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Racial Disparities in Colorectal Cancer Survival: To What Extent Are Racial Disparities Explained by Differences in Treatment, Tumor or Hospital Characteristics?

Arica L. White, PhD, MPH[1], **Sally W. Vernon, PhD**[1,2], **Luisa Franzini, PhD**[3], and **Xianglin L. Du, MD, PhD**[1,3]

[1]Division of Epidemiology, Policy and Community Health, School of Public Health, University of Texas Health Science Center, Houston, Texas

[2]Division of Behavioral Science, Policy and Community Health, School of Public Health, University of Texas Health Science Center, Houston, Texas

[3]Division of Management, Policy and Community Health, School of Public Health, University of Texas Health Science Center, Houston, Texas

Abstract

BACKGROUND—Racial/ethnic differences in colorectal cancer (CRC) survival have been documented throughout the literature. However, the reasons for these disparities are difficult to decipher. The objective of this analysis was to determine to what extent racial/ethnic disparities in survival are explained by differences in socio-demographics, tumor characteristics, diagnosis, treatment and hospital characteristics.

METHODS—A cohort of 37,769 Medicare beneficiaries diagnosed with American Joint Committee on Cancer (AJCC) stages I-III CRC from 1992 to 2002 and residing in 16 Surveillance, Epidemiology and End Results (SEER) regions of the United States was identified in the SEER-Medicare linked database. Survival was estimated using the Kaplan-Meier method. Cox proportional hazard modeling was used to estimate hazard ratios (HR) of mortality and 95% confidence intervals (95% CI).

RESULTS—Blacks had worse CRC-specific survival than Whites but this was reduced after adjustment (aHR=1.24; 95%CI:1.14-1.35). Asians had better survival than Whites after adjusting for covariates (aHR=0.80; 95%CI: 0.70-0.92) for stages I-III CRC. Relative to Asians, Blacks and Whites had worse survival after adjustment (aHR=1.55; 95% CI:1.33-1.81; aHR=1.25; 95%CI: 1.09-1.43, respectively). Comorbidities and SES were associated with a reduction in the mortality difference between Blacks and Whites and Blacks and Asians.

CONCLUSION—Comorbidities and SES appear to be more important factors contributing to Blacks' poorer survival relative to Whites and Asians. However, racial/ethnic differences in CRC survival were not fully explained by differences in a number of factors. Future research should further examine the role of quality of care, the benefit of treatment and post-treatment surveillance in survival disparities.

INTRODUCTION

Colorectal cancer (CRC) is the third most frequently diagnosed non-skin cancer in men and women in the United States.1 In 2009, it was estimated that there would be 146,970 new

Correspondence to: Arica White, PhD, MPH, Centers for Disease Control and Prevention, 4770 Buford Hwy NE, Mailstop K-55, Atlanta, GA 30341-3717, Tel:770.488.3001, AWhite5@cdc.gov.

cases of CRC and 49,920 deaths, accounting for 9% of all cancer deaths in the United States.1 Over the past two decades, there has been a decline in mortality rates, which reflects declining incidence rates and medical advances in early detection and treatment.1 Despite this progress, CRC incidence and mortality varies considerably by race/ethnicity,1 with non-Hispanic Black (hereafter Black) males and females having the highest incidence and mortality, and Hispanics/Latino females and American Indian/Alaskan Native males having the lowest rates.1

Racial/ethnic disparities in CRC survival have been extensively documented in the scientific literature.2–6 These disparities may be attributed to many factors including differences in socioeconomic status (SES),3 tumor biology,7, 8 stage at diagnosis,4, 5 treatment,9–11 post-treatment surveillance,12, 13 physician characteristics,14, 15 and hospital factors.16, 17 Most studies have found that non-Hispanic Blacks have poorer survival relative to non-Hispanic Whites (hereafter White).2–6 The few studies that have included Hispanics and/or Asian/Pacific Islanders (hereafter Asian)2, 4, 6, 18 found that relative to Whites, Hispanics have worse survival 4,18 and Asians have better survival.2, 6 However, no studies have examined survival of other racial/ethnic groups relative to Asians.

