Short Communication

Cancer Epidemiology, Biomarkers & Prevention

Race and Colon Cancer Survival in an Equal-Access Health Care System

Abegail A. Andaya[1], Lindsey Enewold[3], Shelia H. Zahm[3], Craig D. Shriver[1,2,4], Alexander Stojadinovic[1,2,4], Katherine A. McGlynn[3], and Kangmin Zhu[1,4]

Abstract

Studies have shown that Whites have a higher colorectal cancer survival rate than Blacks. However, it is unclear whether racial disparities result from unequal access to medical care or factors other than health care access or both. This study assessed whether non-Hispanic Whites (NHW) and non-Hispanic Blacks (NHB) differ in colon cancer survival in an equal-access health care system and examined whether racial differences varied by demographic and tumor characteristics. The study included 2,537 Military Health System patients diagnosed with colon cancer between 1998 and 2007. Median follow-up time was 31.4 months. Cox models estimated HRs and 95% confidence intervals (CI) for race, overall and stratified by age at diagnosis, sex, and tumor stage. No difference in overall survival (OS) between NHWs and NHBs was observed in general. However, among patients younger than 50 years old, NHBs experienced significantly worse OS than NHWs (HR: 2.03, 95% CI: 1.30–3.19). Furthermore, stratification by sex and tumor stage showed that this racial disparity was confined to women (HR: 2.87; 95% CI: 1.35–6.11) and patients with distant stage disease (HR: 2.45; 95% CI: 1.15–5.22) in this age group. When medical care is equally available to NHWs and NHBs, similar overall colon cancer survival was observed; however, evidence of racial differences in survival was apparent for patients younger than 50 years old. This study suggests that factors other than access to care may be related to racial disparities in colon cancer survival among younger, but not older, patients. *Cancer Epidemiol Biomarkers Prev; 22(6); 1030–6. ©2013 AACR.*

Introduction

Colorectal cancer (CRC) is the third leading cause of cancer-related death among men and women in the United States (U.S.), with an estimated 51,690 cause-specific deaths occurring in 2012 (1). Although CRC mortality rates have declined over the past 3 decades for both sexes, racial disparities have widened over time (1–4), with Blacks experiencing higher mortality rates than Whites (1, 3, 5, 6).

Among the general U.S. population, studies have consistently shown that Whites have a higher CRC survival rate compared with Blacks (7–12). This racial disparity is due to multiple factors, the most influential likely being differences in disease presentation; Blacks are more likely to be diagnosed with advanced CRCs than Whites (5, 6). However, survival rates have been observed to be lower among Blacks than Whites, even after statistical adjustment for or stratification by tumor stage (10, 11), thus indicating the influence of other factors on survival.

Compared with Whites, Blacks are less likely to have health insurance coverage (13, 14) and regular access to physician care (15), which may partially account for the aforementioned disparities in disease presentation and may also account for noted disparities in CRC prevention and treatment (16). Obtaining access to health care is a complex issue that depends on many socioeconomic factors, including education, income, employment status, and proximity to and use of health care facilities. However, because it is difficult to fully adjust for socioeconomic status, it is often unclear whether racial differences that remain after adjustment (17, 18) are due to residual differences in health care access or other factors associated with CRC survival, such as biologic factors that relate to genetic differences, tumor behavior or response to treatment, or cultural/behavioral factors that relate to the use of health care when access to care is available.

