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The Association of Physician Specialty Density and Melanoma Prognosis in the United States, 1988–1993

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Abstract

Background—Studies suggest physician workforce may influence cancer outcomes.

Objective—To quantify the effect of physician-specialty density on melanoma prognosis.

Methods—Data from 17,702 melanoma cases reported to the Surveillance Epidemiology and End Results (SEER) program from 1988–1993 were merged with sociodemographic (1990 US Census) and dermatologists, family practitioners (FP), and internists density data (Area Resouce File). Linear and logistic regression analyses were used to model prognosis: melanoma mortality to incidence ratio (MIR).

Results—A higher density of dermatologists was associated with better prognosis (lower MIR) ($\beta = -50 \times 10^{-4}$; SE 8×10^{-4}). Internist density was also a significant predictor of better prognosis while increased FP density was associated with worse prognosis. Controlling for sociodemographics, physician density remained a significant predictor of the MIR.

Limitations—Socioeconomic factors were estimated. Physician density was examined by county.

Conclusion—Controlling for sociodemographic factors, physician-specialty density predicted melanoma prognosis. This suggests that specialist healthcare availability may affect melanoma outcomes.

Introduction

Melanoma incidence has increased significantly over the past several decades and is responsible for the death of more than 8,000 Americans each year.[1–3]

While melanoma survival in the overall US population is well over 90% at five years and is significantly higher than most other malignancies, survival disparities exist among

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sociodemographic groups.[3–7] For example, the five-year relative survival rate of melanoma is significantly lower for US blacks than for US whites, even if diagnosed with localized disease (black and white 5-year survival respectfully: 86% vs. 97%). [1–4, 8, 9] The explanation for differential survival despite same stage of disease is unclear. While some suggest that more aggressive melanomas in non-whites, such as the acral lentiginous subtype, may be responsible, another potential explanation for these disparities is confounding by socioeconomic position.[6, 7, 10–12] Neighborhood racial heterogeneity, education and median household income have been shown to be significant predictors of melanoma prognosis.[6, 7]

Access to healthcare, independent of SES measures, may also explain racial disparities.[13] Recent studies have suggested that physician workforce composition may influence healthcare delivery and utilization, with physician specialty potentially more important than absolute physician supply.[14–18] Hence, the objectives of this study were to quantify the effect of healthcare provider specialty and density, as an indicator of access to care,[14] on melanoma prognosis in a large dataset representative of the US population: the Surveillance, Epidemiology and End Results (SEER) tumor registry program.

Methods

This is a population-based ecologic analysis of a cohort of melanoma cancer registry patients using data from the SEER-9 program which was linked to the US Census data (socioeconomic estimates) and Area Resource File (physician provider data). Sponsored by the National Cancer Institute (NCI), the SEER program provides the broadest system of cancer registration in the United States, and represents approximately ten percent of the US population in the original nine population-based cancer registries (SEER-9).[8] While the SEER registry is an excellent data resource for the study of melanoma, it is not possible to examine healthcare access factors and their potential impact on mortality with this data alone. By matching SEER data with additional data sources, the contribution of provider specialty and density, a proxy for healthcare access, on melanoma prognosis can be further elicited.

The population sample consisted of all melanoma cases diagnosed between 1988–1993 and reported to the SEER-9 program (SEER Cancer Incidence Public-Use Database, 1973–93. National Cancer Institute, Cancer Statistics Branch, Bethesda, MD. Issued August 1996). The SEER-9 cancer registries include the metropolitan areas of Atlanta, Detroit, San Francisco, and Seattle, and the states of Connecticut, Iowa, New Mexico, Utah and Hawaii. The August 1996 release of the SEER data (the database used for this analysis) is the most recent public-use release of SEER data to indicate census-tract residence of the cancer patient and contains information through 1993. In subsequent public-use releases of the SEER database, geographic residence can only been identified at the county level. Available census tract information allowed us to control for neighborhood contextual factors, including socioeconomic status, which may be associated with health care access and local physician workforce composition.[6, 7] Regretably, because newer releases of the public-use SEER database do not have census tract level identifiers, the newer "expanded" versions of the SEER program (which has slowly expanded to include 21 sites currently, "SEER-21") could not be used, and hence this analysis uses the original SEER-9 program data.

