Rural melanoma patients in Maryland do not present with more advanced disease than urban patients

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Abstract

Purpose: Rural populations have higher poverty rates, lower educational attainment, higher smoking rates, lower rates of health insurance, higher proportions of elderly individuals, decreased access to health services including dermatology, higher all-cause mortality, and higher mortality from melanoma. Despite these disparities, rural patients have not been adequately studied within the dermatologic literature, particularly at geographic units smaller than the county level.

Methods: We used zip codes and Rural Urban Commuting Area (RUCA) codes to conduct a cross-sectional study on the prevalence and severity of melanoma among 31,750 rural versus urban patients treated by the Johns Hopkins Department of Dermatology from January, 2016 to June, 2017.

Results: Compared to urban patients, rural patients had a 2.6 times higher melanoma prevalence (P<0.0001), travelled much greater distances for treatment (101.8 miles versus 17.7 miles, P<0.0001), and lived in zip codes with median household incomes $18,188 lower ($58,718 versus $76,906; P=0.0040). However, there were no significant differences in Breslow depth or clinical stage between rural and urban patients.

Conclusions: Despite having a higher prevalence of melanoma and travelling much greater distances to receive care, rural patients did not present with more advanced disease than their urban counterparts.

Keywords: health disparities, Maryland, melanoma, rural, urban

Introduction

Rural populations have higher poverty rates, lower educational attainment, higher smoking rates, lower rates of health insurance, higher proportions of elderly individuals, decreased access to health services, and higher all-cause mortality across all age groups [1,2]. They also spend more time outdoors than urban populations and are more likely to work outdoors [3]. Such factors place rural patients at higher risk of melanoma and poor skin cancer outcomes. Studies using the Surveillance, Epidemiology, and End Results (SEER) cancer registries have reported higher incidence and mortality from melanoma in rural areas of the U.S. as well as lower likelihoods of receiving sentinel lymph node biopsies, which are widely regarded as the standard of care [1,4,5]. Rural patients are also less likely to live in a county with a dermatologist and to travel farther distances to receive care, leading to worse melanoma outcomes. In a landmark review of the SEER and other cancer registries, Aneja et al. reported that a large proportion of counties in the United States have no dermatologists per 100,000 people, particularly in rural areas of the central U.S. (**Figure 1**). Aneja et al. also reported that the presence of one dermatologist per 100,000 people was associated with a 35% reduction in melanoma mortality rate and the presence of two dermatologists per 100,000 people was associated with a 53% reduction in melanoma mortality [6]. Similarly, Stitzenberg et al. reported that for each one-mile increase in distance that melanoma patients in North Carolina traveled to see their diagnosing provider, Breslow thickness increased by 0.6% [7]. Although rural communities comprise 19% of the U.S. population and face unique barriers to obtaining dermatologic care, they have not been adequately studied within the dermatologic

