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Race and the Likelihood of Localized Prostate Cancer at Diagnosis Among Men in 4 Southeastern States

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Abstract

Objectives—To assess the statistical relationship between stage at diagnosis of prostate cancer and racial category in 4 southeastern states.

Methods—Data from state cancer registries in Florida, Georgia, Kentucky, and Maryland were analyzed using a hierarchical generalized linear model to adjust for both patient-level characteristics and area-based measures of socioeconomic status.

Results—African American men had lower odds of being diagnosed with localized disease than white men in 3 of the 4 state populations. After adjusting for patient- and area-level characteristics, the difference is that odds were statistically significant for men living in Florida (OR, 0.79, 95% CI, 0.73–0.85) but not in Georgia (OR, 0.84; 95% CI, 0.70–1.01), Kentucky (OR, 1.02; 95% CI, 0.82–1.27) or Maryland (OR, 0.91; 95% CI, 0.74–1.12).

Discussion—Differences in the likelihood of localized prostate cancer diagnosis between African American and white men in 4 states were not statistically different in 3 states after adjustments for individual and census-level characteristics. Variation in the proportion of men diagnosed with localized disease across states may reflect differences in sample size or real differences between the populations of these states.

Keywords

prostate cancer; African Americans; health disparities; diagnosis

INTRODUCTION

Prostate cancer is the second most common cause of cancer death among men.¹ The mortality rate from prostate cancer among African American men is more than double that for whites, with age-adjusted mortality rates of 64 per 100 000 and 26 per 100 000, respectively.¹ The disparity in prostate cancer mortality rates is more pronounced in the southeastern United States, where deaths from prostate cancer among African Americans occur at nearly 3 times the national mortality rate for whites.²

Observed differences by racial category in survival after diagnosis of prostate cancer may be attributable, in part, to differences in the proportion of men diagnosed at an early stage of disease, when, presumably, the available treatment options can reduce the risk of cancer death. Compared to white men, the proportion of African American men with late-stage disease at diagnosis is between 6% and 13% higher.^{3–5}

In order to assess whether a person's racial category independently predicts the likelihood of being diagnosed with localized disease, it is important to adequately account for other factors that can confound this relationship. Among the potential confounders are patient socioeconomic characteristics, which have been associated with access to prostate cancer screening and other primary health care services through which early disease can be detected.^{3,4;7–17}

Cancer registries maintained by states are uniquely valuable resources for assessing population differences by racial category in the proportion of men diagnosed with localized disease. The Surveillance, Epidemiology, and End Results (SEER) registry models mortality based upon a subset of state cancer registries, and it, therefore, smooths out variation by state when aggregating these data. This study uses state cancer registries and therefore can reveal this variation, which may be important.

Tumor stage at diagnosis along with the patient's racial category are recorded in the registries. Unfortunately, the availability of information about patient socioeconomic characteristics is very limited within cancer registry data. One method for evaluating the affect of socioeconomic characteristics on health outcomes is to use area-based measures of socioeconomic status (SES) as a proxy for individual-level SES characteristics.^{18–20}

Several prior studies indicate that neighborhood SES factors independently affect health outcomes for individuals living in those neighborhoods.^{21–28} Area-level measures of SES also appear to affect cancer disease patterns.²⁰ Numerous variables have been used to measure SES. Krieger et al, however, show that area poverty levels are adequate singular measures of socioeconomic position in public health research.¹⁹ Singh et al also demonstrate that poverty rates are the preferred singular measure of area-level SES.²⁹ Other measures, such as area-level indicators of educational achievement and median household income, while they are useful in describing socioeconomic variation, contribute little additional information when poverty levels are already included.

To appropriately account for the independent effects of both patient-level and area-level characteristics, an analysis should address the hierarchical structure of the data.³⁰ Hierarchical generalized linear models (HGLM) allow adjustments for both patient-level characteristics and area-based measures of socioeconomic characteristics. This study demonstrates the use of these models to assess the strength and statistical significance of the relationship between localized disease at diagnosis and racial category, using data collected by cancer registries in 4 separate southeastern states.

METHODS

Four separate study populations were developed using incidence data from the Florida, Georgia, Kentucky, and Maryland state cancer registries. The number of consecutive years included by each state registry varied as follows: Florida (1990–2003), Georgia (1999–2002), Kentucky (1995–2001), and Maryland (1992–2002). The study populations include only prostate cancer cases, and the outcomes of interest are the proportionate prevalence of localized prostate cancers.

