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Racial/Ethnic Variation in Use of Ambulatory and Emergency Care for Atopic Dermatitis Among U.S. Children

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Abbreviations: AD, atopic dermatitis; CI, confidence interval; GEE, generalized estimating equation; IQR, interquartile range; OR, odds ratio; PEER, Pediatric Eczema Elective Registry; UIC, urban influence code

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ABSTRACT

Previous studies indicate racial/ethnic differences in healthcare utilization for pediatric atopic dermatitis (AD) but do not account for disease severity impact. We sought to examine the relationship between race/ethnicity and healthcare utilization, both overall and by specific visit type, while accounting for AD control. A longitudinal cohort study of children with AD in the U.S. was performed to evaluate the association between race/ethnicity and healthcare utilization for AD. AD control and healthcare utilization were assessed biannually. Our study included 7,522 children (34.2% white, 54.2% black, 11.5% Hispanic) who were followed for a median of 4 (IQR 0.9-8.4) years. After adjusting for sociodemographic and other factors, black and Hispanic children were up to nearly 3-fold more likely than white children to receive medical care for AD across almost all levels of AD control. Black and Hispanic children had higher odds of primary care and emergency visits compared to whites. Black children with poorly controlled AD were significantly less likely to see a dermatologist than white children with similarly poorly controlled AD (OR 0.74, 95% CI 0.64-0.85 for limited control; OR 0.59, 95% CI 0.47-0.76 for uncontrolled AD). Together, these findings suggest the presence of racial/ethnic disparities in healthcare utilization for AD.

INTRODUCTION

Atopic dermatitis (AD) is a chronic inflammatory skin disease that affects up to 30% of children (Odhiambo et al., 2009) and is associated with significant medical, quality of life, and financial burdens (Drucker et al., 2017, Silverberg and Simpson, 2013). In the United States, AD is more common among black than white and Hispanic children (Kim et al., 2018, Prevention, Shaw et al., 2011). AD may also be more severe and persistent among racial/ethnic minority children (Kim et al., 2018, Silverberg and Simpson, 2014). Relatively little is known about healthcare utilization patterns for AD, both overall and by race/ethnicity, and their relation to disease severity. Some data suggest that there may be racial/ethnic disparities in healthcare for AD whereby black children in the U.S. are less likely than white children to receive medical care for their skin disease (Fischer et al., 2017). However, among those accessing care, minority children had more ambulatory visits for their AD (Fischer et al., 2017), which has also been suggested in other work (Horii et al., 2007, Janumpally et al., 2002). These latter findings may be an indicator of more severe AD among racial/ethnic minority children, but prior studies have been unable to directly evaluate the effect of AD disease severity on healthcare utilization. Furthermore, children with AD seek care in a variety of medical settings, including primary care, specialties such as dermatology or allergy, and the emergency room; however, their patterns of healthcare utilization across different provider or care settings remain uncertain. Given the relative paucity of studies that have evaluated healthcare utilization for AD, especially across racial/ethnic groups, the purpose of our study was to further elucidate the relationship between race/ethnicity and healthcare utilization, both overall and by specific visit type, for AD among U.S. children while accounting for disease control. We hypothesized that racial/ethnic minorities would have different patterns of healthcare utilization than whites, independent of AD disease control.