The purpose of this study was to determine the degree to which racial disparities in survival were explained by differences in socio-demographic factors, tumor characteristics, diagnosis, treatment, and hospital characteristics. We compared factors contributing to survival disparities between Whites and other racial groups and between Asians and other racial groups in order to reveal the underlying mechanisms of racial/ethnic disparities in survival as they relate to specific racial groups. These findings may inform targeted interventions that may ameliorate or eliminate these disparities.

METHODS

Data Sources

Incident CRC cases were identified from the Surveillance, Epidemiology and End Results Program-Medicare (SEER-Medicare) linked database. These data files were used to obtain information about tumor characteristics, treatment, vital status, and other factors for persons diagnosed with CRC at age 66 years and older.19

This study included 16 SEER registries in selected geographic areas: San Francisco/Oakland, Detroit, Seattle, Atlanta, Rural Georgia, Los Angeles county, the San Jose-Monterey area, and the rest of California; and the states of Connecticut, Iowa, New Mexico, Utah, Hawaii, Kentucky, Louisiana and New Jersey, which covers approximately 25% of the U.S. population since 2000.19 California registries were combined and so were Rural Georgia and Atlanta registries. Patients who did not have both Medicare Parts A and B, or were members of a Health Maintenance Organization (HMO) within one year prior to and one year after diagnosis were excluded from this study to ensure completeness of Medicare claims. The University of Texas Health Science Center at Houston Committee for Protection of Human Subjects approved the study protocol.

Study Population

The study population consisted of 37,769 men and women, aged ≥66 years, diagnosed with primary CRC (ICD-0-3 codes C180–C189, C199, C209)20 between January 1, 1992 and December 31, 2002. Of these, 87.4% were White, 7.1% were Black, 4.0% were Asian, and 1.6% were Hispanic. Race/ethnicity was based on racial classification in the Medicare Enrollment. A minimum age of 66 years was set to allow at least 1 year of eligibility in Medicare prior to the date of CRC diagnosis to ascertain comorbidity data.

Study Variables

Outcome: Survival—Survival time in months was calculated from the date of diagnosis to the date of death or date of last follow-up (December 31, 2005). The day of diagnosis was defined as the 15th of the month, since SEER only reported the month and year of diagnosis. CRC-specific mortality was defined if CRC was the underlying cause of death. Patients who died of causes other than CRC or were still alive at the last follow-up were censored. The follow-up time ranged from 3 to 13 years.

Socioeconomic status (SES)—Since individual-level SES data is not available in the SEER-Medicare linked data, the percentage of residents living below the federal poverty level, an aggregated measure of SES at the census tract level from the 1990 Census for 1992-99 cases and the 2000 Census for 2000-02 cases, was used in the analysis. This measure is based on a set of money income thresholds that vary by family size and composition.21 These thresholds are used by the Census to determine who is in poverty or below 200% of the federal poverty line.21 Prior studies have demonstrated that poverty level could be the most directly relevant proxy measure of economic status for elderly Medicare beneficiaries.22, 23 This variable was categorized into quartiles: first (<4.04%), second (4.05–7.61%), third (7.62–13.89%), and fourth (>13.90% or poorest SES).

Treatment

Surgery—SEER and Medicare codes were used to identify surgery. The detailed methods for the identification of surgical resection through Medicare claims have been described previously.10

Chemotherapy—Chemotherapy was identified in the Medicare claims. These methods have been described previously.10

Radiation—Radiation therapy administration within 12 months of diagnosis was ascertained from Medicare claims using ICD-9-CM procedure (92.21-92.29),24 Current Procedural Terminology (77401-77499 or 77750-77799),25 and revenue codes26 (0330 or 0333).