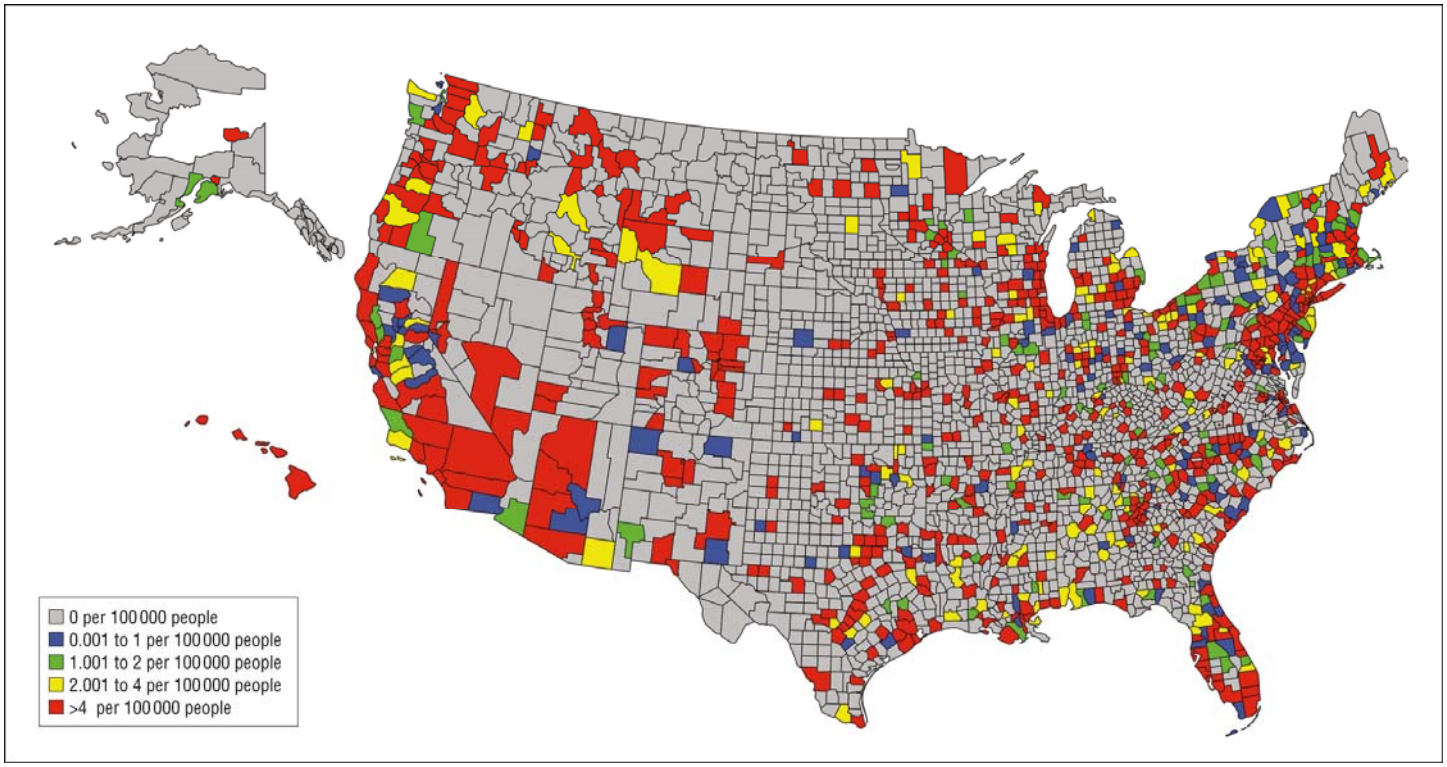

Figure 1. *Large portions of the United States have no dermatologists per 100,000 people. Reprinted with permission [6].*

community, particularly at geographic increments smaller than the county level [8]. We sought to compare rural versus urban dermatology patients in Maryland in melanoma prevalence, melanoma severity, and distance travelled to receive care based on zip code data.

Methods

After approval by the Johns Hopkins Institutional Review Board, all dermatology patients treated at our tertiary care center from January, 2016 to June, 2017 were queried from billing data. A retrospective chart review was completed for all patients treated for melanoma or melanoma in situ (MIS) with a Maryland zip code and complete medical records.

Patients were categorized as Urban Core, Suburban, Large Rural Town, or Small Rural Town according to Rural Urban Commuting Area (RUCA) codes [9]. Zip codes were converted to RUCA codes according to guidelines published by the Federal Office of U.S. Health Policy and the U.S. Department of Agriculture based on 2010 U.S. Census data [10]. Rural Urban Commuting Area codes were categorized as Urban Core, Suburban, Large Rural Town, and Small Rural Town according to the *tier4 2010 RUCA commuting* classification scheme [10].

Chi-squared and t-tests were used to compare demographic factors between rural versus urban patients. To study the relationship between outcomes (Breslow depth and clinical stage) and covariates, we used linear regression for continuous outcomes, logistic regression for binary outcomes, and multinomial logistic regression for categorical outcomes. Owing to skewed distribution, Breslow depth was log transformed prior to analysis. Univariate and multivariate analyses were used to assess relationships between Breslow depth, clinical stage, and covariates. All regression analyses were performed in R 3.5.0 (R language, Vienna, Austria).

