Original Article

Racial Variation in Tumor Stage at Diagnosis Among Department of Defense Beneficiaries

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BACKGROUND: Tumor stage at diagnosis often varies by racial/ethnic group, possibly because of inequitable health care access. Within the Department of Defense (DoD) Military Health System, beneficiaries have equal health care access. The objective of this study was to determine whether tumor stage differed between whites and blacks with breast, cervical, colorectal, and prostate cancers, which have effective screening regimens, based on data from the DoD Automated Cancer Tumor Registry from 1990 to 2003. **METHODS:** Distributions of tumor stage (localized vs nonlocalized) between whites and blacks in the military were compared stratified by sex, active duty status, and age at diagnosis. Logistic regression was used to further adjust for age, marital status, year of diagnosis, geographic region, military service branch, and tumor grade. Distributions of tumor stage were then compared between the military and general populations. **RESULTS:** Racial differences in the distribution of stage were significant only among nonactive duty beneficiaries. After adjusting for covariates, earlier stages of breast cancer after age 49 years and prostate cancer after age 64 years were significantly more common among white than black nonactive duty beneficiaries ($P < .05$), although the absolute difference was minimal for prostate cancer. Racial differences in stage for cervical and colorectal cancers were not significant after adjustment. Compared with the general population, racial differences in the military were similar or were slightly attenuated. **CONCLUSIONS:** Racial disparities in stage at diagnosis were apparent in the DoD equal-access health care system among older nonactive duty beneficiaries. Socioeconomic status, supplemental insurance, cultural beliefs, and biologic factors may be related to these results. ***Cancer* 2012;118:1397–403.** *© 2011 American Cancer Society.*

KEYWORDS: Department of Defense health system, military, racial disparity, tumor state, equal health care access.

Cancer is the second leading cause of death in the United States,[1] resulting in an estimated 569,490 deaths in 2010.[2] Earlier tumor stage at diagnosis, which can be achieved by screening of some cancers, is associated with improved outcome. Cancer screening tests have been established for breast, cervical, colorectal, and prostate cancers. In the general US population, however, many of these tumors still are diagnosed at later stages, particularly among blacks. Consequently, blacks tend to have lower relative survival rates than whites.[3] The reasons for these racial disparities are complex and likely arise because of a combination of factors. The most often cited reasons for the worse statistics among blacks are lower socioeconomic status and decreased insurance coverage, resulting in limited access to quality health care.[4-8] However, other factors, such as cultural beliefs[4,7,9] and genetic or other biologic variations,[6,10] also have been implicated. The Department

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The authors certify that all individuals who qualify as authors have been listed; that each has participated in the conception and design of this work, the analysis of data (when applicable), the writing of the article, and the approval of the submission of this version; that the article represents valid work; that, if we used information derived from another source, then we obtained all necessary approvals to use it and made appropriate acknowledgments in the article; and that each author takes public responsibility for it. Nothing in the presentation implies any federal/Department of Defense/Department of the Navy endorsement.

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of Defense (DoD) Military Health System provides a unique opportunity to study potential racial disparities, because it provides equal access to health care without regard to race or socioeconomic status. A recent survey of DoD beneficiaries indicated that self-reported cancer screening rates were higher and racial/ethnic disparities in cancer screening rates were lower compared with those in the general US population.[11] It is unclear whether these findings translate to decreased racial disparities in tumor stage at diagnosis. Previous studies among combined DoD active duty and nonactive duty beneficiaries produced evidence of racial variation by tumor stage at diagnosis for colorectal and breast cancers.[12-14] However, it was not known whether racial differences varied by active duty status or persisted after adjusting for other covariates.

The objective of the current study was to conduct a DoD-wide comparison of tumor stage at diagnosis between whites and blacks for 4 cancers (breast, cervical, colorectal, and prostate). These cancer sites were selected because racial variations in stage at diagnosis observed in the general population may be attributable in part to access to the established screening tests. Comparisons were made between white and black beneficiaries by sex, active duty status, and age at diagnosis, because active duty personnel may be monitored more closely and because cancer screening practices vary with age.[15] Data on racial differences by tumor stage at diagnosis in the general US population were obtained for comparison. We hypothesized that tumor stage at diagnosis would not differ significantly within the military by race after covariate stratification and adjustment and that any racial differences observed in the military would be less than differences in the general population.

