



Does Location Matter? Geographic Variations in Healthcare Resource Use for Atopic Dermatitis in the United States

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Title: Does Location Matter? Geographic Variations in Healthcare Resource Use for Atopic Dermatitis in the United States

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ABSTRACT (200/200)

It is unknown which region of the U.S. offers the best and worst access to care for atopic dermatitis (AD). We conducted a cross-sectional study using the Medical Expenditure Panel Survey (MEPS) from 1996-2015 to compare healthcare resource use and cost of AD among U.S. census regions. We conducted multivariable regression analyses adjusting for clinicodemographic factors to evaluate regional differences in healthcare resource use and cost per patient per year (PPPY) in terms of ambulatory visits, ED visits, and medications directly attributable to AD. An estimated total of 6,348,578 (95% CI: 5,944,553-6,752,803) AD patients (weighted) were pooled. Compared to the remainder of the country, Midwest AD patients utilized the fewest ambulatory visits (0.55 vs. 0.75 visits PPPY; $p=0.035$). The proportion of patients with ≥ 1 ED visits was highest in the Midwest (7.1%), followed by the South (5.4%), Northeast (4.8%), and West (1.4%). Within the Midwest AD population, those with no ambulatory visits per year utilized nearly three times more ED visits when compared to those with one or more ambulatory visits per year (0.11 vs 0.04 visits PPPY; $p=0.019$). Our results suggest that Midwest AD patients have differential access to outpatient care, which may be resulting in higher ED usage.

INTRODUCTION

Atopic dermatitis (AD) is a chronic inflammatory skin condition affecting 13% of children and 7-10% of adults in the U.S. (1). Patients with AD experience acute flares resulting in intractable pruritus and sleep loss (2). When acute flares occur, AD patients oftentimes require the use of emergency department (ED) resources for disease management, creating a substantial financial burden on both patients and the U.S. healthcare system (3). Treatment goals of AD emphasize regular outpatient care for management and prevention of flares (4-6). With inadequate access to ambulatory care, AD patients may experience more flares and poor clinical and financial outcomes (7).

One method for investigating access to care issues involves quantifying healthcare resource use and cost. Healthcare resource use describes the number of services provided to the patient by a healthcare professional. In the *National Health Disparities Report*, healthcare resource use was noted as an important indicator of the successful or unsuccessful attainment of healthcare services (8).

A variety of factors may impact an AD patient's access to care, including race, ethnicity, and socioeconomic status (9, 10). Preliminary evidence suggests that patient and dermatologist location may also affect access to care (11). There is a critical gap in the knowledge regarding the geographic differences in healthcare resource use and cost of AD in the U.S. Determining these differences enables clinicians and policy makers to implement interventions and policies directed at improving access to care. This study aims to compare the healthcare resource use and cost of AD among the four U.S. census regions: West, South, Midwest, and Northeast.

METHODS

Data Source

We performed a cross-sectional, population-based study using the Medical Expenditure Panel Survey (MEPS) database from 1996-2015 to compare the healthcare resource use and cost of AD among the four U.S. census regions: West, South, Midwest, and Northeast (12).

The MEPS, administered by the Agency of Healthcare Research and Quality (AHRQ), is a nationally representative survey of the U.S. population (13). The MEPS utilized a stratified, multi-stage area probability survey design to sample U.S. households and generate a representative dataset of the entire U.S. population. U.S. households were followed for two consecutive years and completed five sets of interviews during this time. Interviews were conducted using computer-assisted personal interviews (CAPI). MEPS has been validated and used to study healthcare resource use in many disease states (14-16).

We used Full Year Consolidated, Medical Conditions, and Event data files from the Household Component of the MEPS to identify our study population and obtain data on healthcare resource use and cost. Specifically, the Medical Conditions files provided data on healthcare resource use, which is defined as the number of healthcare visits or medications attributable to AD. The Medical Conditions files were combined with the Event files to obtain information on healthcare cost, which is defined as the cost of visits and medications attributable to AD. The Full-Year Consolidated data files provided sociodemographic information such as age, gender, race, ethnicity, and insurance status of each patient in our study sample.

