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Racial Disparity and Socioeconomic Status in Association with Survival in Older Men with Local/Regional Stage Prostate Carcinoma

Findings from a Large Community-Based Cohort

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BACKGROUND. Few studies have examined the outcomes for Hispanic men with prostate carcinoma and incorporated socioeconomic factors in association with race/ethnicity in affecting survival, adjusting for factors on cancer stage, grade, comorbidity, and treatment.

METHODS. We studied a population-based cohort of 61,228 men diagnosed with local or regional stage prostate carcinoma at age 65 years or older between 1992 and 1999 in the 11 SEER (Surveillance, Epidemiology, and End Results) areas, identified from the SEER-Medicare linked data with up to 11 years of followup.

RESULTS. Low socioeconomic status was significantly associated with decreasing survival in all men with prostate carcinoma. Those living in the community with the lowest quartile of socioeconomic status were 31% more likely to die than those living in the highest quartile (hazard ratio [HR] of all-cause mortality: 1.31; 95% confidence interval [CI]: 1.25–1.36) after adjustment for patient age, comorbidity, Gleason score, and treatment. The HR remained almost unchanged after controlling for race/ethnicity (HR: 1.32; 95% CI: 1.26–1.38). Compared with Caucasians, the risk of mortality in African American men was marginally significantly higher (HR: 1.06; 95% CI: 1.01–1.11) after controlling for education, and no longer significant after adjusting for poverty, income, or composite socioeconomic variable; the HR was lower for Hispanic men (HR: 0.80; 95% CI: 0.72–0.89) after adjustment for education and other socioeconomic variables.

CONCLUSION. Racial disparity in survival among men with local or regional prostate carcinoma was largely explained by socioeconomic status and other factors. Lower socioeconomic status appeared to be one of the major barriers to achieving comparable outcomes for men with prostate carcinoma. ***Cancer*** **2006;106: 1276–85.** © *2006 American Cancer Society.*

KEYWORDS: prostate carcinoma, race/ethnicity, disparity, socioeconomic status, survival.

There are remarkable worldwide variations in the incidence of prostate carcinoma, with the highest age-standardized incidence rate in the US.[1] In the US, prostate carcinoma is currently the most commonly diagnosed cancer in men, and incidence and mortality varies greatly by race/ethnicity.[2–6] Previous studies have shown that the increased mortality in African American patients with prostate carcinoma can be attributed to more aggressive cancers and more advanced stage-at-diagnosis,[7–9] differences in treatment,[10–19] socioeconomic factors,[20–23] and physician characteristics.[24] For example, results from the Prostate Cancer Outcomes Study demonstrated that

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African Americans with more aggressive prostate carcinoma were less likely to undergo radical prostatectomy and more likely to be treated conservatively than Caucasians.[13] However, few studies have examined the outcomes in Hispanic men and incorporated socioeconomic factors in association with race/ethnicity and determined their impact on the survival of men with prostate carcinoma, in addition to factors on cancer stage, grade, comorbidity, and treatment. A large cohort of men diagnosed with local/regional stage prostate carcinoma at age 65 or older, identified from the nationwide, population-based Surveillance, Epidemiology, and End Results (SEER) cancer registries–Medicare linked databases with up to 11 years of followup, were studied to examine the effect of race/ethnicity and socioeconomic factors on long-term survival. These linked data not only provided accurate information on tumor stage and grade (Gleason score) at diagnosis and long-term followup of the vital status, but also allowed the examination of various socioeconomic factors at the level of census tract and zip codes. In addition, comorbid conditions and the type of treatment (chemotherapy and hormonal therapy) could be uniquely identified from Medicare claims data. We hypothesized that there were no racial and ethnic differences in long-term survival of prostate carcinoma patients after controlling for differences in age, tumor Gleason score, comorbidity, treatment, and socioeconomic status.

MATERIALS AND METHODS

Data Sources

The SEER program, supported by the National Cancer Institute (NCI), includes population-based tumor registries in 11 selected geographic areas[3,4,25,26]: the metropolitan areas of San Francisco/Oakland, Detroit, Atlanta, and Seattle; Los Angeles county; the San Jose–Monterey area; and the states of Connecticut, Iowa, New Mexico, Utah, and Hawaii, covering $>$ 14% of the US population. The registries ascertain all newly diagnosed (incident) prostate carcinoma cases from multiple reporting sources such as hospitals, outpatient clinics, and laboratories.

