

Duration of Dermatitis Before Patch Test Appointment Is Associated With Distance to Clinic and County Poverty Rate

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Background: Contact dermatitis is a common disease that is associated with impaired quality of life.

Objective: We examined the effect of travel distance and other socioeconomic factors on duration of dermatitis before presentation at the Duke Contact Dermatitis and Patch Testing Center.

Methods: This is a retrospective study of patients who underwent patch testing from March 1, 2012, to August 1, 2018. Associations between duration of dermatitis, distance to clinic, and socioeconomic factors (age, race, payor group, county poverty rate, rural-urban status) were examined.

Results: The median duration of dermatitis was 14 months (Q1 = 7 months; Q3 = 36 months), and the median distance to clinic was 18 miles (Q1 = 7 miles; Q3 = 45.9 miles). For a 50-mile increase in the distance from the patient's zip code to the clinic, the median duration of dermatitis increased by 17.9% ($P < 0.001$). For every 5% increase in the county poverty rate, the median duration of dermatitis increased by 16.3% ($n = 29$; $P = 0.032$). Trends were noted for a longer duration of dermatitis based on insurance payor, rural-urban status, and race.

Conclusions: Distance to patch test provider and county poverty status are important measures of access for patients with dermatitis.

In the United States, more than 13 million patients sought medical treatment for contact dermatitis in 2013, with costs exceeding US \$1.5 billion.¹ In addition to being a common skin disease, contact dermatitis is also associated with significant impairment in quality of life.^{2–7} Consequently, early diagnosis improves patient outcomes and, particularly, the emotional impact on patient quality of life.⁵

Health care access is affected by many factors. Race, ethnicity, age, sex, rural-urban status, occupation, travel distance, insurance status, and provider supply may all influence dermatologic care.^{8–19} Factors that have been linked to allergic contact dermatitis (ACD) specifically include race, ethnicity, age, sex, rural-urban status, and occupation.^{9–14} However, the influence of travel distance, insurance

status, and other socioeconomic factors on the management and outcomes of ACD is not well described.

Prior studies have documented that distance from diagnosing provider affects the severity, treatment adherence, and health outcomes of dermatologic diseases.^{8,15–17} As contact dermatitis is a common skin disease that affects patient quality of life,^{2,3,5–7,10} we sought to determine whether travel distance along with other socioeconomic factors affect the duration of dermatitis before presentation to the contact dermatitis clinic. The primary objective was to assess the effect of distance to the Duke Contact Dermatitis and Patch Testing Center on duration of dermatitis before presentation. Secondary objectives were to assess the effects of sex, race, payor group, county poverty rates, and rural-urban status on the duration of dermatitis before presentation.

METHODS

Study Design and Data

This retrospective study was approved by the Duke Health Institutional Review Board; waiver of consent was obtained. The study included patients who underwent patch testing at the Duke Contact Dermatitis and Patch Testing Center from March 1, 2012, to August 1, 2018. Patients from North Carolina and its bordering states (Georgia, South Carolina, Tennessee, and Virginia) were included

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in the analysis. If duration of dermatitis was not recorded or if the patient did not have active dermatitis (in the case of a concern for metal allergy before implant placement), the patient was excluded from the study. Patients with prior history of patch testing or with missing zip code or socioeconomic data were also excluded from the analysis. Patient addresses were mapped via zip code, and distance to the Duke Contact Dermatitis and Patch Testing Center was calculated.

Data were obtained from 3 sources: Duke Enterprise Data Unified Content Explorer (DEDUCE), a Web-based clinical research and quality improvement query tool that allows for flexible search of data hierarchies²⁰; Clarity, Duke's main electronic medical record data warehouse; and chart review of the Duke electronic medical record (LRH).

Variables

The following clinical and demographic variables were obtained: sex, race, ethnicity, age, payor group, zip code and county of residence, duration of dermatitis, county poverty rates, and rural-urban status. Sex, race, and ethnicity were determined with the DEDUCE tool. Age, payor group, zip code, and county of residence at the time of clinic visit were determined with a Clarity query. Duration of dermatitis was defined as patient-reported time from the first sign of dermatitis to the first encounter with the contact dermatitis specialist and was converted to time in months by LRH. In cases of lifelong dermatitis with recent worsening of disease, the onset of dermatitis was recorded as date of worsening of dermatitis. County poverty rate, which represents the percentage of residents in each county living below the poverty threshold, was obtained from US Census Bureau 2000 census information.²¹ Rural-urban status was determined using 2013 Rural-Urban Continuum Codes from the US Department of Agriculture.²²

Statistical Analysis

Continuous variables such as distance, duration of dermatitis, age at time of encounter, and county poverty rate were summarized using the mean, standard deviation, median, 25th (Q1) and 75th (Q3) percentiles, and range as appropriate based on the data distribution. Categorical variables, such as sex, race, ethnicity, payor group, and rural-urban status, were summarized with frequency counts and percentages. The comparison of dermatitis duration across categorical groups was done using the Kruskal-Wallis test.