Examining survival in an equal-access system can help assess whether racial disparities are associated with unequal access to medical care or whether other factors play a role in racial differences. Studies within the Veterans Affairs (VA) health care system, an "equal-access" system that provides health care to veterans at little to no cost regardless of racial background, have observed similar CRC survival among White and Black patients (19, 20). Similar to the VA system, the Department of Defense's

Authors' Affiliations: [1]John P. Murtha Cancer Center and [2]General Surgery Service, Walter Reed National Military Medical Center; [3]National Cancer Institute, NIH; and [4]Uniformed Services University

Corresponding Author: Kangmin Zhu, Division of Military Epidemiology and Population Sciences, John P. Murtha Cancer Center, Walter Reed National Military Medical Center, 11300 Rockville Pike, Suite 1215, Rockville, MD 20852. Phone: 301-816-4786; Fax: 202-782-5833; E-mail: kangmin.zhu@usuhs.edu

doi: 10.1158/1055-9965.EPI-13-0143

(DoD) Military Health System (MHS) also provides equal health care access, but to a larger beneficiary base, which includes both active duty and retired U.S. military personnel and their dependents. Therefore, the MHS provides a unique opportunity to assess racial differences in CRC survival. A recent study within the MHS that examined the relationship of race and survival observed that Blacks and Whites have similar colon cancer survival (21). However, this study did not account for potential confounding by Hispanic ethnicity, medical comorbidities, or tumor recurrence, and did not assess whether racial differences in survival varied by demographic or tumor characteristics.

Colon cancer constitutes almost three-fourths (72%) of incident CRC cases, of which a majority occur among Whites and Blacks in the United States (1). The aim of the current study was to use data from both the cancer registry and the medical claims system of the MHS to further evaluate disparities in colon cancer survival among non-Hispanic Whites (NHW) and non-Hispanic Blacks (NHB) while controlling for potential confounders such as comorbidities and cancer recurrence. In addition, this study sought to assess whether any racial disparities in survival varied by age at diagnosis, sex, and tumor stage.

Materials and Methods

Data source

Linked data from the DoD's Central Cancer Registry (CCR) and the MHS Data Repository (MDR) were used in this study. Both data sources contain information on DoD beneficiaries, including active duty members, retirees, guards and reserve members, and their dependents. CCR contains information on demographic, health, tumor characteristics, cancer treatment, recurrence, follow-up, and vital status from cancer cases diagnosed and/or treated at military treatment facilities (MTF). The cancer registry conducts lifetime follow-up on patients. CCR information is abstracted from patient medical records, reviewed, and entered into the database by certified cancer registrars. MDR contains administrative and medical care claims information (e.g., demographics, diagnoses, diagnostic and treatment procedures, prescriptions, and vital status) for both inpatient and outpatient services that are provided either directly at MTFs or at civilian facilities paid for by the DoD.

The Data Linkage project was reviewed and approved by the Institutional Review Boards of the Walter Reed National Military Medical Center, Tricare Management Activity, and the National Cancer Institute (NCI) Office of Human Subjects Research.

Study subjects

Patients who were diagnosed with colon cancer between 1998 and 2007 with histologically confirmed, primary adenocarcinomas, not reported via death certificate or autopsy, were eligible for study inclusion ($N = 3{,}214$). We excluded 644 persons who were not NHW or NHB, and 33 patients with missing survival information. Thus, the present analysis included 2,537 patients.

Study variables

Information on demographic characteristics was obtained from CCR. If data elements were unavailable from CCR, then missing values were supplemented from MDR. If values were missing from both data sources, the information was recorded as "unknown." Demographic variables included age, sex, marital status, active duty status, and patient's or sponsor's military service branch and military rank at colon cancer diagnosis. Tumor characteristics were obtained from CCR and included tumor grade, tumor stage, and primary colon cancer site. CCR and MDR data were combined to determine receipt of colon cancer treatment (surgery, chemotherapy, or radiotherapy). If either data source indicated that treatment occurred within one year after colon cancer diagnosis, then receipt of treatment was classified as "yes." Information on recurrence (yes/no) was obtained solely from CCR. The Charlson comorbidity index, not including colon cancer diagnosis, was used to calculate the level of comorbidity for each patient (22). To reduce false diagnoses, comorbidities were considered present if a diagnosis was recorded at least 3 times in the MDR data during the year before colon cancer diagnosis.