The Medicare program provides payments for hospital, physician, and outpatient medical services for $>$ 97% of persons age $\geq$ 65.[27,28] Cases reported by the SEER cancer registries from 1973–1999 were matched against the Medicare master enrollment files. Medicare claims data are available through 2002. For persons age $\geq$ 65 appearing in the SEER records, Medicare eligibility could be identified for 94% of these cases. The method of linking these data has been described elsewhere.[25,26] The Committee for Protection of Human Subjects at the University of Texas Health Science Center at Houston approved this study.

Study Population

Our study is based on the analytical SEER-Medicare files that excluded men who did not have full coverage of both Medicare Parts A and B, and were members of Health Maintenance Organizations (HMOs) to ensure the completeness of Medicare claims. The study population consisted of 61,228 men diagnosed with local/regional stage prostate carcinoma at age $\geq$ 65 between 1992 and 1999 from the 11 SEER areas. Because local and regional diseases were combined as a single category in SEER data, we were unable to further stratify the analysis by local versus regional stage. However, we used the American Joint Committee on Cancer (AJCC) stage available in SEER to control for residual confounding, although 37% of cases had missing information. Of the 61,228 men, 53,764 were Caucasians (non-Hispanic whites), 6,321 African Americans (non-Hispanic blacks), and 1,143 Hispanics.

Study Variables

Outcome variables

The survival time in months was calculated from the date of diagnosis to the date of death or to the date of last followup (December 31, 2002). Because SEER reported only the month and year of diagnosis, we arbitrarily defined the day of diagnosis as the 15th of the month. All-cause mortality was defined as death from any cause that was the underlying cause of death, which was identified by the SEER program through linking the SEER data with the National Death Index data from the National Center for Health Statistics. Patients still alive at the last followup were censored. Prostate carcinoma-specific mortality was defined as prostate carcinoma as the underlying cause of death. In this specific analysis, patients who died of causes other than prostate carcinoma or were still alive at the last followup were censored.

Socioeconomic status

Three variables from the 1990 census available in the SEER-Medicare linked data were used to define socioeconomic status: 1) education: percent of adults age $\geq$ 25 who had younger than 12 years of education at the zip code level, which was categorized into quartiles: first ($<$ 11.9%), second (11.9–18.1%), third (18.2–26.2%), and fourth quartile ($>$ 26.2%); 2) poverty: percent of persons living below the poverty line at the census tract level, which was categorized into quartiles: first ($<$ 3.6%), second (3.6–6.7%), third (6.8–12.6%), and fourth quartile ($>$ 12.6%); 3) income: median annual household income at the zip code

level, which was also categorized into quartiles: first (> $43,875), second ($34,807–43,875), third ($26,111–34,806), and fourth quartile (< $26,111). We used poverty at the census tract level because this variable is not available at the zip code level. For elderly Medicare beneficiaries, poverty level could be the most directly relevant proxy measure of their economic status.[27]

In addition to these socioeconomic variables, we also created a composite variable that was generated by combining these three variables based on the methods of Robert et al.[28]

The above three socioeconomic variables were first recoded to ensure that lower values represent higher socioeconomic status (income was made negative). We then converted these values into normal scores. Finally, we summed the scores of these three variables that were equally weighted and categorized the total scores into quartiles. Those subjects with missing information on socioeconomic status were categorized separately.

Comorbidity index

Comorbidity was ascertained from Medicare claims by identifying diagnoses or procedures performed between 1 year before and 1 month after the diagnosis of prostate carcinoma. Details on creating a comorbidity score have been previously reported.[29,30]

Treatment

Surgery and radiation therapy

Patients were defined as having received radical prostatectomy if it was indicated in the SEER data (codes 40–70)[31] or if there was a Medicare claim for radical prostatectomy (ICD-9 code[32] of 605, or CPT codes[33] of 55810–55815 or 55840–55845). Patients were defined as having received radiation therapy if either SEER or Medicare claims so indicated.[34]

Hormonal therapy

Patients with prostate carcinoma were defined as having received hormonal therapy (androgen deprivation therapy) if any of the following Medicare procedure codes indicated so within 6 months of the diagnosis[33,35]: the procedure codes for leuprolide (J1950 or J9217–J9219) and for goserelin (J9202); or procedure codes for orchiectomy (54520–54521, 54530, or 54535).

Chemotherapy

The detailed methods for the identification of chemotherapy use through Medicare claims have been previously described.[36] In brief, patients with prostate carcinoma were defined as having received chemotherapy if any of the following Medicare procedure codes so indicated within 6 months of diagnosis[31–36]: the ICD-9-CM procedure code of 99.25 and V codes of V58.1, V66.2, or V67.2; the procedure codes of 96400–96549, J8530–J8999, J9000–J9999 (except those codes for hormonal therapy), Q0083–Q0085; or revenue center codes of 0331, 0332, and 0335.