Incident cases from Florida, Kentucky, and Georgia were geocoded to the census-tract level by third-party firms hired by the state registries. Incident cases in Maryland were geocoded to the census-tract level by the state registry itself. Area-based measures of SES were derived from the 1990 US Census data (US Bureau of the Census Summary Tape File 3A). This time period was used so that the presumed exposures related to the locality occurred before the date of prostate cancer diagnosis. Poverty was measured as the percentage of persons in a census tract below the poverty level, categorized as less than 10%, 10% to 19%, and greater than or

equal to 20%. We also derived an education variable from the US Census that measured the percentage of persons aged 25 years or older in a census tract who had finished 4 or more years of college.

Only patients whose racial category was defined as either African American or white were included in this analysis. Men with missing or unknown information about tumor stage and/or grade were excluded from the final study population. Only men with tumors identified as either in situ or localized stage with well-differentiated tumor grade at diagnosis were defined as having localized disease. All other combinations of known tumor stage and grade were classified as nonlocalized disease. Other characteristics measured for each member of the study population included age at diagnosis and year of diagnosis.

Multilevel or hierarchical models are highly useful methods of evaluating and adjusting for area-level characteristics in studies of individual health outcomes.^{1,2} In our study, adjustments for poverty and educational differences among patients are potentially important for assessing the independent effect of race because these socioeconomic measures may be confounded with race. In the registry data, poverty and education are measured not at the patient level, but instead at the census-tract level. We use the hierarchical generalized model with random intercepts and with census-tract level random effects measures of poverty and education to examine their independent effect on whether a patient is diagnosed with localized disease. The hierarchical generalized linear model allows these census-tract level measures to be included as adjustments along with the patient-level characteristics of race, age, and diagnosis year.

Hierarchical generalized linear models with random intercepts and with census-tract level random effects were calculated to estimate the adjusted odds of localized disease at diagnosis by racial category. Separate models were calculated for each of the 4 states. Each model included adjustments for patient-level differences in age at diagnosis and year of diagnosis. Random intercepts were calculated for each census tract to adjust for the global influence of locality on the patient-level covariates. Random effects were calculated for the relationship between racial category and census-tract poverty level and for the relationship between racial category and tract education level. Each model was estimated using the SAS GLIMMIX procedure, using link functions for generalized logistic models. Model goodness of fit was assessed by calculating the generalized χ^2 test statistic, which is a test of the global null hypothesis that none of the model covariates are associated with differences in the likelihood of men being diagnosed with localized disease.^{31,32}

RESULTS

Table 1 presents a summary of the distribution of variable values in each of the state registry data sets. The statewide proportion of men diagnosed with localized disease ranged from 58.61% in Kentucky to 81.27% in Florida. Average age at diagnosis was similar across the 4 states. There were large differences among the 4 states in the proportion of census-tract populations living in poverty. In Maryland, 7.9% of the tracts had 20% or more of the population in poverty, while this percentage was 36.7% in Kentucky. The average percentage of persons with 4 or more years of secondary education across census tracts ranged from 14.3% in Kentucky to 27.2% in Maryland.

Hierarchical generalized linear models were estimated using data for each state. The model formulations were identical except for differences in the number of years of data available. The generalized χ^2 test statistics for each of the 4 models were highly statistically significant, indicating that the global null hypothesis was rejected for each model.^{31,32}

Results obtained for each of the 4 state populations are presented respectively in Table 2 through Table 5. The results demonstrate that African American men had lower adjusted odds

of being diagnosed with localized disease than white men in 3 of the 4 state populations, after accounting for patient-level and tract-level differences. The difference in the adjusted odds for African American was statistically significant only in the data from Florida (OR, 0.79; 95% CI, 0.73–0.85). The differences in adjusted odds were not statistically significant for men in Georgia (OR, 0.84; 95% CI, 0.70–1.01), Kentucky (OR, 1.02; 95% CI, 0.82–1.27), or Maryland (OR, 0.91; 95% CI, 0.74–1.12). Unadjusted comparisons indicated that African American men had significantly lower odds of being diagnosed with localized disease in each state except Kentucky.

The statistical significance of the differences in the diagnosis of localized prostate cancer for African Americans in each state is the main effect of interest. Statistically significant differences were also present for the other patient-level adjustment variables included in the model. Year of diagnosis was significantly associated with the odds of being diagnosed with localized disease, with patients diagnosed in earlier years having substantially lower odds of being diagnosed with localized disease than patients diagnosed in later years. Age in years was also a significant predictor of being diagnosed with localized disease, with decreased odds associated with older age.