Results

Prevalence of melanoma among rural, suburban, and urban patients

A total of 37,234 dermatology patients were seen at our tertiary care center from January, 2016 to June, 2017; 31,750 were Urban Core (85.3%), 4,621 (12.4%)

Table 1. *Prevalence of melanoma and melanoma in situ (MIS) among rural, suburban, and urban patients treated by Johns Hopkins Dermatology from January, 2016 to June, 2017**.

RUCA Code	Total Patients Seen By Johns Hopkins Dermatology (N=31,750)	Patients with Melanoma/ Melanoma in Situ (N=366)	% Dermatology Patients with Melanoma/ Melanoma in Situ
Urban Core (UC)	31750	308	0.97%
Suburban (S)	4621	36	0.8%
All Rural (R)	863	22	2.5%
Large Rural Town	597	16	2.7%
Small Rural Town	266	6	2.3%**
P-value: UC versus R	P<0.0001 (95% CI 0.7–2.8)		

**Patients identified from International Classification of Diseases Tenth Revision diagnostic codes.*
***The prevalence of melanoma/melanoma in situ was 2.6 times higher among rural versus urban patients (P<0.0001).*

were Suburban, and 863 (2.3%) were Rural (**Table 1**). Of the rural patients, 597 (69.2%) lived in large towns (10,000–49,999 people) and 266 (30.8%) lived in small towns (2500–9999 people), [9,10].

During this 18-month period, 366 patients were treated for melanoma/MIS; 308 (84.2%) were Urban Core, 36 (9.8%) were Suburban, and 22 (6%) were Rural. The prevalence of melanoma/MIS was 0.98% in total but 2.6 times higher among rural versus urban patients (2.5% versus 0.97%, P<0.0001, 95%CI=0.7–2.8).

Demographics of melanoma and melanoma in situ (MIS) patients

Complete data was available for 292 urban melanoma/MIS patients, 36 suburban patients, and 22 rural patients (**Table 2**). Rural patients travelled nearly six times farther than urban patients to receive melanoma care (102 versus 18 miles, P<0.0001, 95% CI=77–91) and lived in zip codes with median household incomes $18,188 lower ($58,718 versus $76,906, P=0.0040, 95%CI=-30,530 – -5845). There was no statistically significant difference in mean age at diagnosis, smoking history, gender distribution, or history of non-melanoma skin cancers (NMSC).

Table 2. *Demographic factors for rural versus urban melanoma patients.*

	Urban Core (N=292)	Suburban (N=36)	Rural (N=22)	P-values Rural versus Urban (95% CI)
Mean distance travelled, miles	17.7 (SD 13.7)	48.6	101.8* (SD 33.7)	<0.0001 (77 – 91)
Median household income by Zip code**	$76,906 (SD 29,363)	$87,194	$58,718*** (SD 3,499)	0.0040 (-30,530 to -5845)
Mean household income by Zip Code**	$95,473 (SD 38,880)	$99,428	$76,054 (SD 9,132)	0.0202 (-35,785 to -3052)
Mean age at diagnosis, years	61.4 (SD 15.4)	58.8	62.8 (SD 13.0)	0.6783 (-5 – 8)
Smoking status (current/former)	34.2%	33.3%	35.0%	0.9393 (-16 – 22)
Non-melanoma skin cancers****	35.5%	45.7%	36.4%	0.9323 (-17 – 22)
Gender (%)	Male: 54.8% Female: 45.2%	Male: 52.8% Female: 47.2%	Male: 59.1% Female: 40.9%	0.6962 (-16 – 23)
Diagnosis:	Melanoma: 67.5% MIS: 32.5%	Melanoma: 61.1% MIS: 38.9%	Melanoma: 54.5% MIS: 45.5%	0.2133 (-6 – 33)