Because the distribution of duration of dermatitis was right skewed, a generalized linear model with log normal distribution was fit to study the association between duration of dermatitis and the distance to the contact dermatitis clinic after adjusting for age, sex, race, insurance payor, county poverty rate, and rural-urban status. The distance was calculated as the geodetic distance in miles between the zip code of the patient's address and the zip code of the Duke Dermatology Contact Dermatitis and Patch Testing Center (27707). The centroid of each zip code (the longitude/latitude point) was used in the calculation. Because the closest distance from a different zip code to the contact

dermatitis clinic zip code is 0.8 miles, we assigned 0.4 miles as the distance for those patients who had the same zip code as the clinic. Results are presented using the exponentiated regression estimate (ratio of the geometric mean [median]) with 95% confidence interval (CI).

A *P* value less than 0.05 was considered statistically significant. All statistical analyses were performed using SAS version 9.4 (SAS Institute Inc, Cary, NC).

RESULTS

We identified 1552 patients who completed patch testing between March 1, 2012, and August 1, 2018; 1131 patients who met inclusion criteria were included in the analysis (72.9%). Mean age was 50.6 ± 17.7 years, with 818 female (72.3%) and 313 male (27.7%) patients. Additional study demographics can be reviewed in Table 1. The median duration of dermatitis before the first clinic encounter was 14 months (Q1 = 7 months, Q3 = 36 months; Table 2). The median distance from the patient's zip code to the clinic was 18 miles (Q1 = 7 miles, Q3 = 45.9 miles; Table 1). Ninety percent of the patients traveled less than 90 miles to reach the clinic; the remaining 10% traveled between 90 and 560 miles. Visual distribution map of patient zip code locations can be reviewed in Figure 1.

Univariable analysis of duration of dermatitis revealed no statistical association with sex, insurance payor, county poverty rate, rural-urban status, or race (Table 2). Trends were noted for longer

TABLE 1. Demographics

Age at Encounter (Years)	
Mean (SD)	50.6 (17.7)
Patient sex	
Female	818 (72.3%)
Male	313 (27.7%)
Race	
White	847 (74.9%)
Black or African American	176 (15.6%)
Asian	63 (5.6%)
Other	45 (3.9%)
Ethnicity	
Not Hispanic/Latino	1058 (93.5%)
Hispanic/Latino	21 (1.9%)
Unknown	52 (4.6%)
Distance in miles	
Median	18.0
Q1, Q3	7.0, 45.9
Range	0.4–559.3
State	
North Carolina	1067 (94.3%)
Virginia	41 (3.6%)
South Carolina	20 (1.8%)
Tennessee	2 (0.2%)
Georgia	1 (0.1%)

Note: For race, "other" consists of American Indian or Alaskan Native, Native Hawaiian or Other Pacific Islander, Multiracial, and other.

TABLE 2. Univariable Analysis of Duration of Dermatitis in Months

	Study Population	Sex		Race			Insurance Payor			County Poverty >20%		Metropolitan Area (Urban-Rural Status)		
		Female	Male	White	Black or African American	Asian	Other	Commercial	Medicaid	Medicare	No	Yes	No	Yes
	Total	n = 818	n = 313	n = 847	n = 176	n = 63	n = 45	n = 907	n = 42	n = 141	n = 1102	n = 29	n = 147	n = 984
Median, mo	14	14	13	13	16.5	12	15	14	18.5	12	13	24	18	13
Q1, Q3, mo	7, 36	6, 36	8, 38	7, 36	6, 60	6, 24	7, 60	7, 42	7, 36	6, 36	7, 36	10, 36	8, 36	7, 40
Range, mo	0-720	0-720	0.3-636	0-720	1-720	0.8-360	3-300	0-720	1-264	0.5-720	0-720	2-240	0.5-720	0-720
		P = 0.35*			P = 0.27*				P = 0.54*		P = 0.21*		P = 0.41*	

Note. For race, "other" consists of American Indian or Alaskan Native, Native Hawaiian or Other Pacific Islander, Multiracial, and other.