Standard Therapy—Standard therapy was defined based on the Physician Data Query (PDQ) guidelines27, 28 from the National Cancer Institute and is American Joint Committee on Cancer (AJCC) stage-specific. Details regarding the categorization of this variable are described elsewhere.10

Comorbidity score

Comorbidities were ascertained from Medicare claims by identifying eighteen diagnoses or related procedures recorded between one year prior to and one month after the diagnosis of CRC. A weighted comorbidity score was created. Comorbidity score was coded as 0, 1, 2, 3, or 4 or more. Details on creating this variable have been previously reported.29, 30

Other Characteristics

The following patient and tumor characteristics were also assessed in the study: age, sex, marital status, SEER registry, year of diagnosis (1992-2002), AJCC tumor stage, tumor size, tumor grade, number of lymph nodes positive and rural residence. Hospital characteristics included National Cancer Institute designated cancer center as of 2002, teaching hospital and type of hospital.

Statistical Analysis

All data was analyzed using the statistical software package Intercooled Stata version 10.0 (College Station, TX). The distribution of baseline characteristics among the racial/ethnic groups was assessed for differences using the chi-square statistic. Crude survival was estimated using Kaplan-Meier. The log rank test for equality of survivor functions was used to determine whether there were differences in the observed survival by race/ethnicity. Cox proportional hazards regression models were used to estimate the relative risk of dying from CRC. Two series of statistical models (using Whites and then Asians as referent groups) were used to assess the relationship between race/ethnicity and survival after adjusting for a variety of factors. To determine to what extent racial disparities are explained by each of these factors, the reduction or increase in magnitude of the hazard ratios (HR) from one model to the next was calculated.

RESULTS

There were statistically significant differences for all demographic and tumor characteristics for patients diagnosed with CRC from 1992 through 2002 by race/ethnicity ($p<0.05$) (Table 1). The greatest differences were in SES. Significantly higher percentages of Blacks, Hispanics and Asians resided in the lowest SES areas compared to Whites.

CRC-Specific Mortality

There were significant differences in CRC-specific survival across race/ethnicity (log rank test, p-value <0.0001) (Figure 1A). The survival curve was highest for Asians and lowest for Blacks. The curves for both Whites and Hispanics were between these groups, with the curve for Hispanic higher than the curve for Whites.

Disparities Relative to Whites—Table 2 shows the CRC-specific mortality associated with race/ethnicity in individuals diagnosed with CRC from 1992 to 2002. Blacks had a significantly higher risk of dying (HR=1.33; 95%CI:1.23-1.44) compared to Whites in the unadjusted model. However, this risk was reduced after full adjustment for age, sex, marital status, SEER registry, year of diagnosis, tumor characteristics, treatment, comorbidities, hospital characteristics and SES (1.24;1.14-1.35). For Asians, the risk of death was significantly lower than Whites (0.73;0.64-0.82) in the crude model. However, after full adjustment, their risk increased but remained lower than Whites (0.80;0.70-0.92). Although not statistically significant, Hispanics were at lower risk of dying than Whites (0.86;0.71-1.03) in the unadjusted model. After full adjustment, their risk of death slightly decreased and remained statistically insignificant (0.85;0.70-1.02).

The greatest reduction in the CRC-specific mortality difference between Blacks and Whites was associated with SES (5%), followed by tumor characteristics (3%), treatment (2%) and comorbidities (2%). The largest reduction in mortality differences between Asians and Whites was related to tumor characteristics (5%), followed by treatment (2%) and SES (1%). Also, SES (2%) as well as tumor characteristics (1%), treatment (1%) and comorbidities (1%) accounted for a reduction in the mortality differences between Hispanics and Whites. Hospital characteristics did not make a significant impact on mortality differences for any of the groups.

Disparities Relative to Asians—In Table 3, CRC-specific mortality for all racial/ethnic groups relative to Asians is displayed. Blacks had a significantly higher risk of dying (HR=1.84; 95%CI:1.59-2.12) compared to Asians in the unadjusted model. However, this risk was reduced after full adjustment for age, sex, marital status, SEER registry, year of diagnosis, tumor characteristics, treatment, comorbidities, hospital characteristics and SES

(1.56; 1.33-1.82). For Whites, the risk of death was significantly higher than Asians (1.38; 1.22-1.56) in the crude model. However, after full adjustment, their risk decreased (1.26; 1.10-1.44). Although not statistically significant, Hispanics were at higher risk of dying than Asians (1.18; 0.95-1.47) in the unadjusted model. After full adjustment, their risk of death slightly decreased but remained statistically insignificant (1.06; 0.84-1.33).