Other Characteristics

Patient and tumor characteristics such as age at diagnosis (categorized as 65–69, 70–74, 75–79, 80 or older), race/ethnicity (Caucasian, African American, and Hispanic), AJCC stage (I, II, III, IV, or unknown), grade (Gleason score), year of diagnosis (1992–1999), and geographic area (11 SEER areas) were available from SEER.

Analysis

The differences in the distribution of baseline characteristics among the three racial/ethnic groups were tested using the chi-square statistic. The Cox proportional hazard regression model was used for analysis of survival using the PHREG procedure in the SAS system (Cary, NC).[37] The proportionality assumption was satisfied when the log–log Kaplan–Meier curves for survival functions by race/ethnicity or socioeconomic status were parallel and did not intersect.[37,38] The interaction between race/ethnicity and socioeconomic status was tested using the product term of these two variables in the model. Analyses were adjusted for age, tumor AJCC stage, Gleason score, treatment (surgery or radiation, chemotherapy, or hormonal therapy), comorbidity score, year of diagnosis, and geographic area. A series of statistical models were tested for the associations between survival and socioeconomic status and race/ethnicity and are also noted in the table footnotes.

RESULTS

Table 1 presents the distribution of patient age, tumor characteristics, and type of treatment among three racial/ethnic groups of patients diagnosed with local/regional stage prostate carcinoma. A higher proportion of cases were diagnosed at age ≥ 80 in Caucasian men (16.3%) than in African Americans (13.5%), whereas Hispanics had the highest percentage (36.0%) of cases diagnosed at age 65–69. A slightly greater proportion of cases were diagnosed at a lower tumor grade or lower Gleason score and had a lower comorbidity score in Caucasian and Hispanic men than that in African Americans. Although significant, the percentage of men receiving various treatments was relatively close among ethnic groups. For example, 23.9% of African Americans received hormonal therapy compared with 27.0% of Caucasians and 28.7% of Hispan-

TABLE 1
Comparison of Demographic and Tumor Characteristics and Type of Treatment among Different Racial or Ethnic Groups in Men with Locoregional Prostate Carcinoma

	Caucasian		African American		Hispanic	
Characteristic	***n***	**%**	***n***	**%**	***n***	**%**
Median age, yrs (range)	73 (65–103)		72 (65–103)		71 (65–101)	
Age, yrs						
65–69	15,416	28.7	2131	33.7	411	36.0
70–74	17,324	32.2	2023	32.0	390	34.1
75–79	12,271	22.8	1314	20.8	221	19.3
≥ 80	8753	16.3	853	13.5	121	10.6
AJCC stage						
I	17,636	32.8	2263	35.8	387	33.9
II	6701	12.5	866	13.7	147	12.9
III	7717	14.4	681	10.8	173	15.1
IV	1733	3.2	212	3.4	48	4.2
Unknown	19,977	37.2	2299	36.4	388	34.0
Gleason score						
2–4	7475	13.9	740	11.7	198	17.3
5–7	33,218	61.8	3789	59.9	650	56.9
8–10	10,438	19.4	1410	22.3	240	21.0
Unknown	2633	4.9	382	6.0	55	4.8
Comorbidity score						
0	34,402	64.0	3394	53.7	669	58.5
1	12,565	23.4	1611	25.5	290	25.4
2	4342	8.1	747	11.8	96	8.4
≥ 3	2455	4.6	569	9.0	88	7.7
Surgery and radiation						
Radical prostatectomy	12,907	24.0	1070	16.9	328	28.7
Radiation	20,536	38.2	2463	39.0	327	28.6
Both	1205	2.2	89	1.4	26	2.3
Neither	19,116	35.6	2699	42.7	462	40.4
Chemotherapy						
None	44,219	82.3	5345	84.6	861	75.3
Yes	9545	17.8	976	15.4	282	24.7
Hormonal therapy						
None	39,266	73.0	4808	76.1	815	71.3
Yes	14,498	27.0	1513	23.9	328	28.7
Total	53,764	100.0	6321	100.0	1143	100.0

AJCC: American Joint Commission on Cancer.