*P value determined using Kruskal-Wallis test.

duration of dermatitis for insurance payor, county poverty rate, rural-urban status, and race.

In the generalized linear model analysis, distance to the patch test clinic was statistically significantly associated with duration of dermatitis ($P < 0.001$; Table 3). For each 50-mile increase in distance from the patient's zip code to the patch test clinic, the median duration of dermatitis increased by 17.9% (95% CI, 7.4%–29.4%; Fig. 2). The county poverty rate was also statistically significantly associated with duration of dermatitis ($P = 0.032$). For every 5% increase in the county poverty rate, the median duration of dermatitis increased by 16.3% (95% CI, 1.3%–33.6%). No statistically significant correlations were found between duration of dermatitis and age, sex, race, payor group, or rural-urban status.

DISCUSSION

In this retrospective analysis, distance to the Duke Contact Dermatitis and Patch Test Clinic and county poverty rate were statistically significantly associated with duration of dermatitis before patch test clinic presentation. There was not a statistical association between age, sex, race, payor group, or rural-urban status on the duration of dermatitis. However, we saw trends for payor group, rural-urban status, and race. These trends indicate that patients with Veterans Affairs (VA) and Tricare and Medicaid insurance, those living in rural areas, and black patients had the longest duration of dermatitis before presentation to the patch test clinic.

Prior studies have examined the relationship between distance to provider and stage at diagnosis for cancer patients^{8,15,17,23–25} and phototherapy adherence.¹⁶ Jain et al¹⁷ found that patients who traveled more than 300 miles were more likely to be diagnosed with advanced stage Merkel cell carcinoma. Similarly, a study in North Carolina found that, for each mile increase in distance to the diagnosing provider, melanoma Breslow thickness increased by 0.6%.⁸ Weng et al¹⁶ found that patients who lived farther than 5 miles from the phototherapy center were less likely to adhere to phototherapy. In this study, distance from the clinic was associated with duration of dermatitis before presentation to clinic. It is not difficult to imagine that distance could be a barrier for physicians hoping to send their patients for specialty patch testing and for physician knowledge that specialty referral opportunities exist. Similarly, patients may be less accepting of long travel distances for appointments or may not have resources to make longer trips. Further exploration of the source of barriers to specialty patch test referrals is needed.

Poverty status has been associated with a lesser likelihood of receiving biventricular pacing in heart failure patients²⁶ and reduced general survival time and breast cancer survival time in breast cancer patients.²⁷ Our study identified a significant association between county poverty rate and duration of dermatitis before patch test clinic presentation. It should be kept in mind that in our study, only 29 patients were identified as living in a county with a greater than 20% poverty rate; this small sample size may affect applicability of results. In addition, county poverty rate does not confirm individual

