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ORIGINAL PAPER

Race and overall survival in men diagnosed with prostate cancer in the Department of Defense Military Health System, 1990–2010

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Abstract

Background In the U.S. general population, black men experience poorer survival after prostate cancer (CaP) diagnosis compared to white men, and findings may be impacted by unequal access to healthcare. The objective of the study is to investigate racial differences in overall survival (OS) among Department of Defense beneficiaries diagnosed with CaP.

Methods A retrospective cohort study was conducted utilizing the Automated Central Tumor Registry within the Military Healthcare System, a system designed to provide equal access. Men diagnosed with primary prostate adenocarcinomas between 1990 and 2010 [$n = 18{,}484$; 24% Non-Hispanic black (NHB), 76% Non-Hispanic white (NHW)] were followed through 2013 for vital status. Unadjusted Kaplan–Meier estimation curves and multivariable Cox proportional hazards (PH) regression models were used to examine racial differences in OS.

Results Age-specific Kaplan–Meier analyses showed equivalent OS for NHW and NHB men in all age groups, except for 75+, where NHB had poorer OS ($p = 0.0048$). Multivariable Cox PH models revealed no significant differences in OS for race (HR 1.02; 95% CI 0.95–1.08), except in men aged ≥ 75 years, where NHB men had poorer OS (HR 1.27; 95% CI 1.08–1.49).

Conclusions Findings suggest that in a healthcare system designed for equal access, disparities in OS among men diagnosed with CaP may not exist.

Keywords Prostate cancer · Survival · Racial disparities · Equal access

Introduction

In 2017, over 160,000 men will be diagnosed with prostate cancer (CaP) and more than 26,000 men will die as a result of this disease in the United States (U.S.), remaining the second-leading cause of cancer death in U.S. men [1]. Striking differences in mortality rates between Non-Hispanic black (NHB) and Non-Hispanic white (NHW) men diagnosed with CaP have been observed in the U.S. population, with a rate among NHB men 2.4 times higher than NHW men [1, 2]. Racial differences are reported to be even stronger among younger men (aged 45–49 years), with fatal disease rates among NHB men 4.2 times higher than NHW men [3]. Additionally, NHB men typically have an earlier age at diagnosis of CaP [4].

Factors contributing to racial disparities in survival are not well understood; however, it has been suggested that socioeconomic and biological factors are at play [5, 6], with the former likely playing a role in timing of cancer diagnosis and access to effective treatments [7]. Socioeconomic factors are known to impact access and knowledge/attitudes/behavior related to cancer care and disparities in timeliness and quality of treatment as well as guideline-concordant care. If access to care, particularly timely and quality treatment is a major factor for racial disparities, they would diminish or disappear in equal access healthcare systems [8].

Lack of health insurance and cognitive/behavioral/cultural factors often act as barriers to healthcare access, which can lead to underutilization of cancer-screening services,

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higher stage at diagnosis, and having suboptimal options for treatment [9–11]. NHBs are generally over-represented in lower socioeconomic status groups in the U.S., potentially accounting for the observed excess CaP mortality. Studies in equal access healthcare settings [Department of Defense (DoD), Veterans Health Administration (VA), and United Kingdom National Health Service (NHS)], which should in part address barriers to screening and treatment, have found comparable survival rates across race [12–15]. However, many of these studies involved small populations of NHBs [12–17], or occurred prior to widespread CaP screening [14, 16, 17]. In 1995, a study using the U.S. Military Health System (MHS) Cancer Registry examined overall survival among men diagnosed with CaP between 1973 and 1994 [16]. This previous study found no differences in overall survival; however, it included a small number of NHBs, 96% of cases were diagnosed prior to widespread screening (1980–1990), and substantial changes in screening strategies and treatment options for CaP have occurred since 1995.

In the current study of DoD MHS beneficiaries with CaP, overall survival was examined for NHW and NHB men with CaP, to assess if racial disparities existed within a universal system designed for equal access to healthcare, [16, 18–22] during a period (1990–2010) encompassing widespread CaP screening.