Table 6 presents results for overall hypothesis tests of the significance of race, age, year of diagnosis, poverty, and education for predicting whether men are diagnosed with localized prostate cancer in the data available for each state. Race was a significant predictor of localized prostate cancer diagnosis in each state except Kentucky. Age and year of diagnosis were significant predictors of localized prostate cancer diagnosis in each state. The overall effects of the census-tract level characteristics on the relationship between race and localized prostate cancer at diagnosis were statistically significant in the data from each state, except for poverty, which was not statistically significant in the data from Kentucky and Maryland.

DISCUSSION

This study of the relationship between localized prostate cancer at diagnosis and a patient's racial category in 4 southeastern states found that African Americans are more likely to present with nonlocal disease at diagnosis. However, after adjustment for census-tract and patient-level characteristics, this finding was statistically significant in only 1 of the 4 states. This difference in the statistical significance of results among states may have resulted from differences in the sample sizes from each state, from differences in the years included, or from actual differences in the patient populations. The lack of statistical significance is not necessarily equivalent to a lack of clinical significance. For primary care physicians, cancer care specialists, and public health practitioners, observed trends toward more adverse outcomes among African Americans need to be addressed regardless of the statistical significance of that trend.

Although our results cannot explain the causes of the observed differences among the states and between racial categories, several interesting hypotheses seem credible and worthy of further investigation. We noted that the proportion of men diagnosed with localized prostate cancer varied from nearly 59% of cases in Kentucky to slightly more than 81% of cases in Florida. One might speculate that this range of proportion of men diagnosed with localized disease could be explained by differences in the years included in the data analysis, since those men diagnosed in earlier years—prior to the advent of prostate cancer screening with the prostate-specific antigen (PSA) test—were more likely to be diagnosed with late-stage disease. However, in this case, the Florida cancer registry data came from the years 1990–2003, whereas the Kentucky cancer registry data comprised the years 1995–2001.

Another explanation for the differences across states in the proportion of men diagnosed with localized prostate cancer is that the range results from differences in the statewide prevalence

of poverty. Nearly 37% of the census tracts in Kentucky have populations in which at least 20% live below the federal poverty level; by contrast, in Florida, only 11% of the census tracts have that level of poverty. As noted earlier, poverty is associated with decreased access to health care services, including screening for prostate cancer.^{3,4,7–17} Presumably, PSA screening would lead to detection of prostate cancer at an earlier stage of the disease. The clinical implication here is that men diagnosed with prostate cancer who live in poverty are less likely to have received screening and therefore are more likely to die from their disease than men of higher socioeconomic status.

This consequence of socioeconomic inequity is borne out in a recent study of prostate cancer among low-income, uninsured men in California³³ in which researchers found a disproportionately high number of men presenting with late-stage disease at diagnosis. Miller et al argue that the problem confronting economically disadvantaged populations with respect to prostate cancer is underdetection and undertreatment of the disease.³³ In an accompanying editorial in the same issue of the *Journal of Urology*,³⁴ Oliver notes that this increased disease burden falls especially hard upon African Americans, who have more than 3 times the level of poverty experienced by the white population. All these authors agree that, in addition to eliminating disparities in the delivery of cancer prevention services, a comprehensive program to eliminate socioeconomic disparities is needed to decrease the prevalence of late-stage diagnosis of prostate cancer.

Several limitations attend this analysis. The absence of individual-level data on socioeconomic status complicates our ability to assess this relationship. Area-based measures of socioeconomic status, even when modeled appropriately in a hierarchical fashion, may not capture the effect of individual-level differences in SES. Although the statistical models in this study adjusted for important patient-level and census-tract level variables, other important confounding factors not accounted for by this analysis may exist.

Overall, this study indicates that African Americans are less likely to be diagnosed with localized prostate cancer in these 4 states; however, in all but one of these states, these differences are not statistically significant after adjusting for other important patient-level characteristics and area-based measures of poverty and education. Racial categories are social constructs that are, at best, gross markers for other, more proximal causative factors, including but not limited to genetic predisposition of certain subpopulations, access to care, and differential patterns of health care utilization by various populations.^{35–41} How each of these factors affects the proportion of African Americans who present with late-stage prostate cancer at diagnosis is a rich field for further research.