Melanoma was defined using the International Classification of Diseases for Oncology topography codes C44.0–C44.9 and morphology codes 872–879. Using both types of codes, 24,511 cases were identified between 1988–1993. Of these cases, 24,198 cases had Federal Information Processing Standards (FIPS) code available at the state, county and census tract level, which was necessary for merging the SEER data with the most specific available socioeconomic estimates and provider data. In situ melanomas (N=6,496) were excluded from this analysis because diagnoses of in situ melanoma can have a high degree of variability. These exclusions resulted in a total of 17,702 cases of malignant melanoma available for analysis. Malignant melanoma cases were present in 3,335 (97.4%) of the 3,423 census tracts encompassed by the SEER data. There were no cases of malignant melanoma in 88 census tracts (2.6%). The mean number of melanoma patients per census tract was 7 with a standard deviation of 11.1. Of these 17,702 patients available in the SEER data, 1,383 people died with a melanoma-specific cause of death (International Classification of Disease code of 172). The median time of follow-up of the 17,702 patients (from date of diagnosis to end of reporting period or death) was 2 years 3 months.

Dependent Measures

During *a priori* study design, it was also felt that because the SES estimates were aggregate (US Census tract estimates) values, the main dependent variable should also be based on aggregate data at the same level (the census tract). The conceptual outcome, melanoma prognosis, was operationally defined and measured using the melanoma mortality to incidence ratio (MIR), which was calculated by dividing the aggregate number of malignant melanoma-specific deaths in a census tract by the aggregate number of malignant melanoma cases in that census tract (MIR=number of deaths/number of cases). Poor prognosis was defined *a priori* as a MIR of greater than or equal to 0.5, which was felt to be both clinically significant and consistent with the previous use of this dependent measure in the literature.[5] Alternative operational definitions (individual-level variables) of prognosis were also included to allow comparison to other studies. Breslow thickness, a common proxy for prognosis, was assessed as a continuous variable (as recorded to the nearest 0.01mm).[19] Melanoma-specific death and advanced stage melanoma at time of diagnosis (Stage III and Stage IV) were also examined. Advanced stage melanoma at time of diagnosis was operationally defined using information on lymph node involvement (greater than or equal to one positive node) and extension of disease (satellite nodules, involvement of underlying cartilage, bone, muscle or further, metastasis of skin or subcutaneous tissue beyond nodes, or visceral metastasis).

Independent Measures

Data from the Area Resource File (ARF) (circa 1990), maintained by the US Health Resources and Services Administration's Bureau of Health Professions contains information at the county level and was used to estimate health provider access, including the number of dermatologists, family physicians, and internists in 1990 (American Medical Association Physician Master Files) which were then divided by 1990 US census population estimate for that county to determine the numbers of particular specialty providers per 100,000 population. We did not have data for smaller geographic areas than counties.

Confounding Variables

Potential confounding variables included patient age, gender, marital status, race, and ethnicity. Individual-level variables were obtained from the SEER data, including age at diagnosis, gender, marital status (dichotomous variable compared to single), Race (dichotomous variable compared to White), and Hispanic ethnicity. Hispanic ethnicity, determined in SEER by origin of maiden or surname, was non-significant in all analyses and hence not included in the final model. In the models, we controlled for socioeconomic factors using 1990 United States Census information at the census tract level. Census-tract level SES factors that were included were educational attainment (proportion of population with less than a high school degree), racial composition of the community (proportion of overall tract residents that were white), and median household income (in $10,000 dollar increments).