Methods

Data sources and study population

The DoD's Automated Central Tumor Registry (ACTUR) is a clinical tracking system established in 1986 for cancer patients who are diagnosed and/or receive cancer treatment at military treatment facilities, including active duty members, retirees, and dependents. Certified tumor registrars review various sources such as DoD electronic health records to update and annotate ACTUR data to ensure accurate capture of dates of diagnoses, last patient contact, and death. ACTUR follows all patients for vital status following the Commission on Cancer's Facility Oncology Registry Data Standards [23], using a variety of sources including, but not limited to: contact with patient or patient's family, contact with managing physician(s), program inpatient or outpatient services, and verification via death certificates. (E. Butts, oral communication, June 2017) [24]. ACTUR also uses the National Death Index and the Defense Enrollment Eligibility Reporting System (DEERS), which contains date of death of beneficiaries.

Eligible study subjects included NHB and NHW men who were diagnosed with invasive, histologically confirmed primary prostate adenocarcinoma between 1 January 1990 and 31 December 2010, with continued patient follow-up until the earliest of date of death or the end of the study period (31 December 2013). To minimize potentially incomplete case ascertainment, since ACTUR was new in the late 1980s, we excluded men diagnosed prior to 1990. Subjects were identified using the tumor site (C619) and morphology (8140/3) code of the International Classification of Diseases for Oncology, third edition (ICD-O-3) [25]. Adenocarcinomas comprised more than 95% of all CaP cases [26].

The Institutional Review Board of the Walter Reed National Military Medical Center approved this study.

Outcome and variables

Overall survival (OS) was the primary study endpoint. ACTUR provided vital status and date of death, if applicable, as well as the following variables: age at CaP diagnosis (≤ 50 years of age, 51–64 years, 65–74 years, and ≥ 75 years), race, ethnicity, marital status, active duty status, military service branch, American Joint Committee on Cancer (AJCC) tumor stage (Stages I, II, III, IV, and unknown) [27], tumor grade (well differentiated, moderately differentiated, poorly differentiated, undifferentiated, differentiation unknown), surgery, chemotherapy, hormone therapy, and radiation therapy.

Statistical analysis

Age-adjusted proportions of demographic, tumor, and treatment variables used the total study population as the standard and stratified by race. Survival time was compared between NHB and NHW subjects. For deceased subjects, time between date of CaP diagnosis and date of death defined survival time. Subjects who did not die during the study period were censored at the study end date (31 December 2013).

Kaplan–Meier estimation curves were constructed to compare OS by race, using log-rank test for homogeneity of effect. Multivariable Cox proportional hazards (PH) models assessed the association between race and OS after adjusting for demographics, tumor characteristics, and treatment variables to produce hazards ratios (HRs) and corresponding 95% confidence intervals (95% CIs). Stratification by tumor stage (Stages I, II, III, IV, and unknown) and age groups (<50 years of age, 50–64 years, 65–74 years, and ≥ 75 years) determined whether racial differences in survival varied upon consideration of these variables. Statistical analyses were performed using SAS software version 9.3 (SAS Institute, Inc., Cary, NC). A two-sided p value ≤ 0.05 was considered statistically significant.

Results

After excluding men of unknown race ($n = 1{,}911$), unknown ethnicity (white men: $n = 5{,}159$; black men: $n = 1{,}053$), and Hispanic ethnicity (white men: $n = 1{,}086$; black men: $n = 34$), a total of 4,419 (23.91%) NHB men, and 14,065 (76.09%) NHW men were diagnosed in the MHS with primary prostate adenocarcinomas between 1990 and 2010. Table 1 presents crude and age-standardized proportions of demographic, tumor, and treatment characteristics by race. Despite the difference in age at diagnosis distribution between NHW and NHB cases, age-adjusted proportions of other variables did not differ substantially from crude proportions. Among these men, 1,297 (33.90%) NHBs and 5,609 (38.16%) NHWs died during the follow-up period. At the time of CaP diagnosis, a greater proportion of NHB men were married, had Stage I disease, and underwent surgery compared to NHW men. Also, NHB men were more likely to be affiliated with the Army, be non-active duty status (e.g., dependents or retirees), have poorly differentiated/undifferentiated tumors, and undergo radiation therapy compared to NHW men.

Figure 1(panels a–d) presents results from unadjusted KM curves of age-specific OS. A difference in OS by race was only found among men ≥ 75 years of age ($p < 0.01$, Fig. 1d), with NHB men having poorer OS compared to NHW men. The survival difference observed in the ≤ 50 age group ($p = 0.32$) was not statistically significant. When stratified by tumor stage, Fig. 2(panels a–d), unadjusted KM curves of OS show no differences in Stages I and IV ($p = 0.25$ and $p = 0.59$, respectively); however, within Stages II and III, NHB men had slightly better survival compared to NHW men ($p < 0.01$, $p = 0.03$, and $p = 0.05$, respectively).