TABLE 2
Comparison of SES among Different Racial or Ethnic Groups in Men with Prostate Carcinoma

SES (quartile from high to low)	Caucasian		African American		Hispanic	
	n	**%**	***n***	**%**	***n***	**%**
Education						
1st	14,437	26.9	237	3.8	60	5.3
2nd	14,059	26.2	472	7.5	122	10.7
3rd	13,034	24.2	1168	18.5	225	19.7
4th	9193	17.1	4260	67.4	666	58.3
Missing	3041	5.7	184	2.9	70	6.1
Poverty						
1st	14,861	27.6	267	4.2	69	6.0
2nd	14,429	26.8	529	8.4	132	11.6
3rd	13,974	26.0	838	13.3	208	18.2
4th	9603	17.9	4639	73.4	693	60.6
Missing	897	1.7	48	0.8	41	3.6
Income						
1st	14,033	26.1	288	4.6	99	8.7
2nd	13,593	25.3	587	9.3	175	15.3
3rd	12,772	23.8	1438	22.8	322	28.2
4th	10,325	19.2	3824	60.5	477	41.7
Missing	3041	5.7	184	2.9	70	6.1
Composite SES						
1st	14,059	26.2	204	3.2	56	4.9
2nd	13,732	25.5	460	7.3	121	10.6
3rd	13,199	24.6	914	14.5	199	17.4
4th	9128	17.0	4528	71.6	661	57.8
Missing	3646	6.8	215	3.4	106	9.3
Total	53,764	100.0	6321	100.0	1143	100.0

SES: socioeconomic status.

ics. Similarly, 42.7% of African Americans received neither radical prostatectomy nor radiation compared with 35.6% of Caucasians and 40.4% of Hispanics.

Table 2 presents the distribution of socioeconomic status among three racial/ethnic groups of patients. A large proportion of African American and Hispanic men were in the poorest quartiles of education, poverty, income, and composite socioeconomic status compared with that of Caucasians. For example, 73.4% of African Americans and 60.6% of Hispanics were in the poorest quartile of socioeconomic status as measured by the poverty level compared with 17.9% of Caucasians. The differences in the distribution of the above factors in Tables 1 and 2 between Caucasians and African Americans or Hispanics were all statistically significant.

Table 3 presents the 3-, 5-, and 10-year survival by racial/ethnic groups and socioeconomic status. Because the last date of followup in Medicare was December 2002, all cases in our study cohort had been followed for at least 3 years. The 3-year survival from all-causes was 91% in Hispanics, 87.8% in Caucasians, and 84.1% in African Americans. Survival increased with improving socioeconomic status. For example, the 3-year survival was 84.5% in subjects who lived in the community with lowest education level, and 90.6% in those with highest quartile of education. The improvement in survival associated with higher socioeconomic status was consistent when using other measures of socioeconomic status (poverty, income, and composite socioeconomic status). This survival pattern in association with race/ethnicity and socioeconomic status was similar at the 5- and 10-year level and for prostate carcinoma specific survival (Table 3).

Table 4 presents the effect of socioeconomic factors on all-cause mortality and prostate carcinoma-

TABLE 3
Survival in Men with Locoregional Prostate Carcinoma by Race or Ethnicity and SES

	3-yr survival (%) (cases in 1992-1999)		5-yr survival (%) (cases in 1992-1997)		10-yr survival (%) (cases in 1992–1993)	
Race or ethnicity and SES (quartile from high to low)	All causes	Disease-specific	All causes	Disease-specific	All causes	Disease-specific
Racial or ethnic group						
Caucasian	87.8	98.2	78.0	96.4	52.6	94.0
African American	84.1	97.5	72.6	95.3	43.3	91.1
Hispanic	91.0	98.9	83.5	97.3	61.3	95.6
Education						
1st	90.6	98.7	82.6	97.3	59.5	95.4
2nd	88.2	98.3	78.9	96.6	53.0	93.9
3rd	86.3	98.0	75.6	95.9	49.5	93.0
4th	84.5	97.6	72.9	95.4	45.2	92.3
Missing	87.7	98.7	77.0	97.1	54.1	94.6
Poverty						
1st	89.9	98.4	81.3	96.8	56.4	94.6
2nd	88.3	98.2	79.2	96.4	54.2	93.9
3rd	87.6	98.4	77.3	96.6	51.7	94.2
4th	84.1	97.7	72.3	95.5	41.8	92.2
Missing	87.1	98.6	77.2	96.2	54.6	91.6
Income						
1st	90.0	98.5	81.6	97.0	56.9	94.5
2nd	88.0	98.1	79.0	96.4	53.5	94.1
3rd	86.9	98.2	76.4	96.6	51.0	94.0
4th	84.8	97.7	73.1	95.5	45.7	92.1
Missing	87.7	98.7	77.0	96.2	54.1	94.6
Composite SES						
1st	90.6	98.7	82.5	97.2	58.6	94.9
2nd	88.3	98.1	79.1	96.3	53.9	93.9
3rd	86.9	98.3	76.4	96.3	50.5	94.0
4th	84.0	97.5	72.1	95.4	44.1	92.0
Missing	87.5	98.7	77.1	96.9	54.1	94.1
Total	87.5	98.2	77.5	96.3	51.9	93.7