Study Population

Our study sample included AD patients of all ages using the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) code for AD (691).

Variables

The independent variable was the patients' U.S. census region of residence: West, South, Midwest, or Northeast. The outcome variables included healthcare resource use and cost. Healthcare resource use is defined as AD-specific ambulatory visits per patient per year (PPPY), proportion of patients with at least 1 ED visit per year, and number of medications PPPY. Healthcare cost consisted of the sum of out-of-pocket and insurance payments. Total cost of AD consisted of the sum of ambulatory visit, ED visit, medication, and inpatient visit costs. Inpatient visits were not independently evaluated due to the low number of inpatient visits attributable to AD. All costs were adjusted for inflation to 2015 U.S. dollars using the latest available price index.

Data Analysis

We applied person-level sampling weights to reflect the sampling method used by MEPS and generate a nationally-representative estimate of AD patients in the U.S. We performed descriptive analyses to tabulate the age, gender, race, ethnicity, insurance status, and CCI of AD patients in each region. We performed analysis of variance (ANOVA) analyses for continuous variables and χ^2 analyses for categorical variables to compare the demographic and clinical factors among AD patients in each census region.

For each outcome variable, we performed multivariable linear regression analyses for continuous variables and multivariable logistic regression analyses for categorical variables to examine the relationship between U.S. census region and healthcare resource use and cost of AD. We adjusted for age, gender, race, ethnicity, insurance status, and Charlson comorbidities (CCI)(17) in these analyses. Our analyses compared the respective census region to the remainder of the country excluding that region (e.g. West vs. South, Midwest, and Northeast

combined). Outcome variables included the aforementioned measures of healthcare resource use and cost. The threshold for statistical significance was a 2-sided p value of <0.05 . All statistical analyses were performed using STATA 13.0 [StataCorp LP, College Station, TX].

RESULTS

A total of 6,348,578 (95% CI: 5,944,553-6,752,803) AD patients (weighted) were pooled from 1996-2015. Among these patients, 1,371,111 (21.6%) resided in the West, 2,459,563 (38.7%) resided in the South, 1,484,993 (23.4%) resided in the Midwest, and 1,032,912 (16.3%) resided in the Northeast. These numbers were proportional to the general population density of each region as reported by the U.S. census (18). Sociodemographic and clinical factors are summarized in Table 1. Of these factors, there were significant differences in race ($p<0.001$) and ethnicity ($p<0.001$).

Overall Estimates of Healthcare Resource Use and Cost of AD in the U.S.

Over the entire U.S., AD patients had a mean (SEM) total healthcare cost of \$263 (30) PPPY. With regards to ambulatory visits, U.S. AD patients had a mean (SEM) utilization of 0.71 (0.57) visits PPPY and a mean (SEM) cost of \$121 (12) PPPY (Table 2). With regards to ED visits, 4.8% of U.S. AD patients had ≥ 1 ED visit, and the mean (SEM) cost of ED visits for those with ≥ 1 ED visit was \$683 (161) PPPY. With regards to prescription medications, U.S. AD patients had a mean (SEM) utilization of 0.98 (0.05) prescriptions PPPY and a mean (SEM) cost of \$76 (8) PPPY.

Total Cost by Region

Total cost of AD PPPY by region are summarized in Table 3. Multivariable linear regression analysis found no significant differences in total cost of AD PPPY among the regions (Table 3).

West vs. the Remainder of the Country

Ambulatory Use and Cost

West AD patients utilized 25.7% more ambulatory visits (0.84 (0.08) vs. 0.67 (0.06) visits per person/year; $p=0.15$) and incurred 20.8% more ambulatory cost (\$140 (13) vs. \$116 (8) per person/year; $p=0.689$) when compared to the remainder of the country (Tables 2 and 3).

ED Use and Cost

West AD patients had significantly fewer patients with ≥ 1 ED visit when compared to AD patients in the remainder of the country (1.4% vs 5.8%, $p<0.001$) (Tables 2 and 3). West AD patients incurred significantly less ED cost compared to AD patients in the remainder of the country (\$532 vs \$700 PPPY, $p=0.039$).