Table 2 presents the results of multivariable Cox PH regression analysis. After adjustment for age, marital status, military sponsor branch, active duty status, tumor stage and grade, surgery, hormone therapy, chemotherapy, and radiation therapy, there were no differences in OS rates by race (HR: 1.02, 95% CI: 0.95–1.08). Though race was not an independent predictor of OS, the following groups had poorer survival: being 55 years of age or older (55–59 years: HR 1.39, 95% CI 1.09–1.78; 60–64 years: HR 1.93, 95% CI 1.52–2.45; 65–69 years: HR 2.62, 95% CI 2.06–3.33; 70–74 years: HR 4.04, 95% CI 3.18–5.13; 75–79 years: HR 5.53, 95% CI 4.33–7.06; ≥80 years: HR 11.54, 95% CI 8.97–4.83; compared to those ≤ 50 years of age), not being married (other: HR 1.37, 95% CI 1.26–1.48; single: HR 1.29, 95% CI 1.14–1.47; unknown: HR 1.11, 95% CI 1.02–1.20; compared to those who are married), Stage IV at diagnosis (HR 2.88, 95% CI 2.64–3.15), having moderately differentiated (HR 1.10, 95% CI 1.02–1.19), poorly differentiated/undifferentiated (HR 1.43, 95% CI 1.30–1.57), or unknown differentiation (HR 1.24, 95% CI 1.10–1.39) of tumors, undergoing hormone therapy (HR 1.34, 95% CI 1.26–1.42), and undergoing chemotherapy (HR 1.53, 95% CI 1.19–1.97). Those with better OS rates (i.e., reduced adjusted HRs) included those in Air Force (HR 0.89, 95% CI 0.84–0.94), Marines (HR 0.86, 95% CI 0.76–0.97), or Navy (HR 0.89, 95% CI 0.84–0.95; versus those in Army), being an active duty military service member (HR 0.59, 95% CI 0.45–0.76), and undergoing surgery (HR 0.71, 95% CI 0.67–0.75).

Age-stratified analyses showed that, among those diagnosed at ≥ 75 years of age, NHB men had poorer OS rates compared to NHW men (HR 1.27; 95% CI 1.08–1.49, Table 3). Among those diagnosed at age ≤ 50, NHB men had a HR of 1.28, but the estimate was not statistically significant. No statistically significant associations were observed in other age groups or in analyses stratified by tumor stage.

Discussion

In this large study of DoD MHS beneficiaries diagnosed with CaP during the PSA screening era, we found no statistically significant differences in OS between NHW and NHB men, with a single exception: among men diagnosed at age ≥ 75 years, NHB had significantly poorer OS compared to NHW men. Although the HR for those aged ≤ 50 years at CaP was elevated, it was not statistically significant, despite the large sample size. This younger group may also include a larger proportion than in other age groups of men diagnosed while on active duty, some of whom may have left the military prior to retirement eligibility, thus not having MHS medical benefits after departing the military, which could adversely impact OS. However, the numbers in this age group, though smaller than in some of the other age groups, are still large, and the finding is not statistically significant, thus we cannot infer any difference between NHWs and NHBs.

Prior studies in the U.S. general population found that NHB men often experience higher rates of mortality compared to their NHW counterparts, and reasons for this disparity are likely due to a combination of socioeconomic and biological factors [5, 6], but remain poorly understood. Access to healthcare has been frequently cited as a driving factor for racial disparities in CaP survival in the U.S. general population, as less access to care leads to lower utilization of preventive screenings, and thus a greater proportion of higher stage at diagnosis, suboptimal response to treatment [9–11], and a concomitant increase in mortality rates [8]. Therefore, if racial differences in CaP outcomes persist in equal access healthcare settings, then it is critical to consider behavioral, occupational, and biological drivers of racial differences.