MATERIALS AND METHODS

The Automated Cancer Tumor Registry (ACTUR) was established in 1986 and is the data-collection and clinical tracking system for all cancer cases diagnosed or treated at military treatment facilities among DoD beneficiaries, including active duty military personnel, retired military personnel, and their dependents. Certified cancer registrars at each facility enter and maintain ACTUR data according to state and federal guidelines. The registry includes information on demographic factors (eg, age, race, sex, and geographic location), diagnostic factors (eg, date of diagnosis), and tumor characteristics (eg, histology, stage, and grade). The anatomic sites of the cancers were categorized using the first edition of the International Classification of Diseases for Oncology (ICD-O) for patients who were diagnosed from 1986 to 1991,[16] the second edition (ICD-O-2) for patients who were diagnosed from 1992 to 2001,[17] and the third edition ICD-O-3 for patients who were diagnosed after 2001[18]; all diagnoses were recoded by ACTUR personnel using ICD-O-3 codes.

For the purposes of the current study, registry data for patients aged ≥18 years who were diagnosed from 1990 to 2003 were included. Although all data submitted to ACTUR are reviewed and verified for accurate diagnoses, patients who were diagnosed between 1986 and 1989 were excluded to minimize the possibility of incomplete ascertainment. Procedures were developed with reference to national and state cancer registry guidelines[19,20] to identify and consolidate duplicate records so that only 1 record existed for each primary cancer. Tumor stage at diagnosis was determined based on the Surveillance, Epidemiology, and End Results (SEER) Program of the National Cancer Institute by combining 2 variables: "SEER Summary Stage 1977" for patients who were diagnosed from 1990 to 2000 and "SEER Summary Stage 2000" for patients who were diagnosed from 2001 to 2003, as described and used by the SEER Program.[21,22] When there were multiple records per tumor at the time of diagnosis with different tumor stage codes, the information was chosen as follows: 1) if surgery information was available, then the code associated with the most definitive surgery was selected; and 2) if no surgery information was available, then the most advanced stage code was selected. Cancer-specific age categories were based on American Cancer Society cancer screening recommendations: breast cancer screening with mammography starting at age 40 years, cervical cancer screening with Papanicolaou smears between ages 18 and 69 years, and colorectal and prostate cancer screening starting at age 50 years.[15] Generally, there are few older active duty beneficiaries, especially those who are eligible for Medicare (aged ≥65 years); however, there are many older nonactive duty beneficiaries, which allowed for further age stratification among this latter group. Therefore, breast, prostate, and colorectal cancers were investigated separately among individuals aged >64 years. Breast cancer also was investigated among women ages 50 to 64 years, because the average age at menopause is 50 years, and it is known that breast cancer etiology varies by menopausal status. Cervical cancer was investigated stratified at age 30 years, because American Cancer Society recommendations change at this age from annually/biannually