Statistical analysis

Differences in demographic, tumor, and health characteristics between NHW and NHB patients were compared using χ^2 tests. Cox models were used to estimate HRs and 95% confidence intervals (CI) to assess the effect of race on colon cancer survival while simultaneously adjusting for potential confounders. Racial differences in survival may vary by age at diagnosis, sex, and tumor stage (10, 12, 23); therefore, stratified analyses were conducted by these variables. Analyses by age were dichotomized at the age of 50 years to account for age-related differences in screening recommendations (24). The analytic outcome for this study was all-cause mortality, which was determined on the basis of CCR and MDR data. Follow-up began at the date of colon cancer diagnosis and was calculated through date of death or date of last contact. Follow-up was truncated at December 31, 2007. Length of follow-up ranged from 16 days to 119 months (median = 31.4 months).

Statistical analyses were conducted using Statistical Analysis System (SAS) software, Version 9.3 for Windows (SAS Institute, Inc). All tests of significance were 2-tailed and conducted at an α of 0.05.

Results

This study included 2,028 NHW and 509 NHB patients. Racial variation in demographic, tumor, and health characteristics were observed (Table 1). At the time of

Table 1. Characteristics of non-Hispanic White and non-Hispanic Black patients with colon adenocarcinoma in the DoD military health system ($N = 2,537$)

Characteristic	Non-Hispanic White ($n = 2,028$) *N* (%)	Non-Hispanic Black ($n = 509$) *N* (%)	*P*[a]
Age at diagnosis, years			
<50	286 (14)	122 (24)	<0.01
50–54	204 (10)	66 (13)	
55–59	259 (13)	65 (13)	
60–64	373 (18)	93 (18)	
65–69	230 (11)	67 (13)	
70–74	228 (11)	45 (9)	
75–79	196 (10)	30 (6)	
80+	252 (12)	21 (4)	
Sex			0.86
Men	1,244 (61)	310 (61)	
Women	784 (39)	199 (39)	
Marital status at diagnosis			0.03
Never married	57 (3)	26 (5)	
Married	1,552 (77)	378 (74)	
Other	334 (16)	90 (18)	
Unknown	85 (4)	15 (3)	
Active duty status at diagnosis			<0.01
No	1,876 (93)	443 (87)	
Yes	152 (7)	66 (13)	
Service branch[b]			<0.01
Army	660 (33)	254 (50)	
Air force	683 (34)	130 (26)	
Marines	86 (4)	19 (4)	
Navy	469 (23)	80 (16)	
Other	22 (1)	4 (1)	
Unknown	108 (5)	22 (4)	
Rank[b]			<0.01
Enlisted	950 (47)	336 (66)	
Officer	437 (22)	35 (7)	
Other/unknown	641 (32)	138 (27)	
Tumor stage			<0.01
Localized	798 (39)	174 (34)	
Regional	856 (42)	210 (41)	
Distant	352 (17)	122 (24)	
Unknown	22 (1)	3 (1)	
Tumor grade			0.34
Well differentiated	319 (16)	67 (13)	
Moderately differentiated	1,283 (63)	338 (66)	
Poorly differentiated	287 (14)	65 (13)	
Unknown	139 (7)	39 (8)	
Colon cancer site			<0.01
Cecum	433 (21)	115 (23)	
Ascending colon	398 (20)	95 (19)	
Hepactic flexure	101 (5)	25 (5)	
Transverse colon	163 (8)	47 (9)	
Splenic flexure	67 (3)	34 (7)	
Descending colon	130 (6)	51 (10)	

(Continued on the following page)

Table 1. Characteristics of non-Hispanic White and non-Hispanic Black patients with colon adenocarcinoma in the DoD military health system ($N = 2,537$) (Cont'd)

Characteristic	Non-Hispanic White ($n = 2,028$) *N* (%)	Non-Hispanic Black ($n = 509$) *N* (%)	*P*[a]
Sigmoid colon	686 (34)	129 (25)	
Unknown/colon, NOS	50 (2)	13 (3)	
Comorbidities[c]			0.18
None	1,205 (59)	325 (64)	
One	272 (13)	63 (12)	
Two or more	551 (27)	121 (24)	

[a]Two-sided *P* value.