RESULTS

Our study included 7,522 subjects of whom 2,576 (34.2%) were white, 4,078 (54.2%) were black, and 868 (11.5%) were Hispanic. The median duration of follow-up across all subjects was 4 (IQR 0.9-8.4) years. Baseline characteristics of the subjects are presented in Table 1. The median age at registry enrollment was approximately six years and similar across all three race/ethnicity groups, though small differences were found to be statistically significantly different. The proportion of males was higher among whites than among blacks and Hispanics (51.3% versus 43.7% and 45.9%, $p < 0.001$). Median age of AD onset was similar across all groups; however, AD duration was slightly longer among whites. Annual household income was significantly different across racial/ethnic groups with a greater proportion of black and Hispanic individuals reporting household incomes below \$25,000 and a greater proportion of whites being in the highest income category of \$100,000 or more ($p < 0.001$). All geographic regions of the U.S. were represented in the cohort (Figure 1); however, the South and Midwest were relatively over-represented compared to the Northeast and West. There were greater proportions of whites in the Midwest, blacks in the South, and Hispanics in the West. The median urban influence code (UIC) value was 1 or 2 in all three groups, indicating large and small metropolitan living environments, respectively. There were also significant differences in baseline AD disease control across the groups with fewer whites reporting uncontrolled disease relative to blacks and Hispanics (7.8% versus 10.3% and 11.9%, $p < 0.001$). A greater proportion of whites reported having asthma (51.5% versus 44.6% and 37.5%, $p < 0.001$) and seasonal allergies (72.3% versus 58.1% and 52.1%, $p < 0.001$) than blacks and Hispanics, respectively.

Over the course of follow-up, the proportion of subjects reporting at least one healthcare provider visit in the prior 6 months generally declined over time among all three groups (Figure 2). Compared to whites, a greater proportion of black and Hispanic subjects reported at least 1 visit to any provider or a primary care provider over time.

In multivariable analyses, we found significant evidence of effect modification by AD disease control; adjusted ORs measuring the association between race/ethnicity and healthcare utilization for AD were therefore stratified by level of disease control (Figures 3 and 4). For the primary outcome, both black and Hispanic subjects had significantly higher odds of seeing any healthcare professional compared to white subjects across all levels of disease control with the exception of the uncontrolled disease group among Hispanics (Figure 3). The strength of the association between race/ethnicity and healthcare utilization for AD was attenuated with poorer disease control. Among black subjects, the OR for any healthcare provider visit was greatest among those with complete disease control (OR 2.72, 95% CI 2.28-3.25) and smallest among those with uncontrolled disease (OR 1.47, 95% CI 1.06-2.04). A similar pattern was observed among Hispanic subjects whereby the OR among those with complete disease control was estimated at 2.87 (95% CI 2.17-3.80) and was lowest among those with uncontrolled disease (OR 1.30, 95% CI 0.74-2.26).

In adjusted analyses examining specific types of healthcare visits, both black and Hispanic subjects had higher odds of primary care and emergency room visits compared to whites across all levels of disease control, though not statistically significant in most cases among those with uncontrolled disease (Figure 4). These associations were strongest among those with complete

disease control and decreased with poorer disease control, similar to what was observed for the primary outcome. The patterns for dermatology visits were different. Among those with complete disease control, both black and Hispanic subjects were more likely than whites to have seen a dermatologist (OR 1.77, 95% CI 1.34-2.34 and OR 3.15, 95% CI 2.15-4.62, respectively). Among those with good disease control, only Hispanic subjects remained more likely to have seen a dermatologist than whites (OR 1.58, 95% CI 1.29-2.88), whereas black subjects were equally as likely to have seen a dermatologist as whites (OR 0.90, 95% CI 0.78-1.04). Of note, among those with either limited control of their AD or uncontrolled AD, black subjects were significantly less likely than whites to have seen a dermatologist (OR 0.74, 95% CI 0.64-0.85 and OR 0.59, 95% CI 0.47-0.76, respectively) while there were no statistically significant differences in the odds of Hispanic subjects seeing a dermatologist compared to whites (OR 1.18, 95% CI 0.96-1.47 and OR 0.99, 95% CI 0.69-1.42, respectively). Regarding other medical providers, blacks were less likely to have seen any other types of health professionals than whites across all levels of disease control. Hispanics also had lower odds of having seen other medical providers than whites but the association was only statistically significant among those with limited disease control.