The reductions in the CRC-specific mortality difference between Blacks and Asians were associated with socio-demographics characteristics (29%), SES (4%) and comorbidities (3%). The only reduction in mortality differences between Whites and Asians was related to socio-demographic characteristics (24%). Socio-demographic characteristics (17%), comorbidities (1%) and SES (1%) accounted for a reduction in the mortality differences between Hispanics and Whites, although none of these reductions were statistically significant. Similar to the comparison with Whites, hospital characteristics did not reduce the hazard ratios for any group.

DISCUSSION

This study of a large cohort of men and women diagnosed with colorectal cancer yielded several important findings. There were persistent racial/ethnic survival differences after controlling for numerous variables. Furthermore, some of the factors that appeared to substantially reduce the mortality difference between Whites and Blacks, did not impact the mortality difference between Asians and Blacks. However, adjusting for comorbidities and SES resulted in a reduction in the mortality difference regardless of reference group. Therefore, comorbidities and SES appeared to be more important explanations for the survival differences observed among Blacks relative to Asians and Whites.

Several studies have examined racial/ethnic differences in CRC survival.[3, 22] Our finding that racial disparities are largely explained by socioeconomic status is consistent with most of these findings. However, to our knowledge, all prior studies have compared survival among racial/ethnic groups relative to Whites. No studies of CRC survival have used Asians (the group with the best survival in this case) as a referent group, nor examined the underlying mechanisms as they relate to specific racial groups by comparing the variation in factors contributing to survival differences using different referent groups.

In this study, we found that factors contributing to survival disparities varied by racial/ethnic group. There were no statistically significant differences between Hispanics and Whites and Hispanics and Asians; however, the survival differences between Whites and Asians widened after adjusting for a number of factors. On the other hand, SES, which is associated with survival in CRC patients,[2, 3] was a key determinant of survival for Blacks. These findings are similar to a meta-analysis that demonstrated that the racial disparity in survival for colon cancer between African Americans and Caucasians was attenuated after adjusting for socioeconomic factors and treatment.[3] There were large ethnic differences in SES and rural residence, and SES accounted for large reductions in CRC-specific mortality between Blacks and Whites and Blacks and Asians. Furthermore, comorbidities played a key role in survival disparities for Blacks. As in the case of SES, a larger proportion of Blacks had higher comorbidity scores compared to other racial/ethnic groups and adjusting for comorbidities reduced mortality differences between Blacks and Whites and Blacks and Asians. Although a few studies have shown that comorbidities may independently affect CRC survival,[31, 32] no studies prior to this one have found that they impact racial/ethnic survival disparities.

The persistent racial/ethnic survival differences, despite controlling for numerous variables, may be explained by differences in biology,[33-37] individual-level SES,[3] acculturation,[38,39]

lifestyle,40 beliefs,41, 42 refusal of43, 44 and compliance with treatment,43, 44 post-treatment surveillance,12, 13 and access to high quality cancer care,14 which were not examined in this study.

Differences in tumor site distribution and genetics may explain the high survival rates observed among Asians. A previous study demonstrated that relative to Whites, Asians have higher rates of distal colon cancer, which is associated with a decreased risk of mortality.33 For Blacks, poor survival may be due to biologic features that may contribute to aggressive tumor behavior,7 or inherited or acquired genetic abnormalities35-37 which may impact response to therapy.37

Patients with low SES are more likely to die from CRC than patients with high SES.3 In this study, a large proportion of Blacks and Hispanics resided in low SES neighborhoods, whereas a larger proportion of Asians and Whites resided in high SES neighborhoods. Percentage of persons within a census tract living under the poverty line was used as a measure of SES; therefore, there might have been residual confounding of SES since we were not able to control for differences in SES at the individual level. In addition, other components of SES such as education were not included in our analysis but may influence diagnosis, treatment, and, ultimately, survival. Despite these limitations, there was no multi-collinearity between SES (percentage of persons in a census tract living below the poverty level) and race/ethnicity present.