**Rural patients travelled nearly six times farther than urban patients to receive melanoma care (P<0.0001).*
***Calculated from the mean of the median/mean household income by Zip code.*
****Rural patients lived in zip codes with median household incomes $18,188 lower than urban patients (P=0.004, similar trend for mean household income data).*
*****Prior or concurrent basal cell carcinoma or squamous cell carcinoma (including in situ disease).*

Table 3. *Melanoma features and severity for rural, suburban, and urban patients.*

	Urban core (N=292)	Suburban (N=36)	Rural (N=22)	P-values Rural versus urban (95% CI)
Pathologic Features				
Mean Breslow Depth, (mm)	1.652 (SD 2.85)	0.621	0.953 (SD 1.55)	0.2566 (-1.9 – 0.5)
Breslow Depth >1mm (%)	37.0%	12.5%	16.7%	0.0556
Breslow Depth >2mm (%)	22.1%	8.3%	8.3%	0.1269
Breslow Depth >4mm (%)	10.1%	0%	8.3%	0.7862
Ulceration (%)	7.5%	8.3%	9.1%	0.7853
Mitoses/mm2, mean (SD)	2.70 (7.5)	1.42 (4.5)	1.92 (4.3)	0.6306
Clinical Stage*				
Stage 0 (MIS)	28.5%	38.9%	45.5%	0.0929
Stage 1 (a/b)	52.5%	52.8%	50.0%	0.8212
Stage 2 (a/b/c)	11.7%	5.6%	4.5%	0.3025
Stage 3	6.9%	2.8%	0%	0.2035
Stage 4	0.3%	0%	0%	0.7973
Stage 2+ at Diagnosis	19.0%	8.3%	4.5%	0.0882
Stage 3+ at Diagnosis	7.0%	2.8%	0%	0.2001
Location				
Head/Neck	27.9%	16.7%	31.8%	0.6954
Back/Trunk	28.9%	36.1%	31.8%	0.7731
Extremities	44.4%	47.3%	31.8%	0.2511
Groin/Buttocks	0.3%	0%	4.5%	**0.0136**
Sun-Exposed**	72.3%	64.0%	63.6%	0.3832

**Clinical staging based on the American Joint Committee on Cancer (AJCC) Seventh Edition Melanoma Staging System. Clinical staging was not available for 17 Urban Core patients.*

***Sun-exposed location defined as: head, neck, upper extremities, and lower extremities.*

Breslow depth

There was no statistically significant difference in Breslow depth between rural and urban patients (**Table 3**). Urban patients had Breslow depths 1.54 times greater than rural patients, although not statistically significant (P=0.16, 95% CI=-1.9–0.5). On multivariate analysis, Breslow depth was negatively associated with distance travelled (OR=0.842, P=0.03, SE=0.06) and history of NMSC (OR=0.604, P=0.002, SE=0.16). On univariate analysis, Breslow depth was also positively associated with smoking history (OR=1.70, P=0.0003, SE=0.14), sun-exposed body site (OR=1.36, P=0.03, SE=0.14), and desmoplastic histology (OR=5.31, P=1E-5, SE=0.37). Medicare insurance was associated with 2.4 times greater odds of having a Breslow depth ≥2mm (P=0.05, SE=0.45).

Clinical stage

There were no statistically significant differences in clinical stage between rural and urban patients (**Table 4**). On univariate analysis, urban patients had 6.39 times greater odds of having a clinical stage ≥2, although not statistically significant (P=0.08, SE=1.1). Clinical stage ≥3 was positively associated with Medicare insurance (OR=3.26, P=0.05, SE=0.62) but negatively associated with distance travelled (OR=0.09, P=0.009, SE=0.02) and history of NMSC (OR=0.30, P=0.041, SE=0.58).