to every 2 to 3 years, depending on the method used. Individuals ages 65 to 69 years were not investigated separately for cervical cancer because of their small numbers. For comparison with the general US population, data for patients who were diagnosed from 1990 to 2003 were obtained on breast and cervical cancers among women and on colorectal cancers among both sexes from the 9 original SEER registries (Connecticut, Iowa, New Mexico, Utah, Hawaii, Detroit, San Francisco-Oakland, Atlanta, and Seattle-Puget Sound), which cover about 10% of the US population.[23] Like the ACTUR data, tumor site data were based on ICD-O-3 codes. Stage at diagnosis was determined for each patient according to "SEER Historical Stage A" codes (in situ, localized, regional, distant, unstaged; in situ cancers were not included in this analysis).[24] SEER Historical Stage A codes are comparable to the SEER Summary Stage codes (for localized vs regional/distant stages) that were used by ACTUR for breast and cervical cancers. Codes for colorectal cancer stages differ somewhat, in that colorectal tumors with "invasion of/through serosa" are classified as localized in SEER and regional in ACTUR.[22] Stage comparisons of prostate cancer between the 2 populations were not conducted, because SEER Historical Stage A codes for prostate cancer group localized and regional disease a single category.[25] The distributions of tumor stage between whites and blacks within the same population were compared when stratified by sex, cancer, categorical age at diagnosis, and active duty status at diagnosis. For active duty members, only univariate analyses were conducted using chi-square tests or Fisher exact tests, because the sample sizes were relatively small. For nonactive duty members and the SEER population, odds ratios (ORs) and 95% confidence intervals (CIs) comparing tumor stage (localized vs regional/distant) between blacks and whites while adjusting for continuous age, marital status (married, single/divorced/separated/widowed, or unknown), year of diagnosis, geographic region (North, South, West, unknown),[26] tumor grade (I, II, III/IV, unknown), and military service branch (Army, Navy, Air Force, Marine, other; ACTUR only) were calculated if cell frequencies for the binary tumor stage variable were at least 10. All analyses were conducted using SAS software version 9.1 (SAS Institute Inc., Cary, NC), and the 2-sided significance level was set at $P < .05$. The protocol for this study was reviewed and approved by the National Naval Medical Center Institutional Review Board (IRB) and the Armed Forces Institute of Pathology IRB.

Table 1. Distribution of Demographic Variables Among Cancer Cases in the Department of Defense's Automated Central Tumor Registry and in the General Population (Surveillance, Epidemiology, and End Results Database) by Cancer Site: 1990-2003

		No. of Patients (%)		
		ACTUR		
Cancer Site	Demographic Variable	Active Duty	Nonactive Duty	SEER
Breast	Age, y[a]			
	18-39	407 (52)	1591 (10)	12,608 (6)
	≥40	375 (48)	14,715 (90)	210,344 (94)
	Race			
	White	487 (62)	14,302 (88)	203,353 (91)
	Black	295 (38)	2004 (12)	19,599 (9)
Cervix	Age, y[a]			
	18-29	39 (29)	145 (12)	1048 (9)
	30-69	94 (71)	1051 (88)	10,496 (91)
	Race			
	White	107 (80)	1059 (89)	9742 (84)
	Black	26 (20)	137 (11)	1802 (16)
Colorectum	Age, y[a]			
	18-49	565 (86)	948 (10)	11,480 (7)
	≥50	92 (14)	8747 (90)	147,393 (93)
	Race			
	White	500 (76)	8432 (87)	143,675 (90)
	Black	157 (24)	1263 (13)	15,197 (10)
	Sex			
	Women	69 (11)	3679 (38)	78,896 (50)
	Men	588 (89)	6016 (62)	79,977 (50)
Prostate[a]	Age, y[a]			
	18-49	413 (51)	423 (2)	
	≥50	404 (49)	21,444 (98)	
	Race			
	White	623 (76)	17,894 (82)	
	Black	194 (24)	3973 (18)	

Abbreviations: ACTUR, Automated Central Tumor Registry; SEER, Surveillance, Epidemiology, and End Results.
[a] Age categories were cancer site-specific based on American Cancer Society cancer screening recommendations.
[b]Prostate cancer in SEER was not analyzed.

RESULTS

For descriptive purposes, the demographic characteristics of included patients in the military by duty status and in the general population are presented by cancer site in Table 1. Among active duty beneficiaries, there were 782 breast cancers, 133 cervical cancers, and 69 colorectal cancers with known tumor stage diagnosed from 1990 to 2003 included among women and 817 prostate cancers and 588 colorectal cancers included among men. No significant differences in tumor stage distribution for any of these cancers were observed between white and black active duty beneficiaries (Table 2).

