98)</b>	<b>0.000</b>	1.24 (0.83-1.89)	0.294

<b>Race/Ethnicity</b>				
Non-Hispanic White	1.00 (Reference)		1.00 (Reference)	
Non-Hispanic Black	<b>2.29 (1.82-2.89)</b>	<b>0.000</b>	<b>2.44 (1.64-3.63)</b>	<b>0.000</b>
Hispanic	<b>2.46 (1.99-3.04)</b>	<b>0.000</b>	<b>2.03 (1.17-3.53)</b>	<b>0.013</b>
<b>Sex</b>				
Female	1.00 (Reference)		1.00 (Reference)	
Male	<b>0.70 (0.65-0.77)</b>	<b>0.000</b>	0.87 (0.68-1.09)	0.219
<b>Education</b>				
Some high school	1.00 (Reference)		1.00 (Reference)	
High school graduate	<b>0.56 (0.45-0.71)</b>	<b>0.000</b>	0.64 (0.33-1.21)	0.167
Some college	<b>0.42 (0.34-0.51)</b>	<b>0.000</b>	0.50 (0.24-1.03)	0.061
College graduate	<b>0.19 (0.15-0.23)</b>	<b>0.000</b>	<b>0.18 (0.09-0.37)</b>	<b>0.000</b>
<b>Insurance†</b>				
No	1.00 (Reference)		1.00 (Reference)	
Yes	<b>0.34 (0.28-0.40)</b>	<b>0.000</b>	<b>0.30 (0.20-0.44)</b>	<b>0.034</b>
<b>Marriage Status</b>				
No	1.00 (Reference)		1.00 (Reference)	
Yes	<b>0.41 (0.36-0.46)</b>	<b>0.000</b>	<b>0.44 (0.31-0.61)</b>	<b>0.000</b>
<b>Citizenship Status</b>				
No	1.00 (Reference)		1.00 (Reference)	
Yes	<b>0.65 (0.51-0.83)</b>	<b>0.001</b>	0.82 (0.37-1.79)	0.612
<b>Tobacco use<sup>§</sup></b>				

No	1.00 (Reference)		1.00 (Reference)	
Yes	<b>1.44 (1.31-1.59)</b>	<b>0.000</b>	<b>1.67 (1.33-2.10)</b>	<b>0.000</b>

Values that are statistically significant (two-side P-value  $\leq .05$ ) are in bold.

†† Atopic dermatitis status was assessed by the question “During the past 12 months, have you had dermatitis, eczema, or any other type of red, inflamed skin rash?”

Δ Ethnicity was determined by patients self-identifying as Hispanic or Non-Hispanic. Race was also determined by patients self-identifying.

† Insurance status was assessed by the question “Are you covered by health insurance or some other kind of health care plan?”

§ Tobacco use was assessed by the question “Have you smoked at least 100 cigarettes in your entire life?”