SES: socioeconomic status.

specific mortality while adjusting for race/ethnicity and other factors. There was a clear pattern for the increasing hazard ratio (HR) of mortality associated with lower socioeconomic status. The magnitude and trend in HRs were consistent regardless of which socioeconomic variables were used. For example, those living in communities with the lowest composite socioeconomic level were 31% more likely to die from all-causes than those living in the highest socioeconomic level communities ($P < 0.001$ for trend) (Model 1). The risk of all-cause mortality remained almost unchanged after controlling for race/ethnicity (Model 2). Whereas the HR for prostate carcinoma-specific mortality was reduced slightly after adjusting for race/ethnicity, those living in communities with the lowest socioeconomic status were still considerably more likely to die than those living in communities with the highest quartile (Model 4).

The effects of race/ethnicity on the risk for all-cause mortality and prostate carcinoma-specific mortality are presented in four different statistical models in Table 5. Compared with Caucasian men, African Americans were 14% more likely to die and Hispanic men were 15% less likely to die, after controlling for other factors. When additionally controlled for composite socioeconomic status, the HR of all-cause mortality was no longer significantly higher in African Americans compared with Caucasians (HR: 1.01; 95% confidence interval [CI]: 0.96–1.06), whereas Hispanic men were still significantly less likely to die than Caucasians (HR: 0.78; 95% CI: 0.70–0.87). When controlled for poverty or median income, there was no significant difference in all-cause mortality between Caucasian and African American men. For example, when controlled for income, the HR in African Americans was no longer significantly higher (HR: 1.02; 95% CI: 0.98–1.08) compared with Caucasians, whereas Hispanics still had a significantly lower risk (HR: 0.79; 95% CI: 0.71–0.88). Similarly, after adjusting for poverty, the HR was 1.04 (95% CI: 0.99–1.09) for African Americans and 0.80 (95% CI: 0.72–0.89) for Hispanics as compared with Caucasians. However, the HR was substantially reduced but still marginally higher in African American men after adjusting for education (HR: 1.06; 95% CI: 1.01–1.11), whereas Hispanic men were significantly less likely to die than Caucasians (HR: 0.80; 95% CI: 0.72–0.89).

African American patients also had a higher but insignificant risk of prostate carcinoma-specific mortality than Caucasians, whereas Hispanics had a lower but insignificant risk of prostate carcinoma-specific mortality after adjusting for composite socioeconomic status in addition to other factors (Model 4). However, the HRs of prostate carcinoma-specific mortality were significantly higher in African Americans after adjusting for education (HR: 1.20; 95% CI: 1.03–1.39), income (HR: 1.18; 95% CI: 1.01–1.38), or poverty (HR: 1.19; 95% CI: 1.02–1.40), and were not significantly lower in Hispanics (HR: 0.79; 95% CI: 0.53–1.16; 0.80; 95% CI: 0.54–1.18; and 0.80; 95% CI: 0.54–1.18, respectively) as compared with Caucasians.

Figure 1 presents the Kaplan–Meier survival curve for three racial/ethnic groups and the number of cases at risk. It was clear that the survival was the lowest for African American patients and the highest for Hispanic, whereas the survival curve for Caucasian patients was between African Americans and Hispanics.

Table 5 also presents the effect of age, Gleason score, and comorbidity on mortality. The HR of all-cause and prostate carcinoma-specific mortality in-

TABLE 4
Association between Mortality and SES in Men with Prostate Cancer in 1992–1999