[b]Service branch or rank of active duty member or sponsor.

[c]Charlson comorbidity index. Colon cancer was not included in calculation.

Table 2. Multivariate analysis assessing the effect of race on colon cancer survival among 2,537 DoD beneficiaries with colon adenocarcinoma, overall and stratified by age, sex, and tumor stage

Strata	Number of patients: Alive	Number of patients: Dead	HR[a,b] (95% CI)
Overall			
Non-Hispanic White	1,315	713	1.00 (Reference)
Non-Hispanic Black	325	184	1.02 (0.86–1.21)
Age			
<50 years			
Non-Hispanic White	213	73	1.00 (Reference)
Non-Hispanic Black	74	48	2.03 (1.30–3.19)
≥50 years			
Non-Hispanic White	1,102	640	1.00 (Reference)
Non-Hispanic Black	251	136	0.83 (0.69–1.01)
Sex			
Men			
Non-Hispanic White	786	458	1.00 (Reference)
Non-Hispanic Black	196	114	1.06 (0.85–1.32)
Women			
Non-Hispanic White	529	255	1.00 (Reference)
Non-Hispanic Black	129	70	0.97 (0.73–1.29)
Stage			
Local			
Non-Hispanic White	656	142	1.00 (Reference)
Non-Hispanic Black	156	18	0.96 (0.56–1.66)
Regional			
Non-Hispanic White	580	276	1.00 (Reference)
Non-Hispanic Black	145	65	1.01 (0.76–1.35)
Distant			
Non-Hispanic White	70	282	1.00 (Reference)
Non-Hispanic Black	22	100	0.98 (0.76–1.27)

[a]HR and 95% CI.

[b]Models were adjusted for year at diagnosis, age at diagnosis, race, sex, marital status at diagnosis, active duty status at diagnosis, service branch of active duty member/sponsor, rank of active duty member/sponsor, tumor stage, tumor grade, colon cancer site, comorbidities, recurrence, surgery, chemotherapy, and radiation therapy. Stratified variables were not included in stratified analysis.

Table 3. Multivariate analysis assessing the effect of race on colon cancer survival among 2,537 DoD beneficiaries with colon adenocarcinoma, stratified by age–sex and age–tumor stage

	Age					
	< 50 years ($n = 408$)			≥ 50 years ($n = 2,129$)		
	Number of patients			Number of patients		
	Alive	Dead	HR[a,b] (95% CI)	Alive	Dead	HR[a,b] (95% CI)
Sex						
Men						
Non-Hispanic White	123	33	1.00 (Reference)	663	425	1.00 (Reference)
Non-Hispanic Black	45	24	1.72 (0.82–3.57)	151	90	0.85 (0.67–1.08)
Women						
Non-Hispanic White	90	40	1.00 (Reference)	439	215	1.00 (Reference)
Non-Hispanic Black	29	24	2.87 (1.35–6.11)	100	46	0.79 (0.56–1.12)
Tumor stage						
Local						
Non-Hispanic White	78	3	1.00 (Reference)	578	139	1.00 (Reference)
Non-Hispanic Black	34	2	–[c]	122	16	0.84 (0.48–1.46)
Regional						
Non-Hispanic White	114	28	1.00 (Reference)	466	248	1.00 (Reference)
Non-Hispanic Black	37	14	1.85 (0.63–5.47)	108	51	0.78 (0.57–1.08)
Distant						
Non-Hispanic White	21	42	1.00 (Reference)	49	240	1.00 (Reference)
Non-Hispanic Black	3	32	2.45 (1.15–5.22)	19	68	0.79 (0.59–1.07)

[a]HR and 95% CI.