Prescription Medication Use and Cost

West AD patients utilized a similar number of prescription medications (0.98 (0.96) vs. 0.99 (0.05) medications per person/year; $p=0.935$) and incurred 10.3% less prescription medication cost (\$70 (9) vs. \$78 (9) per person/year; $p=0.718$) when compared to the remainder of the country (Tables 2 and 3).

South vs. the Remainder of the Country

Ambulatory Use and Cost

South AD patients utilized 8.2% more ambulatory visits (0.74 (0.53) vs. 0.69 (0.06) visits per person/year; $p=0.763$) and incurred 22.5% more ambulatory cost (\$136 (10) vs. \$111 (17) per person/year; $p=0.708$) when compared to the remainder of the country (Tables 2 and 3).

ED Use and Cost

The South had a 20% higher proportion of AD patients with ≥ 1 ED visit when compared to the remainder of the country (5.4% vs. 4.5%; $p=0.46$) (Tables 2 and 3). When compared to AD patients with ≥ 1 ED visit in the remainder of the country, South AD patients with at ≥ 1 ED visit incurred 43.6% higher ED cost (\$810 (275) vs. \$564 PPPY; $p=0.138$).

Prescription Medication Use and Cost

South AD patients utilized significantly more prescription medications (1.13 (0.08) vs. 0.89 (0.05) medications per person/year; $p=0.041$) and incurred significantly more prescription medication cost (\$107 (17) vs. \$56 (7) per person/year; $p=0.012$) when compared to the remainder of the country (Table 2 and 3).

Midwest vs. the Remainder of the Country

Ambulatory Use and Cost

Midwest AD patients utilized significantly fewer ambulatory visits (0.55 (0.60) vs. 0.75 (0.06) visits/person/year; $p=0.035$) and incurred significantly less ambulatory cost (\$88 (8) vs. \$131 (14) per person/year; $p=0.005$) when compared to the remainder of the country (Tables 2 and 3).

ED Use and Cost

The Midwest had the highest proportion of AD patients with ≥ 1 ED visit (7.1% vs. 4.1%; $p=0.17$) when compared to the remainder of the country (Tables 2 and 3). When compared to AD patients with at least 1 ED visit in the remainder of the country, Midwest AD patients with ≥ 1 ED visit incurred significantly greater ED cost (\$758 vs. \$658 (222) PPPY; $p=0.013$) (Tables 2 and 3). Exploratory analysis showed that Midwest AD patients with no ambulatory visits used significantly more ED visits when compared to Midwest AD patients with ≥ 1 ambulatory visit (0.11 (0.03) vs. 0.04 (0.001) ED visits PPPY; $p=0.019$).

Prescription Medication Use and Cost

Midwest AD patients used significantly fewer prescription medications (0.84 (0.05) vs. 1.03 (0.06) medications/person/year; $p=0.005$) and incurred 56% less prescription medication cost (\$38 (2) vs. \$87 (10) per person/year; $p=0.16$) when compared to the remainder of the country (Table 2 and 3).

Northeast vs. the Remainder of the Country

Ambulatory Use and Cost

Northeast AD patients utilized 6.9% fewer ambulatory visits (0.67 (0.05) vs. 0.72 (0.06) visits per person/year; $p=0.441$) and incurred 15.5% less ambulatory cost (\$105 (12) vs. \$124 (8) per person/year; $p=0.947$) when compared to the remainder of the country (Table 2 and 3).

ED Use and Cost

The Northeast had a similar proportion of AD patients with ≥ 1 ED visit (4.8% vs. 4.8%; $p=0.932$) when compared to the remainder of the country (Tables 2 and 3). When compared to

AD patients with ≥ 1 ED visit in the remainder of the country, Northeast AD patients with ≥ 1 ED visit incurred 62.9% less ED cost (\$282 vs. \$760 (172) PPPY; $p=0.065$) (Tables 2 and 3).