SES (quartile from high to low)	Hazard ratio (95% CI) of mortality[a]			
	All-cause mortality		Prostate cancer-specific mortality	
	Model 1	Model 2	Model 3	Model 4
Education				
1st	1.0	1.0	1.0	1.0
2nd	1.12 (1.08–1.17)	1.12 (1.08–1.17)	1.15 (1.00–1.33)	1.13 (0.98–1.30)
3rd	1.18 (1.14–1.23)	1.18 (1.13–1.23)	1.28 (1.11–1.48)	1.27 (1.11–1.47)
4th	1.27 (1.22–1.32)	1.26 (1.20–1.31)	1.43 (1.25–1.65)	1.39 (1.20–1.61)
Missing	1.19 (1.11–1.27)	1.19 (1.11–1.27)	1.02 (0.79–1.31)	0.98 (0.76–1.26)
Poverty				
1st	1.0	1.0	1.0	1.0
2nd	1.11 (1.06–1.15)	1.11 (1.06–1.15)	1.17 (1.02–1.33)	1.15 (1.01–1.32)
3rd	1.19 (1.14–1.24)	1.19 (1.14–1.24)	1.12 (0.97–1.30)	1.11 (0.96–1.28)
4th	1.28 (1.23–1.34)	1.28 (1.22–1.34)	1.36 (1.18–1.55)	1.31 (1.13–1.52)
Missing	1.14 (1.02–1.28)	1.14 (1.02–1.28)	1.60 (1.10–2.32)	1.49 (1.03–2.16)
Income				
1st	1.0	1.0	1.0	1.0
2nd	1.12 (1.08–1.17)	1.12 (1.08–1.17)	1.17 (1.02–1.34)	1.16 (1.01–1.33)
3rd	1.22 (1.17–1.28)	1.22 (1.17–1.28)	1.28 (1.11–1.48)	1.25 (1.08–1.45)
4th	1.28 (1.23–1.34)	1.28 (1.22–1.34)	1.43 (1.23–1.67)	1.37 (1.16–1.61)
Missing	1.21 (1.13–1.30)	1.21 (1.13–1.29)	1.02 (0.79–1.32)	0.98 (0.76–1.27)
Composite SES				
1st	1.0	1.0	1.0	1.0
2nd	1.11 (1.07–1.16)	1.11 (1.07–1.16)	1.26 (1.09–1.44)	1.25 (1.09–1.44)
3rd	1.22 (1.17–1.27)	1.22 (1.17–1.27)	1.24 (1.07–1.43)	1.22 (1.05–1.41)
4th	1.31 (1.25–1.36)	1.31 (1.25–1.37)	1.48 (1.28–1.70)	1.40 (1.20–1.64)
Missing	1.19 (1.11–1.26)	1.19 (1.12–1.26)	1.13 (0.89–1.34)	1.11 (0.88–1.40)

SES: socioeconomic status; 95% CI: 95% confidence interval; AJCC: American Joint Commission on Cancer; SEER: Surveillance, Epidemiology, and End Results.
[a] In models 1 and 3, the hazard ratio is adjusted for age, comorbidity, AJCC stage, Gleason score, year of diagnosis, SEER region, surgery and radiation, hormone, and chemotherapy. Models 2 and 4 are adjusted for race or ethnicity, in addition to factors in Models 1 and 3.

creased significantly with age ($P < 0.001$). The HR also increased with more advanced tumor stage, poorer grades, and higher comorbidity scores, but the magnitude of the increased risk was much greater for prostate carcinoma-specific mortality in association with Gleason score and AJCC stage, whereas the magnitude of the risk was greater for all-cause mortality in association with comorbidity.

There was no significant interaction between race/ethnicity and socioeconomic status (education, income, poverty, and composite socioeconomic status) on the risk of mortality. For example, in every quartile of educational level there was no significant difference in HR of both all-cause and prostate carcinoma-specific mortality between African American and Caucasian men, whereas Hispanic men were significantly less likely to die of all causes in the second and fourth quartiles, but had no significantly different risk of prostate carcinoma-specific mortality compared with Caucasians.

DISCUSSION

This study examined the disparities in race/ethnicity and socioeconomic factors in association with survival among men diagnosed with prostate carcinoma. We found that in men with local or regional stage prostate carcinoma, lower socioeconomic status was significantly associated with decreased survival, even after controlling for other patient/tumor characteristics and treatment. We also found racial/ethnic disparities in survival, but these disparities reduced substantially after controlling for socioeconomic factors. Particularly when poverty or income or composite variables were used as indicators of socioeconomic status, the risk of all-cause mortality in African American patients was no longer significantly higher than that in Caucasians, indicating that racial/ethnic differences in survival for prostate carcinoma between African American and Caucasian men were largely explained by socioeconomic status and other factors.