Lifestyle differences may explain some of these differences in survival. Obese patients have a 50% increased risk of developing colon cancer and 30% higher risk of dying from colon cancer.45 Moreover, obese patients treated for colon cancer have poorer overall survival than normal weight patients.46 Studies have also found that higher levels of physical activity may reduce the risk of colon cancer by as much as 50%,47 and patients who engage in vigorous physical activity have lower rates of colon cancer recurrence.40 National data has shown that Blacks and Hispanics have higher rates of obesity48 and lower rates of physical activity than Whites.49

Acculturation may also explain some of the survival differences observed among these racial/ethnic groups. Relative to US-born Whites of equivalent socio-demographic backgrounds, foreign born Blacks, Hispanics and Asians, have lower mortality risks.39 However, immigrants' risk of disability and chronic disease morbidity increases with increasing length of residence.38

Cultural beliefs and norms may be linked to racial/ethnic mortality differences. Cancer fatalism, which is the belief that death is inevitable when cancer is present,41 can be a significant barrier to early detection and treatment all of which are important for achieving optimal survival. Studies have shown that Blacks, Hispanics and Chinese are more likely to possess fatalistic views regarding cancer.41, 42

Adjusting for standard therapy yielded a small reduction (2%) in the survival disparity between Blacks and Whites in this study. However, a more complete depiction of the role of treatment in the racial/ethnic survival disparities may include accounting for differences in treatment compliance and benefit, high-quality surgical care and post-treatment surveillance. Compared to Whites, Blacks are more likely to refuse treatment10, 44 and even when Blacks receive treatment, their survival benefit from adjuvant chemotherapy is not as great. 11, 34 Also, there is evidence to suggest that patients treated by a surgical specialist with high caseloads have improved CRC survival.50 Yet, Black patients are less likely to be treated by these surgeons51 or have access to high-quality subspecialists.14 Finally, post-treatment surveillance can detect CRC recurrence and lead to improved survival; however, racial/ethnic minorities are less likely to receive this care.12, 13Additional research is

needed to determine the role of each of these factors in racial/ethnic disparities in CRC survival.

In addition to the variables that were not measured in this study, another limitation of this study is that the sequence of the variables in the model may have affected the percentage reduction in hazard ratio attributable to each variable; yet, when changes in the order of the variables were made, there was little difference.

There are a number of strengths that support this study's validity. The study included nationwide and population-based cases from 16 SEER areas, which accounts for approximately 25% of the U.S. population. The cases were ethnically diverse and included traditionally understudied racial/ethnic groups: Hispanics and Asians. Therefore, these findings may be generalizable to diverse populations 66 years of age or older residing in other areas of the U.S. Furthermore, the linked database allowed us to incorporate a number of treatment, hospital and comorbidity variables across the cancer care continuum and is an accurate and complete source of data.52, 53

In conclusion, although comorbidities and SES appear to be important factors contributing to the poorer CRC-specific survival for Blacks relative to Whites and Asians, substantial racial disparities in survival still persisted and were not fully explained by variations in a number of factors across the cancer continuum. Future research should examine the role of other factors not included in this study such as the quality of care, particularly the benefit of treatment and post-treatment surveillance.

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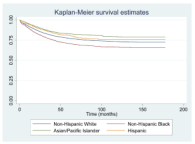

Figure 1.
Colorectal cancer specific survival for men and women diagnosed with AJCC stages I-III colorectal cancer from 1992 to 2002, by race/ethnicity

Table 1

Demographic and tumor characteristics of men and women diagnosed with AJCC stages I, II and III colorectal cancer from 1992-2002, by race/ethnicity (percent)