Prescription Medication Use and Cost

Northeast AD patients used significantly fewer prescription medications (0.86 (0.06) vs. 1.01 (0.05) medications per person/year; $p=0.038$) and incurred 21.5% less prescription medication cost (\$62 (5) vs. \$79 (9) per person/year; $p=0.159$) when compared to the remainder of the country (Tables 2 and 3).

DISCUSSION

This study was among the first efforts to evaluate healthcare resource use and costs of AD using a large, nationally-representative database. From our study of over 6 million AD patients, we found substantial differences in the healthcare resource use and cost of AD among the four U.S. census regions. These data are critical because they identify regional disparities in access to healthcare resources.

When examining differences in healthcare, it is important to first note the distinction between “differences” and “disparities.” A healthcare disparity is defined as “difference in treatment or access *not justified by differences in health status or preferences of the groups*”(19). Therefore, not all differences in healthcare are considered disparities. For example, patients with Fitzpatrick skin type one are more likely to get skin cancers when compared to those with Fitzpatrick skin type six. This is because lighter skinned individuals have inherently lower levels of melanin in their skin, leaving them more vulnerable to the sun’s ultraviolet rays (20). Although this difference does exist, it would not be considered a disparity. With AD, we would not expect large differences in healthcare resource use between geographic regions due to

inherent differences in health status or preferences of the groups. Regardless of patient location, AD patients generally share the same goal: to be clear of their disease. Therefore, differences in healthcare resource use among AD patients living in different regions are considered disparities.

In regard to healthcare resource use, the most ideal region for AD patients to access care appears to be the West. When compared to the remainder of the country, AD patients in the West used the most ambulatory visits PPPY and had the lowest proportion of patients using ≥ 1 ED visit. These results suggest that AD patients in the West have better access to ambulatory care, which may have resulted in better disease control. Better disease control is one possible reason why West AD patients used the fewest ED resources.

In regard to healthcare resource use, the least ideal region for AD patients to access care appears to be the Midwest. Preliminary studies suggest that the Midwest census region may have the poorest access to dermatologic care in the entire U.S. Specifically, an analysis of the American Association of Dermatology's membership database found that the Midwest is the only census region in the U.S. with a net export of new dermatologists (11). With the migration of dermatologists away from the Midwest and the increasing demand for dermatologic care,(21-23) the dermatology shortage in the Midwest is likely intensifying rather than improving. The results of our study corroborate and extend the findings of these preliminary studies. We found that Midwest AD patients used the fewest ambulatory visits PPPY and had the greatest proportion of patients with ≥ 1 ED visits when compared to the remainder of the country. Among Midwest AD patients, those with no ambulatory visits utilized significantly more ED visits when compared to those with at least one ambulatory visit. Overall, these results suggest that Midwest AD patients have markedly poor access to ambulatory resources, which may have resulted in greater flare frequency and ED use.

Surprisingly, despite differences in healthcare resource use, there were no statistically significant differences in total healthcare cost PPPY when comparing a region to the remainder of the country. This observation holds contrary to the belief that regular ambulatory care reduces cost in those with AD and that high ED use leads to an overall greater financial burden (3). However, having similar healthcare costs does not necessarily mean that healthcare quality or patient outcomes are similar across census regions. Although the MEPS database does not provide information on disease severity, high ED use is a marker for greater disease severity in those with AD.(7) Therefore, it remains important to ensure AD patients receive regular ambulatory care to prevent flares and reduce the burden on limited ED resources.

Several interventions may reduce the disparity in healthcare resource use among Midwest AD patients. Clinicians providing care for AD patients, including those practicing primary care and dermatology, should be recruited to underserved areas. One recruitment strategy involves financial incentives. For example, state-sponsored student loan forgiveness programs have been instrumental in attracting primary care practitioners to practice in underserved regions of the U.S. (24). These programs may be expanded to include not only more primary care physicians, but also dermatology practitioners to improve access to care for AD patients. Our results suggest that the Midwest may benefit the most from such recruitment efforts.