Analyses

Statistical analyses utilized SAS 8.2 software (Statistical Analyst Systems, Cary, NC). Pearson Correlation coefficients were calculated to determine the correlation between types of providers and between provider density and prognosis (mortality to incidence ratio). Multiple linear regression was used to model the relationship between the provider access variables and the continuous dependent variables (MIR and Breslow thickness), controlling for census-tract socioeconomic characteristics. Multiple logistic regression was used to model the dichotomous dependent variables: death from malignant melanoma and advanced stage melanoma, controlling for socioeconomic characteristics. Finally, a multiple linear regression model of our primary operational definition of prognosis, MIR, was fitted that included individual-level demographic data from the SEER files, tract-level SES estimates from the 1990 US Census data, and county-level access to care predictors (physician specialty and density measures) from the 1990 Area Resource File.

The study was reviewed and approved by the Brown University Institutional Review Board.

Results

The density of providers in SEER counties was examined for dermatologists, family practitioners, and internists. The median density of dermatologists was 3.4 dermatologists per 100,000 population (Range: 0–27 dermatologists per 100,000 population). The median density of family practitioners (FPs) was 13.9 FPs per 100,000 population (Range: 0–87 FPs per 100,000 population) and the median density of internists was 33.7 (Range: 0–161 internists per 100,000 population). The density of dermatologists was highly correlated with the density of internists (r=0.8; p<0.0001) but less correlated with the density of FPs (r=0.1; p<0.0001). There was a negative correlation between the density of internists and that of family practitioners (r= −0.4; p<0.0001). Prognosis (operationally defined as the mortality to incidence ratio (MIR)) was negatively correlated with both the density of dermatologists (r= −0.04; p<0.0001) and density of internists (r= −0.03; p<0.0001), which suggests a better prognosis in counties where there are more dermatologists and internists. MIR was positively correlated with the density of FPs (r=0.03; p=0.0003), suggestive of a slightly worse prognosis in areas with more FPs.

The relationship of physician density in these specialties and melanoma prognosis was then examined. A higher density of dermatologists was associated with a lower mortality to index ratio (MIR) and decreased Breslow thickness (better prognosis, Table I). However, a higher density of FPs predicted a larger MIR and increased Breslow thickness (worse prognosis, Table I) Internist density was also a significant predictor of a better prognosis (larger MIR) when only provider density was examined. Controlling for socioeconomic factors, dermatologist and FP density persisted as significant predictors of MIR but density of internists was no longer significant. Provider density accounted for minimal variance in prognosis (R^2=0.03).

The secondary (alternative) dependent prognostic variables and their relationship with specialty provider density were also examined. A higher density of dermatologists was predictive of a less advanced stage of melanoma at time of diagnosis and a lower likelihood of death from malignant-melanoma. (Table II). Family Practitioner density was a significant predictor of both advanced stage of melanoma and death. The density of internists was not a significant predictor of advanced stage or death.

After controlling for socioeconomic factors, increased Breslow thickness was significantly predicted by the density of FPs, but not by density of dermatologists or internists (Table I). After controlling for socioeconomic indicators, only FP density was predictive of advanced stage of melanoma or death.

Prognosis (MIR) was then modeled using individual-level demographic factors in the SEER data, US Census tract socioeconomic predictors, and physician specialty and density from the Area Resource File (Table III). Worse prognosis (higher MIR) was predicted by a lower density of dermatologists per county, a higher density of family practitioners, and census tracts with smaller proportions of white residents, lower median household incomes or larger percentages of residents who had less than a high school education. In addition, being male, older, black or Native American (as compared to white), or married, widowed, divorced or separated (as compared to single) was predictive of worse prognosis.

Discussion

This study, which examines multiple operational definitions of prognosis that are relevant to melanoma, illuminates the potential role of access to healthcare in melanoma outcomes, an area in which there has been limited study. In this study, we examined the provider density and specialty type, factors which may reflect potential access to care. Findings from this study suggest that access to specialty care may explain some differences in melanoma prognosis. Alternatively, unmeasured factors associated with melanoma prognosis may be determinants of density of physicians in these specialties. Melanoma patients who live in places with more dermatologists appear to have better prognosis, however those who live in areas with more family practitioners may potentially have worse prognosis.