The ORs for other covariates from the multivariable regression models are shown in Table 2. Of note, males had lower odds of any healthcare visit, primary care visit, and dermatology visit. Relative to subjects in the lowest income category, those in the higher income groups were less likely to have visited any healthcare professional, particularly primary care. Subjects in the higher income groups were also less likely to have had an emergency room visit but increasingly more likely to have seen a dermatologist. Having asthma was associated with greater odds of an

emergency room visit and visit with other healthcare providers. Having seasonal allergies was associated with greater odds of all healthcare visits types except for emergency room visits. A sensitivity analysis additionally adjusting for geography using region of residence in addition to UIC, the latter of which was used in the primary analysis, did not alter the primary findings (data not shown).

We evaluated the proportion of missing survey responses and found the distribution to be similar across all race/ethnicity groups (Figure S1), consistent with the idea that missingness is independent of race/ethnicity. Additionally, the baseline characteristics of subjects with $\leq 50\%$ of their scheduled surveys missing compared to those with $>50\%$ missing surveys were similar (Table S1).

DISCUSSION

In this study of a large, diverse longitudinal cohort of children with AD and access to health care, we found important differences in healthcare utilization patterns for AD by race/ethnicity and disease control. On average, compared to white children, black and Hispanic children were up to nearly three times more likely to have had any medical visits for AD across almost all levels of disease control with the most striking differences observed among those with better disease control. In particular, black and Hispanic children were more likely than white children to have seen a primary care provider or visited the emergency room for their AD. Black children with complete disease control and Hispanic children with complete and good disease control were also more likely than white children to have seen a dermatologist for their AD. In contrast, among those with poorly controlled AD (i.e., limited control or uncontrolled), black children

were less likely than white children to have seen a dermatologist. Importantly, these racial/ethnic differences in healthcare utilization persisted after controlling for sociodemographic factors, AD history, and atopic comorbidities. Together, our results suggest that previously described racial/ethnic disparities in AD healthcare utilization are not fully explained by differences in AD severity across racial/ethnic groups; after stratifying by AD disease control, we still observed significant racial/ethnic differences in healthcare visits for AD.

To our knowledge, our study is the first to evaluate healthcare utilization for AD in children while simultaneously accounting for AD control and is, thus, an important addition to the limited existing literature on this topic. To date, only a few studies have assessed racial/ethnic differences in healthcare utilization for AD. In recent work, Fischer et al. found that black children with AD in the U.S. were less likely than white children to have had at least one outpatient visit for AD (Fischer et al., 2017). However, among those accessing medical care, black children had greater healthcare utilization, a pattern also observed in our current study, which was thought to be an indicator of more severe AD. Older studies using data from the National Ambulatory Medical Care Survey and National Hospital Ambulatory Care Survey also found that blacks and Hispanics were more likely than whites to receive care for AD despite lower healthcare utilization overall (Horii et al., 2007, Janumpally et al., 2002). However, a major limitation of these previous studies is the lack of information on AD severity and an inability to account for disease severity effects on healthcare utilization. In our current study, we leveraged PEER data to address this limitation and found that for any given level of disease control, black and Hispanic children were still more likely to visit a healthcare provider for their AD. Furthermore, unlike most previous studies, we examined patterns for specific visit types and

found differences in the utilization of primary care providers, dermatologists, and the emergency room that suggest the presence of racial/ethnic disparities in AD care. Consistent with our findings, a recent U.S. survey study also found that black and Hispanic adults with AD were more likely to report emergency or urgent care visits for AD compared to whites (Silverberg et al., 2019); however, the effect of disease severity on emergency or urgent care visits was not evaluated, and examination of other medical visit types by race/ethnicity was not performed.