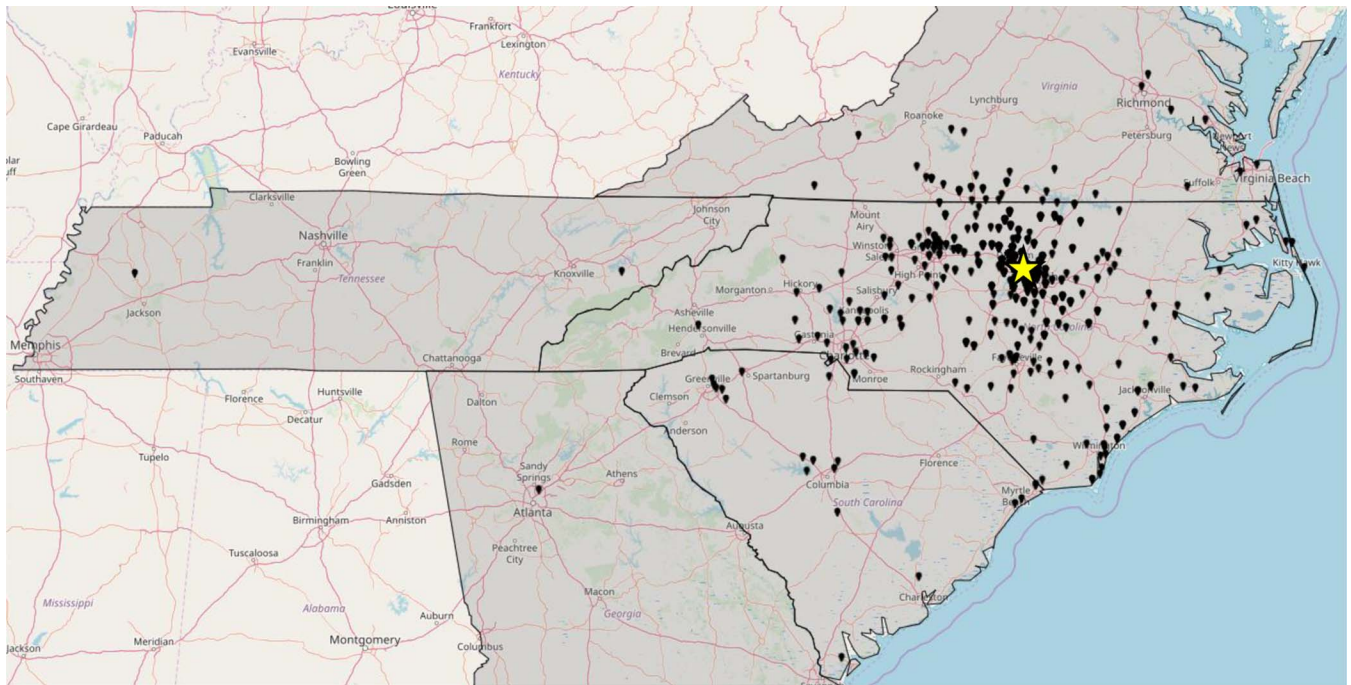


Figure 1. Study population map. Each data point represents 1 patient zip code. The yellow star indicates the location of the Duke Contact Dermatitis and Patch Test Clinic.

poverty status, making this data point potentially less useful. Further studies should investigate the effect of poverty on duration of dermatitis in a larger population.

Racial disparities in medicine are well documented. Specific to dermatology, an analysis of federal survey data revealed that the annual likelihood of black and Asian patients to see a dermatologist was lower than that of white patients¹⁸; in another study, black and Asian patients with bullous pemphigoid were more likely to be admitted to the hospital than white patients.²⁸ In addition, surgical delay of treatment of melanoma has been reported to be more likely if patients are nonwhite.¹⁹ Few studies have addressed US-based

demographic factors such as race or ethnicity in the setting of ACD. The North American Contact Dermatitis Group investigated race and ethnicity in the setting of patch test results.¹³ The study population included 7.1% black patients and 92% white patients. They reported that black patients were more likely to have baseline atopic dermatitis and asthma, were more likely to receive a final diagnosis of atopic dermatitis, and had statistically different rates of patch test reactions. The etiology of the differences in patch test reactions was not known, but they hypothesized that they were related to exposure patterns. The Pediatric Contact Dermatitis Registry evaluated the distribution of race and ethnicity in a patch test population across

TABLE 3. Predictors of Duration of Dermatitis

Parameter	Ratio	95% Confidence Limits		P
Distance (50-mile increase)	1.179	1.074	1.294	<0.001
Age (with 10-year increase)	0.977	0.931	1.025	0.341
Sex: female vs male	0.922	0.774	1.099	0.363
Race: Black/African American vs white	1.136	0.910	1.418	0.260
Race: Asian vs white	0.808	0.571	1.142	0.226
Race: other vs white	1.330	0.889	1.990	0.166
Payor: Medicaid vs commercial	0.893	0.587	1.358	0.595
Payor: Medicare vs commercial	0.886	0.686	1.144	0.354
Payor: VA and Tricare vs commercial	1.096	0.719	1.669	0.670
Poverty rate (5% increase)	1.163	1.013	1.336	0.032
Metropolitan area: yes vs no	1.194	0.911	1.565	0.199

Exponential estimates of the generalized linear model with 95% CIs. The exponentiated estimate is the ratio of the geometric mean (median). P values < 0.05 were considered statistically significant.