Teledermatology, a modality to provide dermatologic care remotely regardless of patient location, may be another viable solution to ameliorate this disparity (25). In a randomized clinical trial of 156 AD patients, adult and pediatric AD patients receiving teledermatology care had equivalent quality of life outcomes when compared to those receiving in-person care (26). This patient-centered online model has the potential to improve access for AD patients living in underserved regions.

The results of this study should be interpreted in the context of the study design. The MEPS does not survey institutionalized people or military personnel and does not provide information regarding disease severity. We were unable to stratify regions with greater specificity than U.S. census region in MEPS. However, information on larger, more macro-geographical populations are integral for policy makers to implement wide-scale changes in healthcare.

In conclusion, our results highlight access to care disparities for AD patients living in the Midwest. When compared to the remainder of the country, Midwest AD patients used significantly fewer ambulatory resources and had the highest proportion of patients with at least 1 ED visit. Midwest AD patients with no ambulatory visits utilized nearly three times more ED visits when compared to those with one or more ambulatory visits. It is important for policy makers to consider ways to reduce disparity that arises from living in different geographical regions.

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TABLES

Table 1. Socio-demographic and clinical characteristics of AD patients between regions

Characteristic	West (n=1,371,111; 21.6%)	South (n=2,459,563; 38.7%)	Midwest (n=1,484,993; 23.4%)	Northeast (n=1,032,912 (16.3%))	P value
Age, mean years (SEM)	4.4 (1.1)	5.8 (1.3)	4.5 (1.9)	4.2 (0.3)	0.664
Gender, n (%)					0.646
<i>Female</i>	771,935 (56.3)	1,344,889 (54.7)	716,212 (48.2)	504,578 (48.9)	
<i>Male</i>	599,175 (43.7)	1,114,674 (45.3)	768,781 (51.8)	528,334 (51.2)	
Race, n (%)					<0.001*
<i>White</i>	727,923 (53.1)	1,526,405 (62.1)	885,947 (59.7)	564,280 (54.6)	
<i>Black</i>	13,437 (1)	219,147 (8.9)	109,147 (7.4)	35,842 (3.5)	
<i>American Indian/Alaska Native</i>	41,133 (3)	-	15,444 (1.0)	54,951 (5.3)	
<i>Asian/Pacific Islander</i>	513,618 (37.5)	671,707 (27.3)	362,487 (24.4)	345,335 (33.5)	
<i>Multiple Races</i>	75,000 (5.5)	42,059 (1.7)	111,968 (7.5)	31,401 (3.0)	
Ethnicity, n (%)					<0.001*

<i>Hispanic</i>	411,333 (30)	415,912 (16.9)	126,670 (8.5)	126,670 (8.5)	
<i>Non-Hispanic</i>	959,778 (70)	2,043,651 (83.1)	1,358,323 (91.5)	1,358,323 (91.5)	
Insurance status, n (%)					0.012*
<i>Insured</i>	1,246,888 (90.9)	2,222,707 (90.4)	1,422,623 (95.8)	1,032,912 (100)	
<i>Uninsured</i>	124,223 (9.1)	236,856 (9.6)	62,370 (4.2)	-	
Charlson Comorbidity Score, n (%)					0.623
<i><1</i>	952,237 (69.5)	1,647,415 (67)	1,145,821 (77.2)		
<i>1</i>	126,279 (9.2)	275,963 (11.2)	153,548 (10.3)		
<i>>1</i>	292,595 (21.3)	536,185 (21.8)	185,624 (12.5)		

Table 2. Healthcare resource use and cost for atopic dermatitis stratified by U.S. census region