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Table 1

Model Variable Means and Percentage Distributions for Florida, Georgia, Kentucky, and Maryland

	Florida	Georgia	Kentucky	Maryland
No. of cases	184231	17138	11444	38388
No. of census tracts	2479	1329	969	1128
Percentage with localized prostate cancer at diagnosis	66.32%	81.27%	58.61%	61.98%
African American	9.46%	29.24%	7.81%	26.74%
White	90.54%	70.76%	92.19%	73.26%
Mean age, y	70.64	66.35	69.52	68.12
Diagnosed in 1990	5.96%	-	-	-
Diagnosed in 1991	7.71%	-	-	-
Diagnosed in 1992	8.52%	-	-	9.94%
Diagnosed in 1993	7.19%	-	-	9.36%
Diagnosed in 1994	6.80%	-	-	8.58%
Diagnosed in 1995	7.00%	-	12.29%	9.12%
Diagnosed in 1996	6.55%	-	12.95%	8.50%
Diagnosed in 1997	7.14%	-	14.54%	7.98%
Diagnosed in 1998	7.33%	-	13.48%	8.25%
Diagnosed in 1999	7.54%	22.19%	15.10%	9.07%
Diagnosed in 2000	7.47%	24.33%	15.83%	9.51%
Diagnosed in 2001	7.66%	26.59%	15.81%	9.56%
Diagnosed in 2002	7.25%	26.89%	-	10.12%
Diagnosed in 2003	5.88%	-	-	-
Census tracts with <10% in poverty	65.60%	51.73%	29.98%	79.04%
Census tracts with 10%-19% in poverty	23.33%	27.23%	30.96%	13.09%
Census tracts with ≥20% in poverty	11.07%	21.01%	36.71%	7.87%
Census tracts with ≥4 years of secondary education	19.01%	20.43%	14.29%	27.17%

Table 2

Odds of Localized Prostate Cancer at Diagnosis Among African American Men in Florida, Adjusted for Patient-Level Differences in Age and Year of Diagnosis, and Locality-Level Differences in Poverty and Education

	Odds Ratio	95% Confidence Interval	
		Lower Limit	Upper Limit
Level 1 covariates			
African American race, referent to white	0.79	0.73	0.85
African American race, referent to white (unadjusted)	0.78	0.76	0.81
Age, y	0.97	0.97	0.97
Diagnosed in 1990, referent to 2003	0.66	0.62	0.69
Diagnosed in 1991, referent to 2003	0.83	0.78	0.87
Diagnosed in 1992, referent to 2003	0.89	0.84	0.94
Diagnosed in 1993, referent to 2003	0.88	0.83	0.93
Diagnosed in 1994, referent to 2003	0.94	0.89	1.00
Diagnosed in 1995, referent to 2003	0.88	0.84	0.93
Diagnosed in 1996, referent to 2003	1.12	1.06	1.19
Diagnosed in 1997, referent to 2003	1.26	1.20	1.34
Diagnosed in 1998, referent to 2003	1.38	1.30	1.46
Diagnosed in 1999, referent to 2003	1.57	1.49	1.67
Diagnosed in 2000, referent to 2003	1.58	1.50	1.68
Diagnosed in 2001, referent to 2003	1.67	1.58	1.77
Diagnosed in 2002, referent to 2003	1.56	1.48	1.65
Level 2 covariates			
African American in locality with <10% in poverty, compared to locality with 20%	1.11	1.00	1.23
African American in locality with 10% to 19% in poverty, compared to locality with 20%	0.99	0.90	1.10
White from locality with <10% in poverty, compared to locality with 20%	1.12	1.05	1.19
White from locality with 10% to 19% in poverty, compared to locality with 20%	1.06	0.99	1.13
Effect of 1% increase in locality population with ≥4 years of secondary education for African American men	1.00	1.00	1.01
Effect 1% increase in locality population with ≥4 years of secondary education for white men	1.01	1.01	1.01

Table 3

Odds of Localized Prostate Cancer at Diagnosis Among African American Men in Georgia, Adjusted for Patient-Level Differences in Age and Year of Diagnosis, and Locality-Level Differences in Poverty and Education

	Odds Ratio	95% Confidence Interval	
		Lower Limit	Upper Limit
Level 1 covariates			
African American race, referent to white	0.84	0.70	1.01
African American race, referent to white (unadjusted)	0.69	0.64	0.75
Age, y	0.98	0.97	0.98
Diagnosed in 1999, referent to 2002	0.70	0.63	0.79
Diagnosed in 2000, referent to 2002	0.77	0.69	0.86
Diagnosed in 2001, referent to 2002	0.88	0.78	0.98
Level 2 covariates			
African American in locality with <10% in poverty, compared to locality with 20%	1.22	0.97	1.54
African American in locality with 10% to 19% in poverty, compared to locality with 20%	1.08	0.89	1.31
White from locality with <10% in poverty, compared to locality with 20%	1.60	1.35	1.90
White from locality with 10% to 19% in poverty, compared to locality with 20%	1.27	1.07	1.51
Effect of 1% increase in locality population with ≥4 years of secondary education for African American men	1.01	1.00	1.02
Effect 1% increase in locality population with ≥4 years of secondary education for white men	1.01	1.00	1.01