As we were unable to determine the precise temporal relationship between AD control and healthcare visits in our study, the interpretation of our findings is complex. AD severity is likely an important driver of healthcare utilization but healthcare utilization also impacts the level of AD control. For children who had complete or good control of their AD, one interpretation of our data could be that black and Hispanic children are more likely than white children to visit a medical provider because their skin disease is well-controlled. As this is an unlikely scenario, we favor an alternative interpretation that black and Hispanic children are more likely than white children to require medical visits for their AD in order to achieve complete or good control of their skin. With regards to specific visit types, our data also suggest that black and Hispanic children are more likely than white children to visit a dermatologist or emergency room in order to maintain complete AD control. Our observations could, in part, be related to possible inherent biological differences in AD activity or therapeutic response across racial/ethnic groups. It has been suggested that AD may be more severe among minority children (Silverberg and Simpson, 2014), hence they may require more medical care to achieve adequate disease control. It is also possible that differential access to healthcare providers and treatment across racial/ethnic groups,

as has been observed for other diseases (Melfi et al., 2000, Melia et al., 2011), may partly drive the different healthcare utilization patterns observed.

Among children with limited AD control or uncontrolled AD, black and Hispanic children remained more likely than white children to have had any medical visits, specifically primary care and emergency room visits. However, the relative differences between the racial/ethnic groups were substantially attenuated compared to children with complete or good disease control. Collectively, these data indicate that, at least for primary and emergency care, differences in healthcare utilization among racial/ethnic groups are smaller when AD is poorly controlled. This was also observed for dermatology visits among Hispanic versus white children. Yet, black children with poor AD control were 25-40% less likely than white children with similarly poorly controlled AD to have seen a dermatologist for their skin disease, suggesting a disparity in specialist care for AD where it would seem most needed.

The reasons for these observed differences in healthcare utilization patterns for AD by race/ethnicity are unclear and could be due to various factors including differential access to primary, emergency, and specialty care as well as different preferences for specific types of medical care. While we tried to minimize the impact of medical access-related factors on healthcare utilization by controlling for household income and rurality of residence, additional confounding by insurance status, for example, may still exist. Although preferences for specific types of medical care have not been directly studied in the setting of dermatologic care, one qualitative study of patients of low socioeconomic status identified greater accessibility, lower cost, and perceptions of higher quality care as reasons for such patients to prefer and use acute

hospital over primary care (Kangovi et al., 2013). Further research will be important in exploring reasons for existing racial differences and potential disparities in healthcare utilization for AD. Nevertheless, our findings emphasize the need to optimize healthcare utilization for minority children with AD, which should include ensuring access to high-quality and routine primary care, appropriate referral to dermatology, and judicious use of emergency care, the financial burden of which has been estimated to be increasing (Kwa and Silverberg, 2018), for this chronic disease. Our findings that minority children are more likely to seek primary and emergency room care for AD also suggest the importance of directing future interventions to reduce disparities in AD care at these points of contact with the healthcare system.

There are additional limitations to consider in our study. First, the PEER data are based on self-report, introducing the potential for recall and misclassification biases. While differential reporting of outcomes or disease control by race/ethnicity could also potentially confound our results, the missingness of data did not vary by race/ethnicity, suggesting that this is unlikely. Second, it is possible that unmeasured variables such as insurance status may serve as confounders for the estimated associations. Third, the small numbers of subjects in other racial/ethnic groups precluded us from including them in this study. Fourth, as subjects were initially enrolled in PEER through a physician's office, the population in PEER may not be generalizable to children who are not accessing healthcare for their AD. Generalizability may also be limited by the requirement for subjects to have used topical pimecrolimus prior to registry enrollment. Topical pimecrolimus is a commonly used treatment for mild-to-moderate AD, and PEER likely represents a population whose AD was severe enough at enrollment to require topical therapy. Our findings may also not be generalizable to non-U.S. or adult

populations. Nevertheless, PEER is one of the largest and longest longitudinal cohorts of children with AD in the U.S. and provides a rich source of data on healthcare utilization for individual children over time.

CONCLUSION

Compared to whites, black and Hispanic children in the U.S. are, on average, more likely to have a medical visit for AD, across nearly all levels of AD control and independent of other sociodemographic factors and atopic comorbidities. Our data suggest the presence of racial/ethnic disparities in healthcare utilization for AD including greater utilization of the emergency room among black and Hispanic versus white children across almost all levels of disease control and underutilization of dermatologists specifically among black children with poor AD control. Future work will be needed to understand the factors driving these differences in healthcare utilization and to design interventions to eliminate these suggested disparities in AD care for children.