	Non-Hispanic White (n=33,023)		Non-Hispanic Black (n=2,665)		Asian/Pacific Islander (n=1,494)		Hispanic (n=587)	
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Age (years)								
Median		77		75		75		74
66-69	5,157	15.6	484	18.2	249	16.7	122	20.8
70-74	7,872	23.8	707	26.5	456	30.5	174	29.6
75-79	8,429	25.5	688	25.8	381	25.5	151	25.7
80-84	7,117	21.6	512	19.2	291	19.5	88	15.0
85-89	4,448	13.5	274	10.3	117	7.8	52	8.9
Sex								
Male	14,811	44.9	999	37.5	760	50.9	282	48.0
Female	18,212	55.2	1,666	62.5	734	49.1	305	52.0
Marital Status								
Married	16,961	51.4	883	33.1	930	62.3	270	46.0
Unmarried	14,869	45.0	1,679	63.0	532	35.6	301	51.3
Unknown	1,193	3.6	103	3.9	32	2.1	16	2.7
Percent in census tract living in poverty								
First quartile, high	9,328	28.3	157	5.9	227	15.2	<45	<8.0%
Second quartile	8,812	26.7	206	7.7	316	21.2	77	13.1
Third quartile	8,362	25.3	405	15.2	336	22.5	115	19.6
Fourth quartile, low	6,152	18.6	1,880	70.5	454	30.4	350	59.6
Unknown	369	1.1	17	0.6	161	10.8	<5	<1.0%
Tumor Stage (AJCC)								
I	11,109	33.6	848	31.8	496	33.2	206	35.1
II	12,461	37.7	985	37.0	534	35.7	207	35.3
III	9,453	28.6	832	31.2	464	31.1	174	29.6
Tumor Size (cm)								

	Non-Hispanic White (n=33,023)		Non-Hispanic Black (n=2,665)		Asian/Pacific Islander (n=1,494)		Hispanic (n=587)	
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
<1.0	933	2.8	79	3.0	37	2.5	14	2.4
1.0 - <2.0	1,467	4.4	91	3.4	77	5.2	26	4.4
2.0 - <3.0	3,367	10.2	215	8.1	197	13.2	54	9.2
3.0 - <4.0	5,158	15.6	423	15.9	245	16.4	89	15.2
≥4.0	15,715	47.6	1,309	49.1	665	44.5	281	47.9
Unknown	6,383	19.3	548	20.6	273	18.3	123	21.0
Tumor Grade								
Well differentiated	3,319	10.1	278	10.4	114	7.6	73	12.4
Moderately differentiated	20,887	63.3	1,747	65.6	1,012	67.7	375	63.9
Poorly differentiated	5,924	17.9	350	13.1	238	15.9	88	15.0
Unknown	2,893	8.8	290	10.9	130	8.7	51	8.7
Comorbidity Score								
0	17,089	51.8	1,182	44.4	803	53.8	294	50.1
1	8,895	26.9	725	27.2	403	27.0	144	24.5
2	3,829	11.6	334	12.5	138	9.2	77	13.1
3	1,631	4.9	172	6.5	71	4.8	27	4.6
4+	1,579	4.8	252	9.5	79	5.3	45	7.7
Lymph Nodes Positive								
0	18,535	56.1	1,389	52.1	778	52.1	316	53.8
1	2,946	8.9	292	11.0	162	10.8	64	10.9
2-3	2,893	8.8	249	9.3	156	10.4	52	8.9
4-5	1,270	3.9	123	4.6	53	3.6	26	4.4
6-9	939	2.8	89	3.3	48	3.2	17	2.9
10-51	792	2.4	64	2.4	38	2.5	12	2.0
Unknown	5,648	17.1	459	17.2	259	17.3	100	17.0
Standard Therapy								
No	6,794	20.6	658	24.7	365	24.4	131	22.3
Yes	26,299	79.4	2,007	75.3	1,129	75.6	456	77.7