Density and specialty of physician appear to be significant predictors of melanoma prognosis, regardless of patient socioeconomic status. Regardless of age, sex, race, marital status, or SES, physician density in these specialties were found to be significant predictors of melanoma prognosis, operationalized as the melanoma mortality to incidence ratio. While the literature in this area of access to care and melanoma prognosis is limited, these findings are consistent with other studies.

Roetzheim and colleagues[15] examined predictors of racial differences in stage of melanoma at diagnosis in Florida. While they were unable to completely explain racial difference, they did find that people who had limited access to care were more likely to be diagnosed with late stage cancer.[15] They found that for each additional dermatologist per 10,000 population, there was an increased odds of earlier diagnosis (OR 1.39), suggesting that physician composition could impact health outcomes in melanoma.[16] In a subsequent study, Roetzheim et al. [20] found that physician supply explained a portion of the variability in melanoma incidence and mortality rates. An increasing supply of dermatologists was associated with a lower overall mortality rate.[20] These findings are consistent with our findings that melanoma patients who reside in counties with more dermatologists per 100,000 population have better prognostic outcomes (lower MIR) than those who live in areas with fewer dermatologists. However, unlike Roetzheim et. al, we did not find a protective effect for supply of family practitioners or a significant detrimental effect for density of internal medicine physicians.

In a study of Novia Scotia melanoma patients, DiQuinzio and colleagues[17] used a provincial billing database to examine utilization of family practitioner services and melanoma thickness.[17] They found that patients with melanoma who had not consulted a family physician in the two year period before diagnosis were more likely to have melanomas thicker than 0.75mm. They also found that patients seeing the same physician, as opposed to multiple different providers, also were at lower, though statistically insignificant, risk for having a thicker than 0.75mm melanoma at time of diagnosis. Patients living in rural areas were also more likely to have thicker melanomas at time of diagnosis.[17] Di Quinzio et al.[17] believed the thicker melanomas seen in patients having a rural residence supported a role of geographic barriers to care and delayed diagnosis.

In a cohort of 2020 Medicare patients, Pennie et al.[18] examined melanoma detection by dermatologists compared to non-dermatologists (defined as family practitioners, internists, general practitioners, obstetricians, plastic surgeons, and oncologists).[18] Diagnosis of melanoma that was attributed to detection by a non-dermatologist was associated with an increased Breslow thickness and with more late stage melanomas (Regional/Stage III and Distant/Stage IV) at time of diagnosis compared to melanoma that was diagnosed by a dermatologist. Rural residence was not associated with 2-year survival.

In a study examining melanoma diagnosed in 42 counties in North Carolina in 2000, Stitzenberg and colleagues found that the median Breslow thickness diagnosed by dermatologists was significantly less (0.5mm) than that by other providers.[21] While they found that the absolute number of dermatologists corresponded to a decrease in melanoma thickness by 0.09% per additional dermatologist, they found no association with density of dermatologists per 100,000 per county. In multivariate analysis examining distance, demographics, poverty, and absolute number of dermatologists/county, they found only that distance and age >80 years old predicted Breslow thickness. Patients who lived in counties with at least 1 dermatologist traveled approximately 8 miles less regardless of who diagnosed their melanoma and the authors theorized that proximity to dermatologic care was a marker of increased supply of local health care resources.