MATERIALS AND METHODS

Study design and data source

We conducted a cohort study using data from the Pediatric Eczema Elective Registry (PEER), an ongoing longitudinal prospective cohort of children with AD. PEER was primarily created for a post-marketing safety evaluation of the risk of malignancy associated with pimecrolimus cream, a common topical calcineurin inhibitor for the treatment of AD (Margolis et al., 2015). At the time of enrollment, all subjects in PEER were 2 to 17 years old, had a physician-confirmed

diagnosis of AD, and had used pimecrolimus cream for at least 6 weeks. Subjects were not required to continue pimecrolimus treatment to remain in the cohort, and most did not (Kapoor et al., 2009). Subjects completed a baseline questionnaire at enrollment that collected information on basic demographics including race, ethnicity, and socioeconomic status. At baseline and every six months thereafter, subjects were also surveyed about their AD disease control in the preceding 6-month period, measured as complete control, good control, limited control, or uncontrolled. Subjects also reported treatment use and visits to a pediatrician, family physician, dermatologist, emergency room, nurse, or other medical professional specifically for AD in the preceding six months. Subjects in the PEER registry are followed for up to 10 years for a total of up to 21 surveys. Informed written consent was obtained from each study participant. The present study was granted exempt status by the University of Pennsylvania Institutional Review Board.

Study population

We included subjects who were enrolled between November 2004 and September 2017 and who self-reported race/ethnicity as non-Hispanic white (hereafter referred to as white), non-Hispanic black (hereafter referred to as black), or Hispanic. Other racial groups were excluded due to small numbers.

Definitions of exposure and covariates

Race/ethnicity was the primary explanatory variable or exposure, categorized as white (reference), black, and Hispanic. Current age, age of AD onset, gender, duration of AD, annual household income, zip code of residence, and the presence of asthma and seasonal allergies were

determined at enrollment. Zip codes were used to assign a UIC to each subject's county of residence. UIC is a measure of rurality that has been used in health services research and ranges from one (most urban) to 12 (most rural) (Baer et al., 1997, Hall et al., 2006). Information on AD disease control was obtained from baseline and biannual surveys. In previous analyses of PEER data, self-reported AD disease control has demonstrated substantial to moderate agreement with the Patient-Oriented Eczema Measure (POEM), a core patient-reported outcome measure used in AD research (Chang et al., 2017).

Definitions of outcomes

The primary outcome was healthcare utilization for AD defined by at least one visit to a healthcare provider (pediatrician, family physician, dermatologist, emergency department, nurse, or other healthcare provider) in the preceding six months specifically for AD. We also examined visits to specific healthcare providers as follows: primary care (pediatrician, family physician, or nurse), dermatology, emergency room, and other healthcare provider.

Statistical analysis

Comparisons of baseline characteristics between race/ethnicity categories were evaluated using ANOVA F-tests for continuous variables and χ^2 test for categorical variables. To assess the association between race/ethnicity and healthcare utilization for AD, we used binary-outcome (logistic) generalized estimating equations (GEEs) with a working independence correlation structure to estimate covariate-adjusted odds ratios (OR) while accounting for repeated healthcare utilization measures for each subject. Separate analyses were performed for the primary outcome and each of the four secondary outcomes. In each analysis, we adjusted for

time-stable covariates of gender, age at AD onset, annual household income, UIC, and atopic comorbidities (asthma and seasonal allergies); and the time-varying covariates of AD duration and disease control. We also tested for an interaction between race/ethnicity and AD disease control. A sensitivity analysis additionally adjusting for geographic region was also performed. Since the GEE method requires the assumption that missingness in the outcome occurs completely at random, we examined missing data patterns to determine if there was any clear evidence that this assumption was violated (Table S1, Figure S1). Analyses were conducted using R 3.4 (R Foundation), SAS 9.4 (SAS Institute Inc), and Stata 15.1 (StataCorp).