The differences in survival between African

TABLE 5
Mortality Associated with Race or Ethnicity and SES in Men with Locoregional Prostate Carcinoma

	Hazard ratio (95% CI) of mortality[a]			
	All-cause mortality		Prostate cancer-specific mortality	
Race or ethnicity and other factors	Model 1	Model 2	Model 3	Model 4
Race or ethnicity				
Caucasian	1.00	1.00	1.00	1.00
African American	1.14 (1.09–1.19)	1.01 (0.97–1.06)	1.33 (1.16–1.53)	1.17 (0.99–1.37)
Hispanic	0.85 (0.76–0.94)	0.78 (0.70–0.87)	0.84 (0.57–1.24)	0.78 (0.53–1.16)
Age, yrs				
65–69	1.0	1.0	1.0	1.0
70–74	1.24 (1.19–1.29)	1.24 (1.19–1.29)	1.17 (1.02–1.35)	1.17 (1.01–1.34)
75–79	1.73 (1.66–1.81)	1.73 (1.66–1.81)	1.44 (1.25–1.67)	1.45 (1.25–1.67)
≥ 80	3.01 (2.88–3.15)	2.99 (2.86–3.13)	2.41 (2.08–2.79)	2.39 (2.07–2.77)
AJCC stage				
I	1.0	1.0	1.0	1.0
II	1.13 (1.08–1.18)	1.13 (1.08–1.18)	1.40 (1.19–1.64)	1.39 (1.18–1.64)
III	1.21 (1.16–1.27)	1.21 (1.15–1.27)	1.93 (1.66–2.24)	1.92 (1.65–2.23)
IV	1.67 (1.56–1.79)	1.66 (1.55–1.78)	3.52 (2.97–4.18)	3.49 (2.94–4.14)
Unknown	1.08 (1.04–1.12)	1.08 (1.05–1.12)	1.34 (1.18–1.52)	1.33 (1.18–1.52)
Gleason score				
2–4	1.0	1.0	1.0	1.0
5–7	1.16 (1.11–1.21)	1.16 (1.12–1.21)	2.47 (2.01–3.05)	2.48 (2.01–3.05)
8–10	1.73 (1.66–1.82)	1.74 (1.66–1.82)	8.29 (6.73–10.21)	8.28 (6.72–10.20)
Unknown	1.36 (1.28–1.45)	1.36 (1.28–1.44)	3.69 (2.86–4.76)	3.70 (2.86–4.77)
Comorbidity score				
0	1.0	1.0	1.0	1.0
1	1.61 (1.56–1.66)	1.60 (1.55–1.65)	1.03 (0.93–1.15)	1.03 (0.92–1.14)
2	2.26 (2.17–2.36)	2.23 (2.14–2.33)	1.18 (1.01–1.38)	1.16 (0.99–1.35)
≥ 3	3.49 (3.33–3.66)	3.44 (3.28–3.60)	1.56 (1.30–1.87)	1.53 (1.27–1.84)
Composite SES (quartile from high to low)				
1st	—	1.0	—	1.0
2nd	—	1.11 (1.07–1.16)	—	1.25 (1.09–1.44)
3rd	—	1.22 (1.17–1.27)	—	1.22 (1.05–1.41)
4th	—	1.31 (1.25–1.37)	—	1.40 (1.20–1.64)
Missing	—	1.19 (1.12–1.26)	—	1.11 (0.88–1.40)

SES: socioeconomic status; 95% CI: 95% confidence interval; AJCC: American Joint Commission on Cancer.

[a] In models 1 and 3, the hazard ratio is adjusted for variables listed in the footnote of Table 4. Models 2 and 4 are adjusted for composite socioeconomic status in addition to above factors.

American and Caucasian patients have been attributed to numerous factors.[7–24] A recent study reported that African American patients may be more likely to seek physicians who provide poorer quality of care.[24] Although racial/ethnic differences are likely multifactorial, access to quality care and socioeconomic factors are shown to play a major role.[10–24] Several studies demonstrated that if patients had equal access to quality healthcare, the outcomes would be similar among different racial groups.[10,15,39] However, other studies showed the racial disparities still existed even after controlling for socioeconomic factors and for access to equitable care and treatment.[18,22] Our study showed that among patients who had the same coverage of Medicare insurance and had same stage (local/regional) prostate carcinoma, African American men were more likely to present with a higher-grade cancer. Although the receipt of treatment differed among racial/ethnic groups, the impact of this factor was minimal in this cohort of cases. However, differences in mortality between African American and Caucasian men were substantially reduced (after adjusting for education) or no longer existed (after adjusting for poverty or income or composite socioeconomic variable). This indicates that socioeconomic differences are one of the major barriers to achieving equal outcomes for men with prostate carcinoma. These socioeconomic differences are modifiable factors that have important implications in our society. If we make efforts to achieve equal opportunity for education, employment, and health