[b]Models were adjusted for year at diagnosis, age at diagnosis, race, sex, marital status at diagnosis, active duty status at diagnosis, service branch of active duty member/sponsor, rank of active duty member/sponsor, tumor stage, tumor grade, colon cancer site, comorbidities, recurrence, surgery, chemotherapy, and radiation therapy. Stratified variables were not included in stratified analysis.

[c]The model had too few deaths to converge, therefore data was unavailable.

diagnosis, NHBs were younger and more likely than NHWs to be never married, active duty military service members, affiliated with the Army, and enlisted in the military ($P \leq 0.03$). In addition, compared with the NHWs, NHBs were more likely to be diagnosed with distant stage colon cancer and cancers located in the splenic flexure or descending colon, and less likely to have cancer in the sigmoid colon ($P \leq 0.01$).

During multivariate analysis, no racial differences in overall survival (OS) were observed (Table 2: HR: 1.02; 95% CI: 0.86–1.21). Stratified analysis by sex and tumor stage yielded similar results. However, evidence of effect modification by age was apparent. Among patients ages 50 years or older, no racial difference in survival was observed; however, among younger patients, mortality was twice as high for NHBs than NHWs (HR: 2.03; 95% CI: 1.30–3.19).

Table 3 shows the results further stratified by age–sex and age–tumor stage. Although mortality risk was elevated among younger NHB men and women, only NHB women had a significantly worse survival than their White counterparts (HR: 2.87; 95% CI: 1.35–6.11). In addition, among younger patients with distant stage disease, mortality was significantly worse for NHBs compared with NHWs (HR: 2.45; 95% CI: 1.15–5.22).

Discussion

This study shows no overall difference in OS between NHWs and NHBs in the MHS, an equal-access health care system. This is similar to what was found among patients in the VA health care system and a previous analysis within the MHS (19–21). However, there were indications of effect modification by age; among patients younger than 50 years of age, NHBs experienced significantly worse survival than NHWs. Furthermore, stratification by sex and tumor stage showed that this racial disparity was confined to women and patients with distant stage disease below the age of 50 years.

Our findings seem to indicate that among older individuals, but not younger individuals, having equal access to health care results in similar colon cancer survival among NHWs and NHBs. A recent study among individuals in the general U.S. population ages 50 years and older estimated that approximately 20% of

the Black–White disparity in CRC mortality rates could be attributed to the racial differences in screening, which are related to access to health care (25). In the current study, when access to screening is seemingly equal, no racial difference in survival was observed among individuals for whom screening is recommended (patients $\geq$ 50 years of age), suggesting that equal access to health care may play an even larger role than previously estimated.

Among younger patients for whom screening is typically not recommended, racial variation in colon cancer survival within our equal access system implies that factors beyond access to care may contribute to the racial disparity. However, it is unclear why racial disparities were found primarily in younger women and younger patients with distant cancer stage. It is possible that the age-related racial variations seen in this study are due to differences in knowledge, attitudes, and behavior toward diagnosis or the use of medical care such as treatment among NHWs and NHBs. However, to the best of our knowledge, research is limited in this area and, therefore, further population-based outcomes research is warranted.

This study had several strengths. Namely, the possible confounding effects of multiple factors including Hispanic ethnicity, medical comorbidities, and tumor recurrence were simultaneously controlled for, and effect modification by age at diagnosis, sex, and tumor stage were assessed using detailed, linked electronic cancer registry and medical claims data. Limitations were also present. Sample sizes were limited for certain stratified analyses. For example, there were small numbers of patients with localized or regional cancer among those aged younger than 50 years. This prevented us from ascertaining whether decreased survival among Blacks was truly specific to distant tumors only. All-cause mortality, not disease-specific mortality, was the outcome of this study; therefore, it is possible that the inclusion of non-colon cancer deaths may have affected our results. However, the impact on our results is likely minimal, particularly among older individuals. Only if other causes of death were less common among NHBs than NHWs, which is unlikely, could the inclusion of all-cause mortality have obscured a true difference in cause-specific mortality among older individuals. It is harder to rule out the possibility that the racial disparity in survival among the young was not driven by racial differences in other causes of death. However, given that no significant difference in comorbidity was observed between NHWs and NHBs, even after stratifying by age (data not shown), the likelihood that other causes of death influenced any racial differences seen in this study is minimal.