Among nonactive duty beneficiaries, there were 16,306 breast cancers, 1196 cervical cancers, and 3679 colorectal cancers included among women and 21,867 prostate cancers and 6016 colorectal cancers included

Table 2. Racial Comparison of Tumor Stage at Diagnosis for Selected Cancers Among Active Duty Department of Defense Health Care Beneficiaries by Sex, Cancer Site, and Age at Diagnosis: Automated Central Tumor Registry, 1990-2003

Cancer Site	Age at Diagnosis, y	Stage[a]	No. of Patients (%) Whites	Blacks	P[b]
Women					
Breast	18-39	Localized	112 (49)	90 (50)	.89
		Regional/distant	115 (51)	90 (50)	
	≥40	Localized	162 (62)	62 (54)	.13
		Regional/distant	98 (38)	53 (46)	
Cervix	18-29	Localized	27 (84)	4 (57)	.14
		Regional/distant	5 (16)	3 (43)	
	30-69	Localized	67 (89)	16 (84)	.69
		Regional/distant	8 (11)	3 (16)	
Colorectum	18-49	Localized	17 (46)	6 (26)	.12
		Regional/distant	20 (54)	17 (74)	
	≥50	Localized	3 (43)	1 (50)	1.00
		Regional/distant	4 (57)	1 (50)	
Men					
Prostate	18-49	Localized	242 (88)	119 (86)	.61
		Regional/distant	33 (12)	19 (14)	
	≥50	Localized	280 (80)	47 (84)	.54
		Regional/distant	68 (20)	9 (16)	
Colorectum	18-49	Localized	140 (37)	42 (34)	.62
		Regional/distant	242 (63)	81 (66)	
	≥50	Localized	39 (53)	5 (56)	1.00
		Regional/distant	35 (47)	4 (44)	

[a] Surveillance, Epidemiology, and End Results (SEER) Summary Stage 1997 (cases diagnosed during 1990-2000) and SEER Summary Stage 2000 (cases diagnosed during 2001-2003).
[b] Two-sided P values were calculated with chi-square tests or Fishers exact tests (for expected cell frequencies <5) comparing the distribution between whites and blacks.

among men (Table 3). Significant racial variation was observed among both sexes. White women aged >49 years were less likely to have nonlocalized breast cancers than black women after adjustment for age, marital status, year of diagnosis, geographic region, military service branch, and tumor grade. This racial difference increased with age (ages 18-39 years: OR, 1.07; ages 40-49 years: OR, 0.85; ages 50-64 years, OR, 0.77; aged ≥65 years: OR, 0.63; $P_{\text{interaction}} < .01$). A significant racial difference in stage distribution was observed for prostate cancer among men aged ≥65 years (adjusted OR, 0.78; 95% CI, 0.68-0.91), but the actual variation in the distribution was small, suggesting that statistical significance was the result of the large sample size. After adjustment, no significant racial differences in stage distribution were observed for cervical or colorectal cancers. There were 222,952 breast cancers, 11,544 cervical cancers, and 78,896 colorectal cancers included among women and 79,977 colorectal cancers included among men in the general population (Table 3). The percentages of cancers that were localized were significantly greater among whites than blacks for all 4 cancers, even after adjustment. Racial differences did not vary significantly by age. Compared with the general population, racial differences in the percentage of cancers that were localized among nonactive duty beneficiaries tended to be similar or slightly attenuated. For example, in SEER, among women ages 18 to 39 years, 53% of white women and 44% of black women were diagnosed with local breast cancers (difference, 9%) compared with 50% and 51% of their respective counterparts in ACTUR (difference, −1%). Comparisons between the general population and the active duty military population were not conducted, because no significant racial differences were observed among the latter population.

DISCUSSION

The distribution of tumor stage by race did not appear to vary greatly among active duty beneficiaries for the 4 cancers that were studied, but small sample sizes may have resulted in insufficient power to detect true differences. In contrast, racial differences were observed among nonactive duty beneficiaries, particularly among older

Table 3. Racial Comparison of Tumor Stage at Diagnosis for Selected Cancers Among Nonactive Duty Department of Defense Health Care Beneficiaries (Automated Central Tumor Registry) and Individuals in the General US Population (Surveillance, Epidemiology, and End Results) by Sex, Cancer Site, and Age at Diagnosis: 1990-2003