Service	West	South	Midwest	Northeast	All of the U.S.
Ambulatory Visits PPPY (SEM)					
Mean visits	0.84 (0.08)	0.74 (0.53)	0.67 (0.05)	0.55 (0.60)	0.71 (0.57)
Mean cost (all) ^a	140 (13)	136 (10)	105 (12)	88 (10)	121 (12)
Mean cost (≥ 1) ^b	215 (16)	252 (11)	185 (13)	190 (24)	220 (18)
Emergency Department Visits (SEM)					
Proportion of patients with ≥ 1 ED visits per year	1.4% (0.5)	5.4% (2.0)	7.1% (1.7)	4.8% (2.2)	4.8% (1.0)
Mean cost PPPY (all) ^b	20 (1.6)	76 (57)	21 (10)	66 (50)	52 (26)
Mean cost PPPY (≥ 1 ED visit) ^b	532	810 (275)	282	758	683 (161)
Prescription Drugs PPPY (SEM)					
Mean prescription drugs	0.98 (0.96)	1.12 (0.08)	0.86 (0.06)	0.84 (0.05)	0.98 (0.05)
Mean cost (all) ^a	70 (9)	107 (17)	62 (5)	38 (2)	76 (8)
Mean cost (≥ 1) ^b	80 (10)	124 (20)	71 (6)	46 (3)	88 (9)
Total Healthcare Costs PPPY (SEM)					
Mean cost (all) ^{a, c}	229 (14)	343 (53)	210 (49)	188 (18)	263 (30)

^a Includes data from all respondents with atopic dermatitis^b Includes cost data only from respondents with atopic dermatitis who have ≥ 1 ambulatory visits, emergency department visits, or prescription drugs^c Total healthcare costs includes combined costs for ambulatory visits, emergency department visits, inpatient visits, and prescription drugs

PPPY: per patient per year; SEM: standard error of mean; ED: emergency department

Table 3. Healthcare Resource Use and Cost Comparison Analyses by U.S. Census Region

U.S. Census Region	Outcome	β Coefficient [†]	Odds Ratio (95% CI) [‡]	P Value
HEALTHCARE RESOURCE USE				
West	Ambulatory Use	0.24	-	0.15
	Proportion of patients ≥ 1 ED visit	-	0.21 (0.087 – 0.49)	<0.001*
	Rx Use	-0.0094	-	0.935
South	Ambulatory Use	0.037	-	0.763
	Proportion of patients ≥ 1 ED visit	-	1.24 (0.48 – 3.22)	0.46
	Rx Use	0.21	-	0.041*
Midwest	Ambulatory Use	-0.21	-	0.035*
	Proportion of patients ≥ 1 ED visit	-	1.77 (0.78 – 4.04)	0.17
	Rx Use	-0.14	-	0.156
Northeast	Ambulatory Use	-0.074	-	0.441
	Proportion of patients ≥ 1 ED visit	-	1.05 (0.34 – 3.22)	0.932
	Rx Use	-0.18	-	0.038*
HEALTHCARE COST				
West	Total Cost	-23.78	-	0.689
	Ambulatory Cost	38.30	-	0.346
	ED Cost in those with ≥ 1 ED visit	-449.68	-	0.039*
	Rx Cost	-5.81	-	0.718
South	Total Cost	90.84	-	0.053

	Ambulatory Cost	9.75	-	0.708
	ED Cost in those with ≥ 1 ED visit	248.19	-	0.138
	Rx Cost	44.94	-	0.012*
Midwest	Total Cost	-54.17	-	0.217
	Ambulatory Cost	-49.54	-	0.005*
	ED Cost in those with ≥ 1 ED visit	331.25	-	0.013*
	Rx Cost	-43.00	-	<0.001*
Northeast	Total Cost	-56.35	-	0.085
	Ambulatory Cost	-1.21	-	0.947
	ED Cost in those with ≥ 1 ED visit	-455.95	-	0.065
	Rx Cost	-14.74	-	0.159

[†] β Coefficient from multivariable linear regression analyses comparing the respective region to the remainder of the country (e.g. West vs South, Northeast, and Midwest combined), after adjustment for age, gender, race, ethnicity, insurance status, and Charlson comorbidities.

[‡]Odds Ratio from multivariable logistic regression analyses comparing the respective region to the remainder of the country (e.g. West vs South, Northeast, and Midwest combined), after adjustment for age, gender, race, ethnicity, insurance status, and Charlson comorbidities.