There are likely several ways in which specialty and density of provider may be related to care access. First, while we are unable to demonstrate that more physicians translates to more people seeing physicians or reduced wait time in scheduling appointments, higher physician density may be related to higher community demand for health services. Residents in areas with more primary care physicians are more likely to report a usual source of care.[14] Second, there is a higher density of physicians and more specialty providers in urban as opposed to rural areas with specialty providers tending to cluster in a tertiary care (as opposed to primary care) setting. Therefore, geographic proximity (i.e. travel distance) to care may also be an underlying factor in these measures. Third, it is possible that more physicians, including in-demand specialty providers like dermatologists, may in some regions facilitate ease and speed of care-referral. Higher dermatology density may translate to earlier detection (definitive diagnosis by biopsy) or initiation of treatment (wide excision). Fourth, the economic success of a community might impact the availability of providers, including the difficulty of attracting and retaining care providers. Furthermore, provider density and specialty may be influenced by the economic viability of a region (e.g. communities struggling economically or with higher unemployment may have less corporate-funded health insurance coverage or other available local healthcare resources and hence be less able to support providers than communities with better economic climates), Finally, there may be social or other factors that determine the areas in which family physicians or dermatologists practice that also influence the propensity of members of the community to self-detect their melanomas early, and hence the prognosis of those melanomas. Increased physician density could be capturing different healthcare utilization (people from various regions of the country may visit physicians, including specialists, with different frequencies or they may feel more or less comfortable addressing their problems with primary providers).

There are several notable limitations of this study. First, while the results are generally felt to be representative of the US population, they may not be generalizable outside of the SEER-9 population or the United States. Second, only select access to care and socioeconomic factors were examined. These socioeconomic and access to care factors were not available at the individual level and had to be examined in aggregate at the census tract or county levels. However, these methods of applying aggregate measures are generally accepted for use with many datasets, including the SEER-Medicare data, and are generally believed to provide reasonable estimates of actual individual values (e.g. median household income has been

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reported to be well correlated with self-reported individual income).[22] Third, the use of physician specialty density is only a proxy for access to care, and may not always correlate to access in certain areas.[23] More specific measures of care access should be examined, including access to physician services (e.g. need for referral for specialty care) and preventive care use. Fourth, results may be confounded by variables not examined. It is likely that there are other factors not examined in this study which may contribute to prognosis, such as health insurance or perhaps health care quality itself. We did not have estimates on geographic barriers, rural residence, or direct health care utilization. Next, because census tract data on cancer cases is only available publicly before 1993, the data may not represent the current state of melanoma outcomes, including the reported stabilization of melanoma mortality noted recently.[2] However we felt that it was important to use census-tract level information because tract data, as compared to county-level data, provided a narrower estimate for socioeconomic status. We regret that tract level data was unavailable for the physician specialty density data. Finally, the density of internists presumably encompasses internal medicine subspecialty providers (e.g. cardiologists, gastroenterologists,etc.), which may explain the insignificant findings for density of internists. If internal medicine data includes all medical sub-specialists, this may also explain the very high correlation between density of internists and density of dermatologists and limits comparisons of internists with dermatologists or family practitioners.

In conclusion, this study examines melanoma prognosis and density of physicians in dermatology, internal medicine, and family practice in a population representative of the United States. While personal risk factors as well as occupational and environmental hazards across social strata remain important in melanoma prognosis, there may be a contribution of inequity of access to, and use of, preventive and therapeutic medical care, including specialty provider accessibility. Increased efforts to recruit physicians, especially specialty physicians like dermatologists, to underserved communities may be indicated to improve the melanoma prognosis in the US. However, with wait times of sometimes as much as several months for an evaluation by a dermatologist even in some large metropolitan areas, many more communities than would be expected may actually be “underserved” in terms of dermatologic care.[23]

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Table I

Relation between health provider density (providers per 100,000 population) and the melanoma Mortality to Incidence Ratio (MIR) and Breslow thickness, controlling for Socioeconomic Status (SES)**, SEER-9 program 1988–1993.