			ACTUR			SEER		
			No. of Patients (%)			No. of Patients (%)		
Cancer Site	Age, y	Stage[a]	Whites	Blacks	OR [95% CI][b]	Whites	Blacks	OR [95% CI][b]
Women								
Breast	18-39	Localized	606 (50)	193 (51)	1.07 [0.85-1.36]	5533 (53)	919 (44)	0.71 [0.64-0.79]
		Regional/distant	605 (50)	187 (49)		5005 (47)	1151 (56)	
	40-49	Localized	1491 (58)	271 (52)	0.85 [0.70-1.03]	19,914 (60)	2311 (51)	0.76 [0.71-0.81]
		Regional/distant	1059 (42)	253 (48)		13,509 (40)	2202 (49)	
	50-64	Localized	4076 (67)	450 (58)	0.77 [0.66-0.90]	41,701 (65)	3551 (55)	0.73 [0.69-0.77]
		Regional/distant	2036 (33)	329 (42)		22,579 (35)	2941 (45)	
	≥65	Localized	3297 (74)	202 (63)	0.63 [0.49-0.81]	67,086 (71)	3963 (61)	0.72 [0.68-0.76]
		Regional/distant	1132 (26)	119 (37)		28,026 (29)	2562 (39)	
Cervix	18-29	Localized	99 (78)	15 (83)	—[c]	768 (84)	101 (77)	0.63 [0.37-1.07]
		Regional/distant	28 (22)	3 (17)		148 (16)	31 (23)	
	30-69	Localized	645 (69)	81 (68)	1.01 [0.65-1.57]	5286 (60)	837 (50)	0.74 [0.66-0.84]
		Regional/distant	287 (31)	38 (32)		3540 (40)	833 (50)	
Colorectum	18-49	Localized	128 (30)	47 (34)	1.30 [0.83-2.04]	1655 (37)	307 (32)	0.71 [0.60-0.84]
		Regional/distant	301 (70)	90 (66)		2759 (63)	663 (68)	
	50-64	Localized	486 (39)	88 (37)	0.92 [0.68-1.26]	5281 (40)	853 (38)	0.81 [0.73-0.89]
		Regional/distant	749 (61)	147 (63)		7765 (60)	1413 (62)	
	≥65	Localized	634 (43)	52 (33)	0.71 [0.49-1.02]	22,460 (42)	1860 (39)	0.84 [0.78-0.89]
		Regional/distant	853 (57)	104 (67)		31,008 (58)	2872 (61)	
Men								
Prostate	18-49	Localized	190 (84)	157 (80)	0.70 [0.39-1.27]			
		Regional/distant	36 (16)	40 (20)				
	50-64	Localized	5743 (81)	1707 (82)	1.14 [0.99-1.31]			
		Regional/distant	1336 (19)	380 (18)				
	≥65	Localized	8904 (84)	1369 (81)	0.78 [0.68-0.91]			
		Regional/distant	1685 (16)	320 (19)				
Colorectum	18-49	Localized	77 (26)	24 (29)	0.96 [0.52-1.76]	1895 (36)	292 (32)	0.79 [0.67-0.93]
		Regional/distant	221 (74)	60 (71)		3301 (64)	608 (68)	
	50-64	Localized	864 (39)	132 (36)	0.85 [0.67-1.08]	7640 (42)	897 (37)	0.77 [0.70-0.85]
		Regional/distant	1363 (61)	237 (64)		10,669 (58)	1502 (63)	
	≥65	Localized	1221 (44)	112 (40)	0.78 [0.60-1.01]	21,665 (44)	1573 (40)	0.81 [0.76-0.87]
		Regional/distant	1535 (56)	170 (60)		27,578 (56)	2357 (60)	

Abbreviations: ACTUR, Automated Central Tumor Registry; CI, confidence interval; OR, odds ratio; SEER, Surveillance, Epidemiology, and End Results.
[a] ACTUR:SEER Summary Stage 1977 (cases diagnosed during 1990-2000), SEER Summary Stage 2000 (cases diagnosed during 2001-2003). SEER: SEER Historical Stage A.
[b] ORs and 95% CIs comparing local tumors versus regional/distant tumors between blacks and whites are adjusted for continuous age, marital status, year of diagnosis, geographic region, tumor grade, and military service branch (ACTUR only) and were not calculated for prostate cancer in SEER, because SEER Historical Stage A codes combine local and regional disease.
[c] Not calculated if frequency was <10.

individuals with breast or prostate cancers. Nonetheless, the racial differences observed in the military appeared to be similar or attenuated compared with the general population; the racial difference in the percentage of cancers that were localized was smaller for breast cancer among young women who were nonactive duty beneficiaries compared with young women in the general population.