DATA AVAILABILITY STATEMENT

The dataset related to this article cannot be publicly shared as it is part of an ongoing FDA-mandated post-marketing study.

CONFLICTS OF INTEREST STATEMENT

Dr. Takeshita receives a research grant from Pfizer Inc. (to the Trustees of the University of Pennsylvania) and has received payment for continuing medical education work related to psoriasis that was supported indirectly by Eli Lilly. Dr. Wan has received research fellowship funding from Pfizer Inc. (to the Trustees of the University of Pennsylvania) and payment for consulting work with Health Union, LLC. Dr. Margolis has served on advisory committees for Sanofi/Regeneron and Pfizer. The other authors have indicated they have no conflicts of interest relevant to this article to disclose.

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Data Curation: Hoffstad (lead); Wan (supporting)

Formal Analysis: Mitra (supporting); Oganisian (lead); Spieker (supporting); Wan (supporting)

Funding Acquisition: Margolis (lead); Takeshita (supporting); Wan (supporting)

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Methodology: Oganisian (equal); Spieker (equal); Takeshita (equal); Wan (equal)

Project Administration: Takeshita (supporting); Wan (lead)

Resources: Margolis (lead)

Software: Oganisian (lead); Spieker (supporting)

Supervision: Margolis (supporting); Mitra (supporting); Takeshita (lead)

Validation: Mitra (supporting); Oganisian (lead); Spieker (supporting)

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Writing – Review and Editing: All authors (equal)

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Table 1. Baseline Characteristics of Study Participants

Baseline Variable ^a	White N = 2576	Black N = 4078	Hispanic N = 868	p-value ^b
Age at enrollment (years)	6.58 (3.91 - 10.32)	6.68 (4.01 - 10.58)	6.04 (3.87 - 9.96)	0.049
Male sex	1321 (51.3%)	1781 (43.7%)	398 (45.9%)	<0.001
Annual household income (USD)				<0.001
\$0-\$24,999	378 (14.7%)	2465 (60.5%)	427 (49.5%)	
\$25,000-\$49,999	394 (15.3%)	490 (12.0%)	185 (21.4%)	
\$50,000-\$74,999	323 (12.5%)	116 (2.9%)	67 (7.8%)	
\$75,000-\$99,999	228 (8.9%)	56 (1.4%)	17 (2.0%)	
\$100,000 or more	295 (11.5%)	51 (1.3%)	9 (1.0%)	
Prefer not to answer	958 (37.2%)	895 (22.0%)	158 (18.3%)	
Region				<0.001
Northeast	261 (10.1%)	253 (6.2%)	103 (11.9%)	
Midwest	665 (25.8%)	755 (18.5%)	108 (12.4%)	
South	1502 (58.3%)	2956 (72.5%)	540 (62.2%)	
West	121 (4.7%)	50 (1.2%)	113 (13.0%)	
Urban influence code	2 (1 - 6)	2 (1 - 2.33)	1 (1 - 2)	<0.001
Age at atopic dermatitis onset (years)	0.75 (0.25 - 3)	0.75 (0.75 - 3)	0.75 (0.25 - 4)	0.12
Duration of atopic dermatitis (years)	4.11 (2.3 - 7.09)	4.08 (2.33 - 7.28)	3.55 (2.04 - 6.23)	<0.001
Atopic dermatitis disease control				<0.001
Complete	183 (7.1%)	135 (3.3%)	64 (7.4%)	
Good	1319 (51.2%)	1855 (45.6%)	373 (43.1%)	
Limited	871 (33.8%)	1662 (40.8%)	325 (37.6%)	
Uncontrolled	201 (7.8%)	419 (10.3%)	103 (11.9%)	
Asthma	1326 (51.5%)	1814 (44.6%)	325 (37.5%)	<0.001
Seasonal allergies	1856 (72.3%)	2364 (58.1%)	451 (52.1%)	<0.001

Notes:

a) Median and interquartile range reported for all continuous variables. Counts and proportions [No. (%)] reported for all categorical variables. Counts may not match sample size due to missing-ness.

b) p-values were calculated using ANOVA F-tests for continuous variables and Chi-squared tests for categorical variables.