	Non-Hispanic White (n=33,023)		Non-Hispanic Black (n=2,665)		Asian/Pacific Islander (n=1,494)		Hispanic (n=587)	
Characteristic	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
NCI Cancer Center								
No	23,813	72.1	1,891	71.0	1,136	76.0	442	75.3
Clinical	122	0.4	7	0.3	12	0.8	<10	<2.0
Comprehensive	898	2.7	60	2.3	16	1.1	<10	<2.0
Unknown	8,190	24.8	707	26.5	330	22.1	132	22.5
Teaching Hospital								
No	8,436	25.6	688	25.8	392	26.2	177	30.2
Yes	14,503	43.9	1,119	42.0	658	44.0	232	39.5
Unknown	10,084	30.5	858	32.0	444	29.7	178	30.3
Type of Hospital								
Non-profit	19,373	58.7	1,485	55.7	856	57.3	333	56.7
Private	1,767	5.4	171	6.4	139	9.3	48	8.2
Government	3,679	11.1	299	11.2	168	11.2	74	12.6
Unknown	8,204	24.8	710	26.6	331	22.2	132	22.5
Urban/Rural Residence								
Big metropolitan	17,765	53.8	2,182	81.9	1,040	69.6	388	66.1
Metropolitan	9,457	28.6	329	12.4	370	24.8	140	23.9
Urban	2,292	6.9	48	1.8	<85	<8.0%	24	4.1
Less urban or Rural	3,509	10.6	106	4.0	<5	<1.0%	35	6.0
SEER Registry								
Connecticut	4,740	14.4	174	6.5	17	1.1	17	2.9
Detroit	4,245	12.9	886	33.3	18	1.2	14	2.4
Hawaii	206	0.6	<10	<1.0	366	24.5	<5	<1.0
Iowa	4,611	14.0	35	1.3	6	0.4	<5	<1.0
New Mexico	1,173	3.6	17	0.6	<5	<1.0	112	19.1
Seattle	3,033	9.2	56	2.1	77	5.2	8	1.4
Utah	1,389	4.2	<10	<1.0	12	0.8	12	2.0
Atlanta/Rural Georgia	1,139	3.5	376	14.1	19	1.27	6	1.02
Kentucky	1,293	3.9	64	2.4	<5	<1.0	<5	<1.0

Characteristic	Non-Hispanic White (n=33,023) n	%	Non-Hispanic Black (n=2,665) n	%	Asian/Pacific Islander (n=1,494) n	%	Hispanic (n=587) n	%
Louisiana	784	2.4	208	7.8	<5	<1.0	5	0.9
New Jersey	2,367	7.2	194	7.3	23	1.5	33	5.6
California	8,043	24.4	646	24.2	952	63.7	377	64.2
Year of diagnosis								
1992	2,635	8.0	200	7.5	66	4.4	34	5.8
1993	2,477	7.5	169	6.3	80	5.4	31	5.3
1994	2,440	7.4	204	7.7	108	7.2	34	5.8
1995	2,433	7.4	191	7.2	108	7.2	39	6.6
1996	2,433	7.4	184	6.9	105	7.0	43	7.3
1997	2,290	6.9	207	7.8	117	7.8	38	6.5
1998	2,319	7.0	209	7.8	144	9.6	38	6.5
1999	2,260	6.8	180	6.8	142	9.5	56	9.5
2000	4,494	13.6	356	13.4	174	11.7	78	13.3
2001	4,567	13.8	392	14.7	208	13.9	97	16.5
2002	4,675	14.2	373	14.0	242	16.2	99	16.9

The number of cases less than 5 was masked as required by the NCI.

*All chi-square tests for the distribution of demographic and clinical characteristics among these 4 racial/ethnic groups were significant (P <.01).

Table 2

Analysis of predictors of colorectal cancer specific mortality for men and women diagnosed with AJCC stages I, II and III colorectal cancer from 1992-2002