Discussion

Compared to urban patients, rural Maryland patients treated at our large tertiary center had a higher prevalence of melanoma, lived in zip codes with lower median household incomes, and travelled

Table 4. *Univariate and multivariate analyses of melanoma outcomes (Breslow depth and clinical stage).*

	Breslow Depth* Univariate	BD <1mm versus ≥1mm	BD <2mm versus ≥2mm	BD <4mm versus ≥4mm	Breslow Depth Multivariate	Clinical Stage 0 versus 2+	Clinical Stage 0 versus 3+
	Odds Ratios (P-value; Standard error). Emboldened text, P<0.05						
Urban versus Rural	1.54 (0.17; 0.31)	2.94 (0.17; 0.79)	3.12 (0.28; 1.1)	1.24 (0.84; 1.1)		6.39 (0.08; 1.1)	3418 (0.82; 36)
Suburban versus Rural	0.744 (0.42; 0.37)	0.714 (0.73; 0.99)	1.00 (1.00; 1.3)	9.51×10^{-8} (0.99; 1331)		2.14 (0.53; 1.2)	922 (0.85; 36)
Female versus Male	0.940 (0.65; 0.13)	1.052 (0.850; 27)	0.912 (0.78; 0.32)	0.502 (0.15; 0.48)	0.856 (0.28; 0.14)	1.19 (0.59; 0.33)	1.45 (0.42; 0.46)
Median Income by Zip Code	1.00 (0.41; 2×10^{-6})	1.00 (0.38; 5×10^{-6})	1.00 (0.62; 6×10^{-6})	1.00 (0.52; 8×10^{-6})		**1.00 (0.0006; 2×10^{-6})**	**1.00 (5×10^{-5}; 3×10^{-6})**
Distance Traveled	**0.992 (0.003; 0.002)**	**0.977 (0.005; 0.008)**	0.987 (0.12; 0.008)	0.993 (0.52; 0.01)	**0.842 (0.03; 0.06)**	**0.976 (0.005; 0.009)**	**0.0954 (0.009; 0.02)**
Medicare	1.27 (0.28; 0.22)	1.801 (0.16; 0.42)	**2.403 (0.05; 0.45)**	0.986 (0.98; 0.69)		**2.66 (0.04; 0.48)**	**3.26 (0.05; 0.62)**
Medicaid	0.891 (0.66; 0.26)	1.178 (0.75; 0.52)	1.46 (0.51; 0.58)	7.96E-08 (0.99; 1458)		0.488 (0.30; 0.70)	0.427 (0.44; 1.1)
Self-pay	0.955 (0.76; 0.15)	1.023 (0.94; 0.31)	-0.230 (0.55; 0.39)	1.01 (0.98; 0.48)		0.857 (0.69; 0.39)	0.875 (0.81; 0.56)
Age at Diagnosis	**1.01 (0.01; 0.29)**	**1.026 (0.01; 0.63)**	**1.04 (0.002; 0.82)**	**1.05 (0.004; 1.2)**	**1.02 (0.002; 0.005)**	1.01 (0.26; 0.01)	1.01 (0.63; 0.02)
Current/Former Smoking Status	**1.70 (0.0003; 0.14)**	**1.879 (0.03; 0.28)**	**2.73 (0.002; 0.33)**	**5.61 (0.0006; 0.5)**		2.22 (0.02; 0.34)	2.26 (0.08; 0.47)
History of NMSC**	**0.738 (0.0334; 0.14)**	**0.508 (0.02; 0.30)**	0.859 (0.65; 0.34)	1.29 (0.57; 0.45)	**0.604 (0.002; 0.16)**	0.515 (0.07; 0.36)	**0.304 (0.04; 0.58)**
History of Prior Melanoma or MIS	0.805 (0.21; 0.17)	0.617 (0.19; 0.37)	0.924 (0.85; 0.41)	0.920 (0.89; 0.59)		0.928 (0.85; 0.40)	0.966 (0.95; 0.56)
Family History Melanoma/MIS	0.780 (0.18; 0.18)	0.573 (0.20; 0.44)	0.735 (0.58; 0.55)	0.289 (0.25; 1.1)	0.881 (0.40; 0.15)	0.899 (0.85; 0.57)	0.711 (0.69; 0.85)
Sun-Exposed Body Site	**1.36 (0.03; 0.14)**	1.736 (0.06; 0.30)	**2.44 (0.02; 0.38)**	2.59 (0.10; 0.57)		0.945 (0.88; 0.37)	0.771 (0.61; 0.50)
Race (Other versus Caucasian)	1.08 (0.85; 0.41)	0.795 (0.79; 0.85)	1.65 (0.56; 0.85)	1.71 (0.63; 1.1)	0.607*** (0.21; 0.14)	0.954 (0.96; 0.88)	0.0046 (0.73; 16)
Histologic Subtype: desmoplastic versus others	**5.31 (1×10^{-5}; 0.37)**	34780802 (0.98; 0.77)	**2.58 (0.002; 0.83)**	**6.73 (0.01; 0.77)**	1.71 (0.42; 0.67)	2235 (0.77; 26)	4128 (0.87; 51.7)