ED: emergency department; Rx: medications; CI: confidence interval

FIGURES

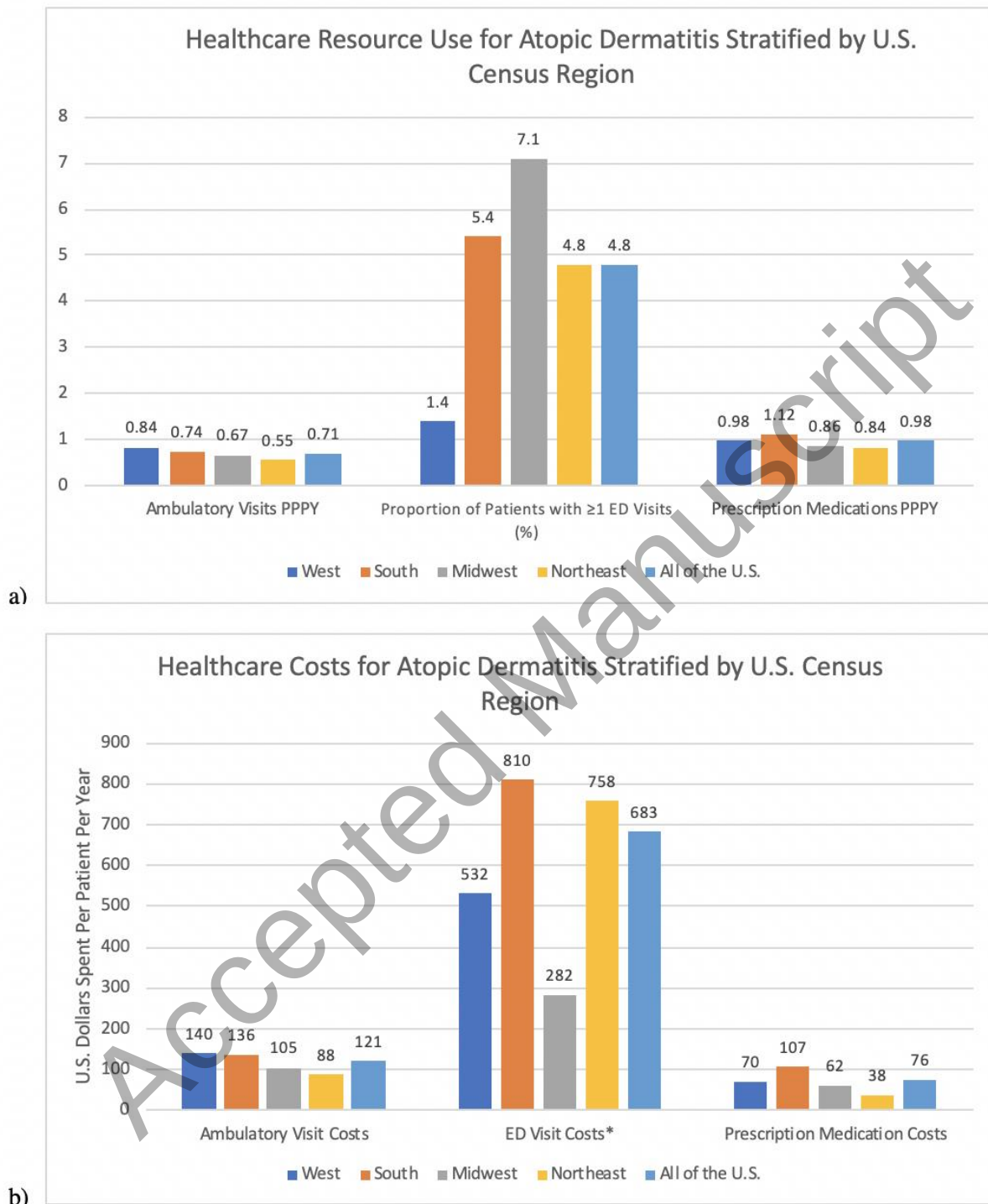


Figure 1. Healthcare Resource Use (a) and Cost (b) Stratified by U.S. Census Region

Costs adjusted to 2015 U.S. dollars

*Emergency department (ED) cost calculations reported for patients with ≥ 1 ED visits.