	Number at risk	Number of deaths	Model 1 Hazard Ratio (95% CI)	Model 2 Hazard Ratio (95% CI)	Model 3 Hazard Ratio (95% CI)	Model 4 Hazard Ratio (95% CI)	Model 5 Hazard Ratio (95% CI)	Model 6 Hazard Ratio (95% CI)
Race/ethnicity								
White	32,837	7,137	1.0 Ref	1.0 Ref	1.0 Ref	1.0 Ref	1.0 Ref	1.0 Ref
Black	2,646	709	**1.36(1.25-1.48)**	**1.33(1.23-1.45)**	**1.31(1.21-1.42)**	**1.29(1.19-1.40)**	**1.29(1.19-1.40)**	**1.24(1.14-1.35)**
Asian	1,490	259	0.88(0.77-1.01)	**0.83(0.72-0.95)**	**0.81(0.71-0.92)**	**0.81(0.71-0.92)**	**0.81(0.70-0.92)**	**0.80(0.70-0.92)**
Hispanic	587	115	0.89(0.74-1.07)	0.88(0.73-1.06)	0.87(0.72-1.05)	0.86(0.72-1.04)	0.86(0.72-1.04)	0.85(0.70-1.02)
Standard Therapy								
No	-	-	-	-	1.0 Ref	1.0 Ref	1.0 Ref	1.0 Ref
Yes	-	-	-	-	**0.71(0.68-0.75)**	**0.72(0.69-0.76)**	**0.72(0.69-0.76)**	**0.72(0.69-0.76)**

Model 1 adjusted for age(5 categories), sex, marital status, SEER registry, and year of diagnosis.

Model 2 adjusted for tumor stage, tumor size, tumor grade and number of lymph nodes positive, in addition to the factors in Model 1.

Model 3 adjusted for standard therapy and factors in Model 2.

Model 4 adjusted for comorbidities and factors in Model 3.

Model 5 adjusted for NCI-designated cancer center, teaching hospital, hospital type, and factors in Model 4.

Model 6 adjusted for percent of residents in census tract living below poverty (quartiles) and urban/rural residence in addition to factors in Model 5.

Bold denotes statistical significance.

Table 3

Analysis of predictors of colorectal cancer specific mortality relative to Asian/Pacific Islanders for men and women diagnosed with AJCC stages I, II and III colorectal cancer from 1992-2002

	Number at risk	Number of deaths	Model 1 Hazard Ratio (95% CI)	Model 2 Hazard Ratio (95% CI)	Model 3 Hazard Ratio (95% CI)	Model 4 Hazard Ratio (95% CI)	Model 5 Hazard Ratio (95% CI)	Model 6 Hazard Ratio (95% CI)
Race/ethnicity								
Asian	1,490	259	1.0 Ref	1.0 Ref	1.0 Ref	1.0 Ref	1.0 Ref	1.0 Ref
White	32,837	7,137	1.14(1.00-1.31)	**1.21(1.06-1.39)**	**1.24(1.08-1.42)**	**1.24(1.08-1.42)**	**1.24(1.09-1.42)**	**1.26(1.10-1.44)**
Black	2,646	709	**1.55(1.33-1.81)**	**1.61(1.38-1.88)**	**1.62(1.39-1.90)**	**1.59(1.37-1.86)**	**1.60(1.37-1.86)**	**1.56(1.33-1.82)**
Hispanic	587	115	1.01(0.81-1.27)	1.07(0.85-1.34)	1.08(0.86-1.35)	1.07(0.85-1.34)	1.07(0.86-1.34)	1.06(0.84-1.33)
Standard Therapy								
No	-	-	-	-	1.0 Ref	1.0 Ref	1.0 Ref	1.0 Ref
Yes	-	-	-	-	**0.71(0.68-0.75)**	**0.72(0.69-0.76)**	**0.72(0.69-0.76)**	**0.72(0.69-0.76)**

Model 1 adjusted for age(5 categories), sex, marital status, SEER registry, and year of diagnosis.

Model 2 adjusted for tumor stage, tumor size, tumor grade and number of lymph nodes positive, in addition to the factors in Model 1.

Model 3 adjusted for standard therapy and factors in Model 2.

Model 4 adjusted for comorbidities and factors in Model 3.

Model 5 adjusted for NCI-designated cancer center, teaching hospital, hospital type, and factors in Model 4.

Model 6 adjusted for percent of residents in census tract living below poverty (quartiles) and urban/rural residence in addition to factors in Model 5.

Bold denotes statistical significance.