	Mortality to Incidence Ratio (MIR)			Breslow Thickness		
	Provider Density (univariate)	Provider Density †	Controlling for SES**	Provider Density (univariate)	Provider Density †	Controlling for SES**
	Coefficient (Standard Error)‡	Coefficient (Standard Error)‡	Coefficient (Standard Error)‡	Coefficient (Standard Error)‡	Coefficient (Standard Error)‡	Coefficient (Standard Error)‡
sts	−20 (4)*	−50 (8)*	−20 (8)*	−17000 (4000)*	−24000 (8000)*	−15000 (8000)
	4 (1)*	6 (1)*	7 (1)*	6000 (1000)*	6000 (1000)*	6000 (1000)*
r	−[illegible] (0.4)*	3 (1)*	1 (1)	−2000 (500)*	500 (900)	600 (900)

5

ermatologists, family practitioners and internists examined in same model.

providers examined in same model which controlled for the census tract median household income, proportion of the population white, and proportion with less than a high school education.

ents and standard errors $\times 10^{-4}$

ave been rounded to one significant figure.

endent variables of Mortality to Incidence Ratio (census tract level) and Breslow thickness (individual level) were analyzed as continuous values using linear regression (please refer to on for further detail).

Table II

Relation between health provider density (by specialty) and the log-likelihood of dying from or being diagnosed with advanced stage malignant melanoma, controlling for Socioeconomic Status (SES), SEER-9 program, 1988–1993.

	Advanced Stage of Melanoma at Diagnosis		Death from Malignant Melanoma	
	Provider Density alone† Log-odds (Standard Error) ‡	**Controlling for SES** Log-odds (Standard Error) ‡**	**Provider Density alone† Log-odds (Standard Error) ‡**	**Controlling for SES** Log-odds (Standard Error) ‡**
Dermatologists per 100,000 population	−410 (200)*	−160 (200)	−660 (200)*	−360 (200)
Family Practitioners per 100,000 population	63 (27)*	80 (30)*	70 (30)*	80 (30)*
Internists per 100,000 population	30 (21)	3 (20)	40 (20)	20 (20)
Likelihood Ratio χ^2, df (p-value)	8.7, df 3 (p=0.03)	96.1, df 6 (p<0.0001)	20.1, df 3 (p=0.0002)	154.7, df 6 (p<0.0001)

*P-value <0.05.

†Density of dermatologists, family practitioners and internists examined in same model.

**Density of providers examined in same model which controlled for the census tract median household income, proportion of the population white, and proportion with less than a high school education.

‡All Log-odds and standard errors × 10^{-4}

Note: The dependent individual-level variables of Malignant Melanoma-specific death (yes/no) and Advanced stage of melanoma at diagnosis (lymph node or metastatic involvement vs. not) were analyzed as dichotomous variables using logistic regression (please refer to methods section for further detail).

Table III

Demographic, Socioeconomic and Healthcare Accessibility Predictors of Melanoma prognosis (Mortality to Incidence Ratio), 1988–1993.

	Variable	Coefficient	SE	T (df)	P-value
Demographic Predictors (Individual-level)					
Gender		0.014	0.002	6.1 (1)	<0.0001
Age		0.0002	0.0001	2.6 (1)	0.009
Race	Black	0.08	0.02	5.1 (1)	<0.0001
	Asian	−0.01	0.005	−1.9 (1)	0.06
	Native American	0.05	0.01	3.6 (1)	0.0003
	White	Reference			
Marital Status	Married	0.01	0.003	5.0 (1)	<0.0001
	Widowed	0.04	0.005	7.6 (1)	<0.0001
	Divorced	0.02	0.005	3.6 (1)	0.0003
	Separated	0.07	0.02	3.6 (1)	0.0003
	Never married	Reference			
Socioeconomic Predictors (census-tract level)					
	Percent of population	−0.03	0.007	5.45 (1)	<0.0001
	White				
	Percent of population with less than HS education	0.18	0.02	11.9 (1)	<0.0001
	Median Household Income of Tract	−0.002	0.0008	2.0 (1)	0.045
Access to Care predictors (county-level)					
	Dermatologists per 100,000 population	−0.002	0.0008	2.6 (1)	0.009
	Family Practitioners per 100,000 population	0.0007	0.0001	5.7 (1)	<0.0001
	Internists per 100,000 population	0.00008	0.00009	0.9 (1)	0.4

F-value of model (DF)=49.66 (15, 17686), $p < 0.0001$

$R^2=0.04$