In a health care system where medical care is equally available to NHWs and NHBs, similar OS in patients with colon cancer was observed. However, there was evidence of racial differences in survival by age. Thus, it is possible that factors other than equal-access to care influence racial disparities in OS among younger, but not older, patients with colon cancer.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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Authors' Contributions

Conception and design: A.A. Andaya, L. Enewold, S.H. Zahm, C.D. Shriver, K. Zhu
Development of methodology: A.A. Andaya, L. Enewold, S.H. Zahm, K. Zhu
Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): K. Zhu
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): A.A. Andaya, L. Enewold, S.H. Zahm, K.A. McGlynn, K. Zhu
Writing, review, and/or revision of the manuscript: A.A. Andaya, L. Enewold, S.H. Zahm, C.D. Shriver, A. Stojadinovic, K.A. McGlynn, K. Zhu
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): L. Enewold, C.D. Shriver
Study supervision: C.D. Shriver, K. Zhu

Acknowledgments

The authors thank the following individuals and institutes for their contributions to or support for the original data linkage project: Mr. Guy J. Garnett, Mr. David E. Radune, and Dr. Aliza Fink of ICF Macro; Ms. Wendy Funk, Ms. Julie Anne Mutersbaugh, Ms. Linda Cottrell, and Ms. Laura Hopkins of Kennel and Associates, Inc.; Ms. Kim Frazier, Drs. Elder Granger, and Thomas V. Williams of TMA; Ms. Annette Anderson, Drs. Patrice Robinson, and Chris Owner of the Armed Forces Institute of Pathology; Drs. Joseph F. Fraumeni, Jr, Robert N. Hoover, Susan S. Devesa, and Ms. Gloria Gridley of NCI; Dr. John Potter, Mr. Raul Parra, Ms. Anna Smith, Ms. Fiona Renalds, Mr. William Mahr, Mrs. Hongyu Wu, Dr. Larry Maxwell, Mr. Miguel Buddle, and Ms.Virginia Van Horn of the United States Military Cancer Institute (USMCI), Washington, D.C.

Grant Support

This work was supported by John P. Murtha Cancer Center, Walter Reed National Military Medical Center via the Uniformed Services University of the Health Sciences under the auspices of the Henry M. Jackson Foundation for the Advancement of Military Medicine, and by the intramural research program of the NCI. The original data linkage was supported by the USMCI and Division of Cancer Epidemiology and Genetics, NCI.

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Received February 6, 2013; revised March 22, 2013; accepted April 1, 2013; published OnlineFirst April 10, 2013.

References

1. American Cancer Society Colorectal cancer facts & figures 2011–2013. Atlanta, GA: American Cancer Society; 2011.
2. Wingo PA, Cardinez CJ, Landis SH, Greenlee RT, Ries LA, Anderson RN, et al. Long-term trends in cancer mortality in the United States, 1930–1998. Cancer 2003;97:3133–275.