**Breslow depth values converted to logarithmic scale to account for data not having normal distribution, then converted back. Multivariate value calculated from log of distance travelled.*
***NMSC=Non-melanoma skin cancer.*
****Caucasian race versus other.*

nearly six times farther to receive care. Despite these differences, rural patients did not have more advanced disease than urban patients at time of diagnosis. Although not statistically significant, we observed larger Breslow depths and more advanced clinical stages among urban patients. This may have

been influenced by our urban population coming almost entirely from the city of Baltimore, one of the poorest cities with highest crime rates in the United States, possibly masking disparities between rural and urban patients because both groups in the study were disadvantaged [11,12]. A recent study by Abudu et al. found that patients with Medicaid or no health insurance were two and three times more likely, respectively, to be diagnosed with late-stage melanoma than those with private insurance [13]. Such findings highlight the impact of socioeconomic factors on melanoma outcomes and it is important to note that both rural and low-income urban communities face barriers to skin cancer care.

Surprisingly, distance travelled was associated with shallower Breslow depths and lower clinical stages. It is possible that this relationship was skewed by other confounding factors, such as patient affluence, education level, and motivation to travel great distances to be treated at Johns Hopkins. For example, we may have had a selection bias in which only the most affluent rural patients were able to travel to our tertiary care center. Our study could be missing a significant subset of rural melanoma patients who are unable to travel owing to limited financial resources and thus may have had more advanced disease at time of diagnosis.

In light of such unexpected findings, larger, multi-center studies are needed to better characterize melanoma prevalence, severity, treatment, and mortality among rural populations, particularly in regions of the U.S. where rural areas are larger and more isolated. It is likely that greater health disparities in skin cancer care exist in more remote rural areas that are farther from tertiary care centers. In our study, the mean distance travelled by rural patients was 102 miles. Although such distance undoubtably represents a burden to patients, many patients will be able to drive this distance in a one-day trip. No patients in our study lived in Isolated Rural Areas (fewer than 2500 people and no commuting flow to Urbanized Areas), [9,10]. We suspect that if this study was done in the Western U.S., where rural areas are much larger and there are fewer dermatologists (**Figure 1**), melanoma patients would have to travel greater distances to see a general dermatologist and even farther from home to see a dermatologic surgeon. This would likely result in primary care physicians shouldering greater responsibility for melanoma diagnosis and melanoma patients having more advanced disease at time of diagnosis and higher mortality.

Limitations of this study include small sample sizes for rural and suburban groups and the use of zip codes instead of census tracts for conversion to RUCA codes. Although census tract data has been reported to be more accurate than zip code data for the RUCA coding system, zip codes are the smallest geographic identifiers available in the majority of healthcare datasets and are used in the majority of medical studies involving rural and urban populations [9,10].

Conclusion

Rural patients had a higher prevalence of melanoma than urban patients and travelled greater distances to receive care. Despite these differences, rural patients did not have more advanced disease. Further multi-center studies are needed to better characterize melanoma prevalence, severity, treatment, and mortality among rural populations, particularly in regions of the U.S. where rural areas are larger and more isolated.

Potential conflicts of interest

The authors declare no conflicts of interests.

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