ED: Emergency department; PPPY: Per patient per year

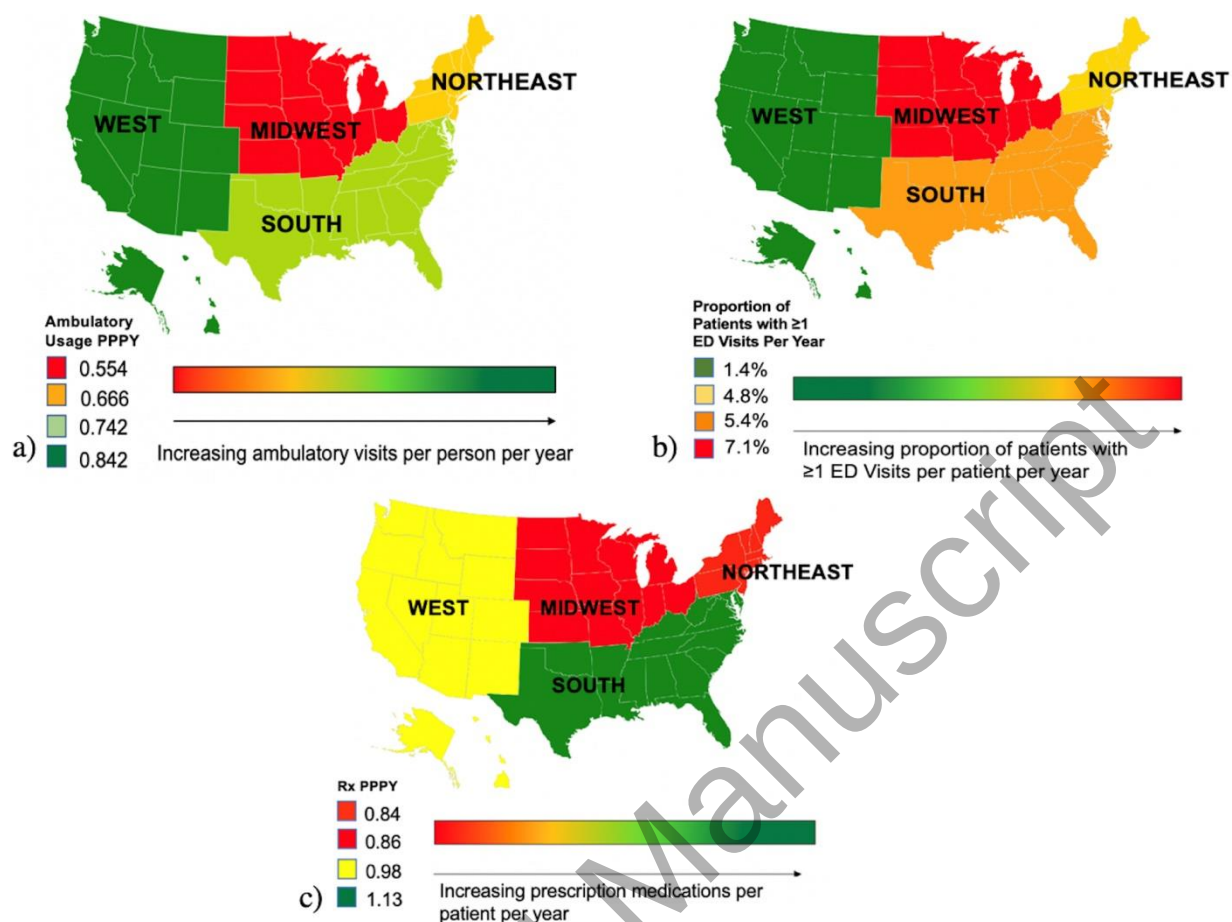


Figure 2. Heat Maps of (a) Ambulatory Visits Per Patient Per Year, (b) Proportion of Patients with ≥ 1 Emergency Department Visits, and (c) Prescription Medications Per Patient Per Year by U.S. Census Region

ED: emergency department; PPPY: per patient per year; Rx: prescription medications