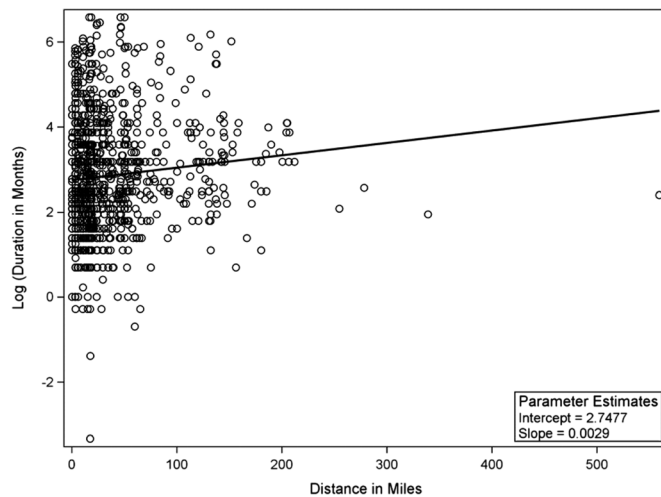


Figure 2. Bivariate relationship between duration of dermatitis and distance to patch test clinic. The natural log of duration of dermatitis is plotted against distance. The line represents the linear regression line.

34 US states in 2015 to 2016; this study included 12% black patients, 15.7% Hispanic patients, 7.1% Asian patients, and 57% white, non-Hispanic patients.^{14,29} The authors theorized that minority groups may not be adequately represented in patch test studies because of a lack of geographic diversity in researchers along with socioeconomic factors, such as language barriers, low rate of medical insurance coverage, lower income, and limited knowledge of health services.¹⁴

A US population statistics report from 2017 documents 14.6% black individuals³⁰; our study included 15.6% black patients, which closely parallels these statistics. The 2017 North Carolina Census Bureau, however, reported a black population of 24%.³¹ Although our study numbers are representative of the US black population, there is still room for improvement in terms of representing the black population of North Carolina. In addition, our study does not adequately represent the Hispanic/Latino community of North Carolina; our study included 1.9% Hispanic/Latino and 9% of North Carolina residents identify as Hispanic/Latino.³² Better representation of minorities in patch test and contact dermatitis research is necessary and will help us to better understand disease processes and management in patients with skin of color.

Insurance type has been associated with decreased frequency of dermatology visits,¹⁸ later stage diagnosis and surgical delay in melanoma,^{19,33} and morbidity and mortality in bullous pemphigoid.²⁸ Mulcahy et al¹⁸ reported that Medicaid enrolled patients were less likely to see a dermatologist than those with private insurance and were less likely to receive a diagnosis from a provider. Another study reported that Medicaid patients are also more likely to present with later stage melanoma³³ and experience surgical delays compared with those with private insurance.¹⁹ Ren et al²⁸ reported that bullous pemphigoid patients with Medicaid and Medicare have increased hospitalization rates and those with Medicaid have increased mortality rates. Similarly, our study identified a trend that patients with VA and Tricare insurance and Medicaid insurance had a longer

duration of dermatitis before presentation to the clinic. Fewer published studies exist on civilian dermatology access for VA- and Tricare-insured patients, possibly because many of these patients are cared for within the VA system or because they are pooled with other insurance types in studies. Analysis of a larger population of patients with VA and Tricare and Medicaid insurance may be necessary to further analyze this trend for delay in care.

Rural-urban status was the final factor noted to be a trend for increased duration of dermatitis. A 2009 dermatology workforce study in Ohio did not find a difference between urban and rural wait times to see a dermatologist.³⁴ Although differences between rural and urban wait times are not traditionally noted for general dermatology care, it may be more difficult for rural patients to access comprehensive patch test dermatology care as these specialty centers are frequently located in metropolitan areas. This may be a factor of greater distance to the clinic, or could be related to cultural differences or preferences specific to medical care.

LIMITATIONS

There are several limitations to this study. First, this is a single-center study, thus, the distance to the Duke Contact Dermatitis and Patch Testing Center may not be representative of other patch test centers across the United States. In addition, several of the socioeconomic categories did not have large enough sample sizes to accurately compare the duration of dermatitis. Specifically, the American Indian/Alaskan Native, Native Hawaiian/Other Pacific Islander, Multiracial, and other categories had small sample sizes. Similarly, the number of patients who identified as Hispanic/Latino and those designated as low poverty rate was low. Poverty rate was based on zip code and not income; this designation may have missed patients who individually qualified as poverty status. Human error could have been introduced as the duration of dermatitis was manually extracted from the electronic medical record. Finally, there is risk of recall bias, because the duration of dermatitis was recorded in the medical record based on patient recall.

CONCLUSIONS

We identified a significant relationship between duration of dermatitis and both distance to the contact dermatitis clinic and county poverty rates. In addition, trends existed for race, payor status, and rural-urban status. Further work is needed to explore these very important potential relationships between patient access to comprehensive contact dermatitis and patch testing care and demographic and socioeconomic factors.

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