Table 2. Adjusted Odds Ratios (OR) for Healthcare Utilization Outcomes from Multivariable Model

Multivariable Model Variables, OR (95% CI)	Any Visit N = 7357	Primary Care N = 7306	Dermatology N = 7148	Emergency N = 7101	Other N = 7131
Male sex	0.84 (0.77 - 0.91)	0.89 (0.83 - 0.96)	0.81 (0.73 - 0.89)	0.91 (0.78 - 1.07)	0.97 (0.88 - 1.08)
Annual household income (USD)					
\$0-\$24,999	Reference	Reference	Reference	Reference	Reference
\$25,000-\$49,999	0.77 (0.68 - 0.88)	0.74 (0.65 - 0.83)	1.3 (1.11 - 1.51)	1.03 (0.81 - 1.31)	0.92 (0.78 - 1.09)
\$50,000-\$74,999	0.55 (0.47 - 0.63)	0.45 (0.39 - 0.52)	1.42 (1.18 - 1.7)	0.53 (0.39 - 0.72)	0.97 (0.78 - 1.21)
\$75,000-\$99,999	0.51 (0.43 - 0.62)	0.39 (0.33 - 0.48)	1.55 (1.24 - 1.93)	0.33 (0.2 - 0.54)	1.01 (0.77 - 1.31)
\$100,000 or more	0.57 (0.48 - 0.68)	0.39 (0.32 - 0.47)	1.94 (1.59 - 2.35)	0.39 (0.25 - 0.6)	1 (0.77 - 1.3)
Prefer not to answer	0.87 (0.78 - 0.97)	0.85 (0.77 - 0.94)	1.16 (1.01 - 1.33)	1.14 (0.93 - 1.4)	1.27 (1.1 - 1.45)
Urban influence code	0.99 (0.98 - 1.01)	1.02 (1 - 1.04)	0.94 (0.92 - 0.97)	1.00 (0.96 - 1.04)	1.04 (1.02 - 1.06)
Age at atopic dermatitis onset (years)	0.97 (0.96 - 0.98)	0.97 (0.95 - 0.98)	1.00 (0.98 - 1.01)	0.99 (0.96 - 1.02)	0.98 (0.96 - 1)
Duration of atopic dermatitis (years)	0.95 (0.95 - 0.96)	0.95 (0.94 - 0.96)	0.99 (0.98 - 1)	0.98 (0.96 - 0.99)	0.97 (0.96 - 0.98)
Asthma	1.02 (0.93 - 1.11)	1.05 (0.96 - 1.14)	0.96 (0.86 - 1.06)	1.33 (1.13 - 1.56)	1.29 (1.15 - 1.44)
Seasonal Allergies	1.17 (1.07 - 1.28)	1.11 (1.02 - 1.21)	1.17 (1.05 - 1.31)	1.13 (0.95 - 1.35)	1.76 (1.54 - 2.02)
Intercept	0.36 (0.3 - 0.43)	0.29 (0.24 - 0.35)	0.03 (0.03 - 0.04)	0.005 (0 - 0.01)	0.02 (0.02 - 0.03)

Figure Legends

Figure 1. Geographical distribution of study subjects. Each circle represents an individual zip code, and the size of the circle reflects the number of individuals within a zip code. Five subjects were missing zip code data, and 240 zip codes were unable to be matched for mapping.

Figure 2. Proportion of subjects with at least one visit

Figure 3. Odds of any health professional visit by race/ethnicity and atopic dermatitis disease control

Figure 4. Odds of specific health professional visits by race/ethnicity and atopic dermatitis disease control

Supplementary Material

Table S1. Characteristics of study participants with more than half of surveys missing

Figure S1. Distribution of missing surveys (outcomes) by race/ethnicity

ACCEPTED MANUSCRIPT