Table 1 Selected demographics for patients diagnosed with prostate cancer in the DoD Tumor Registry (ACTUR), 1990–2010

Variable	Non-Hispanic White $n=14,065$			Non-Hispanic Black $n=4,419$		
	n	% (Crude)	% (Age-adjusted[a])	*n*	% (Crude)	% (Age-adjusted[a])
Age						
≤50 years	817	5.81	8.08	677	15.32	8.08
51 to 64 years	6,477	46.05	47.20	2,248	50.87	47.20
65 to 74 years	4,913	34.93	33.09	1,203	27.22	33.09
≥75 years	1,858	13.21	11.63	291	6.59	11.63
Marital status						
Married	11,540	82.05	82.19	3,351	75.83	74.60
Single	444	3.16	3.21	222	5.02	4.95
Other	1,134	8.06	7.86	492	11.13	11.99
Unknown	947	6.73	6.65	354	8.01	8.47
Military sponsor branch						
Army	4,323	30.74	30.79	2,185	49.45	49.84
Navy	3,367	23.94	23.88	544	12.31	12.27
Marines	654	4.65	4.67	170	3.85	3.64
Air force	4,714	33.52	33.49	1,256	28.42	28.26
Other	1,002	7.12	7.13	264	5.97	6.00
Unknown	5	0.04	0.04	0	0.00	0.00
Active duty status						
Yes	798	5.67	6.92	357	8.08	4.93
No	13,267	94.33	93.08	4,062	91.92	95.07
Tumor stage						
Stage I	150	1.07	1.05	18	0.41	0.43
Stage II	10,222	72.68	73.02	3,349	75.79	74.96
Stage III	1,220	8.67	8.75	369	8.35	7.98
Stage IV	658	4.68	4.57	207	4.68	5.15
Unknown	1,815	12.90	12.61	476	10.77	11.48
Tumor grade						
Well differentiated	1,540	10.95	10.98	429	9.71	9.49
Moderately differentiated	7,196	51.16	51.67	2,170	49.11	47.99
Poorly differentiated/undifferentiated	2,754	19.58	19.41	1,073	24.28	24.84
Unknown	2,575	18.31	17.94	747	16.90	17.69
Surgery						
Yes	6,631	47.15	48.73	2,024	45.80	40.91
No	7,434	52.85	51.27	2,395	54.20	59.09
Hormone therapy						
Yes	2,465	17.53	16.99	801	18.13	20.05
No	11,600	82.47	83.01	3,618	81.87	79.95
Chemotherapy						
Yes	87	0.62	0.61	29	0.66	0.60
No	13,978	99.38	99.39	4,390	99.34	99.40
Radiation therapy						
Yes	3,847	27.35	26.73	1,408	31.86	34.24
No	10,218	72.65	73.27	3,011	68.14	65.76
Vital status						
Alive	8,456	60.12	61.84	3,122	70.65	66.10
Dead	5,609	39.88	38.16	1,297	29.35	33.90

[a]Age adjusted to the combined population of Non-Hispanic Whites and Non-Hispanic Blacks