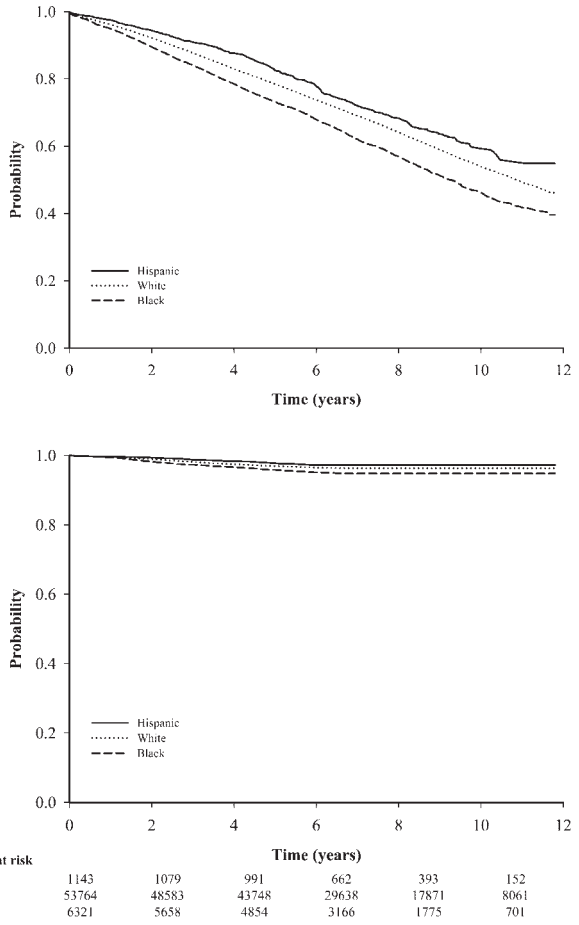

FIGURE 1. Kaplan–Meier survival curve by race/ethnic group (upper curve: all-cause; bottom curve: prostate carcinoma-specific).

insurance, the Healthy People 2010's goal[40] of eliminating racial disparities in cancer survival is possible.

Our study found that Hispanics had a lower risk of mortality from prostate carcinoma than did Caucasians and African Americans, even though their socioeconomic status was similar to that of African Americans. This mortality advantage among Hispanics has often been described as the 'Hispanic Paradox' because their low socioeconomic status was a known determinant of mortality as evidenced in our study, and because they are also known to have a higher prevalence of risk factors for mortality. Many studies explored the reasons for this paradox, including the 'healthy immigrant theory' and the factor of strong social support.[41] However, a recent study reported that the National Death Index may have underestimated mortality for Hispanic men by 9%.[41] The small number of Hispanic subjects in our study may also have generated some unstable results.

Our study has several strengths. First, it was a population-based study, covering all incident cases of prostate carcinoma in the 11 SEER regions. This large cohort of patients were pathologically confirmed by the SEER registries, one of the most authoritative data sources on cancer. SEER registries also provided reliable information on tumor stage, grade, and long-term followup on vital status.[3–5,42] In addition, Medicare claims data enabled us to identify information on patient comorbidity, which is a strong confounder of survival. Furthermore, information on chemotherapy and hormonal therapy can be uniquely identified from Medicare claims data.[43]

This study also has several limitations. First, socioeconomic variables are based on the zip code or census tract level, and are imperfect proxy measures of individual level socioeconomic status. Therefore, it is possible that residual confounding was not properly controlled in our analyses. One study using the National Longitudinal Mortality Study data showed that family income and education at the individual level did not account for much of the excess risk for African American men with prostate carcinoma compared with Caucasian men.[20]

Second, we did not have information on physician and hospital characteristics, which have also been shown to be associated with cancer outcomes.[24] We also do not have information on patient or physician preferences toward treatment such as choice of prostatectomy. The marginal differences in survival between racial/ethnic groups after adjusting for education were likely because of unmeasured factors such as physician characteristics. Third, we only studied Medicare beneficiary men age ≥ 65. The results for the association between race/ethnicity and survival may not be generalizable to younger patients. However, most incident cases of prostate carcinoma occur in older persons,[1–5] so the findings will still be generalizable to a large population. Furthermore, older persons are often reported to be at higher risk of underutilization of cancer therapies and are underrepresented in clinical trials.[44] Therefore, targeting this population would have great importance for much-needed research in identifying health problems and for improving quality of life. In addition, we examined only patients who had both Medicare Parts A and B, and were not members of an HMO. The patterns in survival may be different from other cases excluded.

In conclusion, lower socioeconomic status was strongly associated with decreased survival in men with local/regional stage prostate carcinoma. The racial/ethnic disparities in survival in these men were largely explained by socioeconomic status and other factors. These findings have important public health

implications if we are to achieve the goals of Healthy People 2010, one of which is to eliminate health disparities among different segments of the population. Furthermore studies may be needed to address whether this association is true in younger men with prostate carcinoma and in subjects diagnosed with prostate carcinoma in other parts of the world.

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