3. DeLancey JO, Thun MJ, Jemal A, Ward EM. Recent trends in Black–White disparities in cancer mortality. Epidemiol Biomarkers Prev 2008;17:2908–12.
4. Robbins AS, Siegel RL, Jemal A. Racial disparities in stage-specific colorectal cancer mortality rates from 1985 to 2008. J Clin Oncol 2012;30:401–5.
5. Polite BN, Dignam JJ, Olopade OI. Colorectal cancer and race: understanding the differences in outcomes between African Americans and Whites. Med Clin North Am 2005;89:771–93.
6. Polite BN, Dignam JJ, Olopade OI. Colorectal cancer model of health disparities: understanding mortality differences in minority populations. J Clin Oncol 2006;24:2179–87.
7. Wingo PA, Ries LA, Parker SL, Heath CW Jr. Long-term cancer patient survival in the United States. Cancer Epidemiol Biomarkers Prev 1998;7:271–82.
8. Merrill RM, Henson DE, Ries LA. Conditional survival estimates in 34,963 patients with invasive carcinoma of the colon. Dis Colon Rectum 1998;41:1097–106.
9. Clegg LX, Li FP, Hankey BF, Chu K, Edwards BK. Cancer survival among US Whites and minorities: a SEER (Surveillance, Epidemiology, and End Results) program population-based study. Arch Intern Med 2002;162:1985–93.
10. Mayberry RM, Coates RJ, Hill HA, Click LA, Chen VW, Austin DF, et al. Determinants of Black/White differences in colon cancer survival. J Natl Cancer Inst 1995;87:1686–93.
11. Hashiguchi Y, Hase K, Ueno H, Shinto E, Naito Y, Kajiwara Y, et al. Impact of race/ethnicity on prognosis in patients who underwent surgery for colon cancer: analysis for White, African, and East Asian Americans. Ann Surg Oncol 2012;19:1517–28.
12. Marcella S, Miller JE. Racial differences in colorectal cancer mortality. The importance of stage and socioeconomic status. J Clin Epidemiol 2001;54:359–66.
13. Kirby JB, Kaneda T. Unhealthy and uninsured: exploring racial differences in health and health insurance coverage using a life table approach. Demography 2010;47:1035–51.
14. Ward E, Halpern M, Schrag N, Cokkinides V, DeSantis C, Bandi P, et al. Association of insurance with cancer care utilization and outcomes. CA Cancer J Clin 2008;58:9–31.
15. Mahmoudi E, Jensen GA. Diverging racial and ethnic disparities in access to physician care: comparing 2000 and 2007. Med Care 2012;50:327–34.
16. Demissie K, Oluwole OO, Balasubramanian BA, Osinubi OO, August D, Rhoads GG. Racial differences in the treatment of colorectal cancer: a comparison of surgical and radiation therapy between Whites and Blacks. Ann Epidemiol 2004;14:215–21.
17. Du XL, Fang S, Vernon SW, El-Serag H, Shih YT, Davila J, et al. Racial disparities and socioeconomic status in association with survival in a large population-based cohort of elderly patients with colon cancer. Cancer 2007;110:660–9.
18. Du XL, Meyer TE, Franzini L. Meta-analysis of racial disparities in survival in association with socioeconomic status among men and women with colon cancer. Cancer 2007;109:2161–70.
19. Dominitz JA, Samsa GP, Landsman P, Provenzale D. Race, treatment, and survival among colorectal carcinoma patients in an equal-access medical system. Cancer 1998;82:2312–20.
20. Robinson CN, Balentine CJ, Marshall CL, Anaya DA, Artinyan A, Awad SA, et al. Ethnic disparities are reduced in VA colon cancer patients. Am J Surg 2010;200:636–9.
21. Hofmann LJ, Lee S, Waddell B, Davis KG. Effect of race on colon cancer treatment and outcomes in the Department of Defense healthcare system. Dis Colon Rectum 2010;53:9–15.
22. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373–83.
23. Hendifar A, Yang D, Lenz F, Lurje G, Pohl A, Lenz C, et al. Gender disparities in metastatic colorectal cancer survival. Clin Cancer Res 2009;15:6391–7.
24. Screening for colorectal cancer: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med 2008;149:627–37.
25. Lansdorp-Vogelaar I, Kuntz KM, Knudsen AB, van Ballegooijen M, Zauber AG, Jemal A. Contribution of screening and survival differences to racial disparities in colorectal cancer rates. Cancer Epidemiol Biomarkers Prev 2012;21:728–36.