Our results among nonactive duty beneficiaries were in agreement with a previous DoD-wide breast cancer study, although the calendar years differed.[14] Our findings further indicated that significant racial differences exist after covariate adjustment and occur within age groups for which mammography is recommended. It is unclear why racial differences in breast cancer stage increased with age in the military but not in the general population. After covariate adjustment, our findings indicated that stage at diagnosis for colorectal cancer did not differ significantly between whites and blacks, which is contradictory to previous unadjusted studies among DoD beneficiaries.[12,13] This inconsistency may have resulted from differences in study populations, because 1 of the previous studies[12] was based on registry data from 1 DoD medical center, whereas our study was DoD-wide. Geographic variations in use of health care and physician practice have been observed in the Department of Veterans Affairs health care system,[27] which provides care for

military veterans. In addition, our study adjusted for covariates, whereas the previous studies[12,13] did not. To our knowledge, stage at diagnosis of prostate and cervical cancers among DoD beneficiaries have not been previously summarized and compared by race.

Larger racial disparities were observed among older nonactive duty individuals. We can only speculate about the reasons for these disparities. They may be caused by the increased physical or cultural barriers to health care use and variations in health care options among older individuals. These barriers could result in a greater tendency for black individuals to forgo more frequent care and/or postpone seeking medical care until after symptoms appear, thus resulting in a greater proportion of older black beneficiaries diagnosed at later stages of cancer. Although our data did not contain information on the use of cancer screening tests and could not demonstrate any racial differences in cancer screening, it has been observed that perceived cancer risk and cancer screening awareness vary by race.[28,29] Racial variations in other health insurance (ie, through employment, spouse, or Medicare) also may influence health care seeking behaviors. In addition, it is possible that racial differences in genetics or other biologic factors may result in variations in tumor aggressiveness[30] and, thus, differences in tumor stage at diagnosis.

The main strength of this study was the use of data from a health care system that is based on equal access to assess racial variations. Limitations of the study included the small numbers of specific cancers by race among active duty beneficiaries. Such numbers may have limited the power to detect racial differences. Second, the grouped categorization of localized and regional prostate cancers in the SEER data precluded us from comparing the magnitude of the racial difference in tumor stage between the 2 populations for this cancer site. There also is the possibility of under reporting in ACTUR. Although DoD policies require cancer cases to be reported to ACTUR, some military treatment facilities, especially small ones, may not have reported their cancer patients. Although the extent of the under reporting is not known, differential reporting of tumor stage by race would have to exist to explain the observed differences. In addition, there is the possibility of selection bias of the patients who were included in the study, because beneficiaries have to be seen at a DoD medical center to be reported to ACTUR, and beneficiaries who have other health insurance may seek care elsewhere. There would have to be differential selection by stage and race for this to account for the observed differences. If whites have greater access to other health care and are diagnosed elsewhere at earlier stages, then it is possible that our findings may represent an underestimate of the true racial difference in tumor stage at diagnosis among nonactive duty military beneficiaries. Finally, for colorectal cancer, differences in tumor stage criteria between the 2 populations may explain in part the higher percentage of localized tumors in the general population; therefore, the results should be interpreted with caution. However, unless the percentage of tumors with "invasion of/through serosa" differed by race, the racial difference in the percentage of localized tumors in the 2 populations should be comparable.

In conclusion, racial disparities in tumor stage at diagnosis were not observed in the DoD Military Health System among active duty beneficiaries, but disparities were apparent among older nonactive duty beneficiaries, and whites generally were diagnosed with earlier stage breast and prostate cancers than blacks. Although the DoD system is based on equal access, racial variation in socioeconomic status and supplemental insurance still may affect tumor stage at diagnosis. Therefore, more studies are needed to assess the independent impact of these and other possible factors.

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CONFLICT OF INTEREST DISCLOSURES

The authors made no disclosures.

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