Table 4

Odds of Localized Prostate Cancer at Diagnosis Among African American Men in Kentucky, Adjusted for Patient-Level Differences in Age and Year of Diagnosis, and Locality-Level Differences in Poverty and Education

	Odds Ratio	95% Confidence Interval	
		Lower Limit	Upper Limit
Level 1 adjustment covariates			
African American race, referent to white	1.02	0.82	1.27
African American race, referent to white (unadjusted)	0.95	0.85	1.07
Age, y	0.96	0.96	0.97
Diagnosed in 1995, referent to 2001	0.46	0.41	0.53
Diagnosed in 1996, referent to 2001	0.51	0.45	0.59
Diagnosed in 1997, referent to 2001	0.53	0.46	0.60
Diagnosed in 1998, referent to 2001	0.60	0.53	0.69
Diagnosed in 1999, referent to 2001	0.68	0.60	0.77
Diagnosed in 2000, referent to 2001	0.69	0.61	0.79
Level 2 covariates			
African American in locality with <10% in poverty, compared to locality with 20%	1.05	0.66	1.65
African American in locality with 10% to 19% in poverty, compared to locality with 20%	1.09	0.79	1.52
White from locality with <10% in poverty, compared to locality with 20%	1.21	1.02	1.44
White from locality with 10% to 19% in poverty, compared to locality with 20%	1.08	0.94	1.24
Effect of 1% increase in locality population with ≥4 years of secondary education for African American men	1.00	0.99	1.01
Effect 1% increase in locality population with ≥4 years of secondary education for white men	1.01	1.00	1.01

Table 5

Odds of Localized Prostate Cancer at Diagnosis Among African American Men in Maryland, Adjusted for Patient-Level Differences in Age and Year of Diagnosis, and Locality-Level Differences in Poverty and Education

	95% Confidence Interval		
	Odds Ratio	Lower Limit	Upper Limit
Level 1 covariates			
African American race, referent to white	0.91	0.74	1.12
African American race, referent to white (unadjusted)	0.80	0.76	0.84
Age, y	0.96	0.96	0.96
Diagnosed in 1992, referent to 2001	0.47	0.43	0.52
Diagnosed in 1993, referent to 2001	0.56	0.51	0.62
Diagnosed in 1994, referent to 2001	0.69	0.63	0.76
Diagnosed in 1995, referent to 2001	0.93	0.85	1.03
Diagnosed in 1996, referent to 2001	1.02	0.93	1.13
Diagnosed in 1997, referent to 2001	1.31	1.19	1.46
Diagnosed in 1998, referent to 2001	1.26	1.14	1.40
Diagnosed in 1999, referent to 2001	1.47	1.32	1.62
Diagnosed in 2000, referent to 2001	1.39	1.26	1.53
Diagnosed in 2001, referent to 2001	1.45	1.31	1.60
Level 2 covariates			
African American in locality with <10% in poverty, compared to locality with 20%	1.01	0.86	1.18
African American in locality with 10% to 19% in poverty, compared to locality with 20%	1.08	0.90	1.30
White from locality with <10% in poverty, compared to locality with 20%	1.18	0.98	1.42
White from locality with 10% to 19% in poverty, compared to locality with 20%	1.14	0.92	1.40
Effect of 1% increase in locality population with ≥ 4 years of secondary education for African American men	1.00	1.00	1.00
Effect 1% increase in locality population with ≥ 4 years of secondary education for white men	1.00	1.00	1.01

Table 6

Hypothesis Test Results for the Statistical Significance of Each Effect Specified in the Model for Florida, Georgia, Kentucky, and Maryland

	Florida	Georgia	Kentucky	Maryland
Race	<.0001	<.0001	.8321	.0032
Age at diagnosis	<.0001	<.0001	<.0001	<.0001
Year of diagnosis	<.0001	<.0001	<.0001	<.0001
Race by census tract poverty	.0035	<.0001	.2706	.3363
Race by census tract education	<.0001	.0014	.0700	.0023