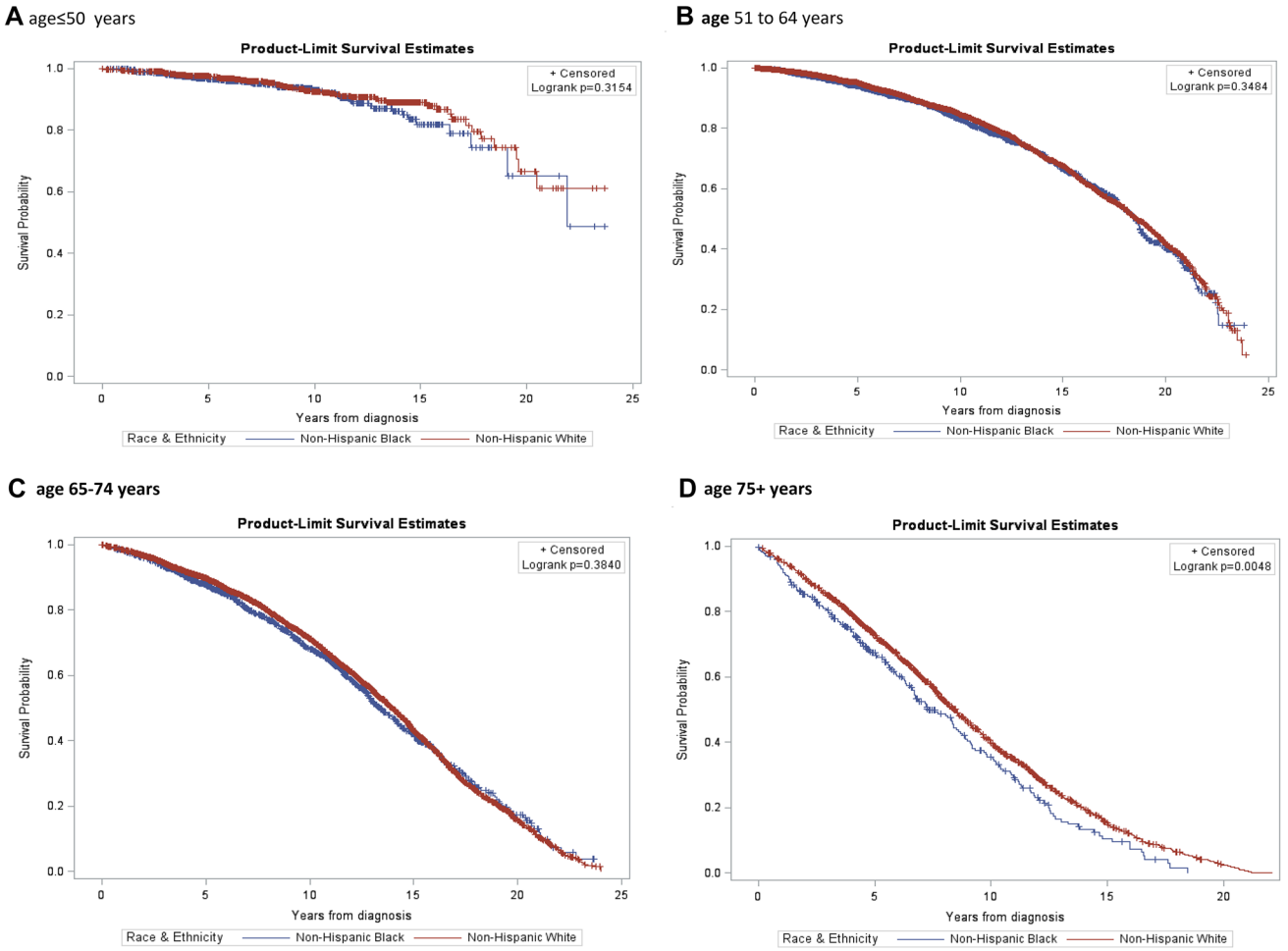

Fig. 1 Unadjusted Kaplan–Meier (KM) survival curves of overall survival (OS) among Non-Hispanic black (NHB) and Non-Hispanic white (NHW) prostate cancer patients diagnosed between 1990 and 2010 in the Automated Cancer Tumor Registry (ACTUR), stratified by age. **a** KM survival curves for NHB and NHW prostate cancer patients diagnosed at ≤50 years of age. **b** KM survival curves for NHB and NHW prostate cancer patients diagnosed at 51 to 64 years of age. **c** KM survival curves for NHB and NHW prostate cancer patients diagnosed at 65 to 74 years of age. **d** KM survival curves for NHB and NHW prostate cancer patients diagnosed at ≥75 years of age

An earlier study within the DoD found that race was not a predictor in OS, a finding supported in the present study [16]. However, that study had a small number of black men diagnosed with CaP ($n=121$), which may have limited their ability to draw any definitive conclusions. Of note, 96% of cases in that study were diagnosed between 1980 and 1990, prior to widespread PSA screening. Recent studies have examined the association between race and CaP survival in equal access settings and, similar to the present study, found no racial differences [12–15, 28]. The present study confirmed that surgical treatment for CaP is often independently associated with lower risk of mortality [29, 30]. Though NHB men were less likely to receive surgical treatment compared to NHW men in military and non-military populations in prior studies [12, 31, 32], results from the present study did not find evidence of racial differences in survival, after adjustment for important factors, including surgery. Interestingly, in the present study, chemotherapy and hormone therapy were associated with poorer all-cause survival; however, higher rates of these treatments were found among those diagnosed at later stages compared to earlier stages (data not shown), which was also associated with poorer all-cause survival. Because stage at diagnosis often predicts survival, we stratified models by stage and found no evidence of racial differences in survival in multivariate analyses, demonstrating that in the time of PSA screening and advanced treatments, having equal access to care mitigated disparities in CaP survival.

To our knowledge, this is the largest DoD-wide study conducted to date, with a substantial number of NHB men diagnosed with CaP, enabling comparisons of OS between NHB and NHW in multiple subgroups, including among

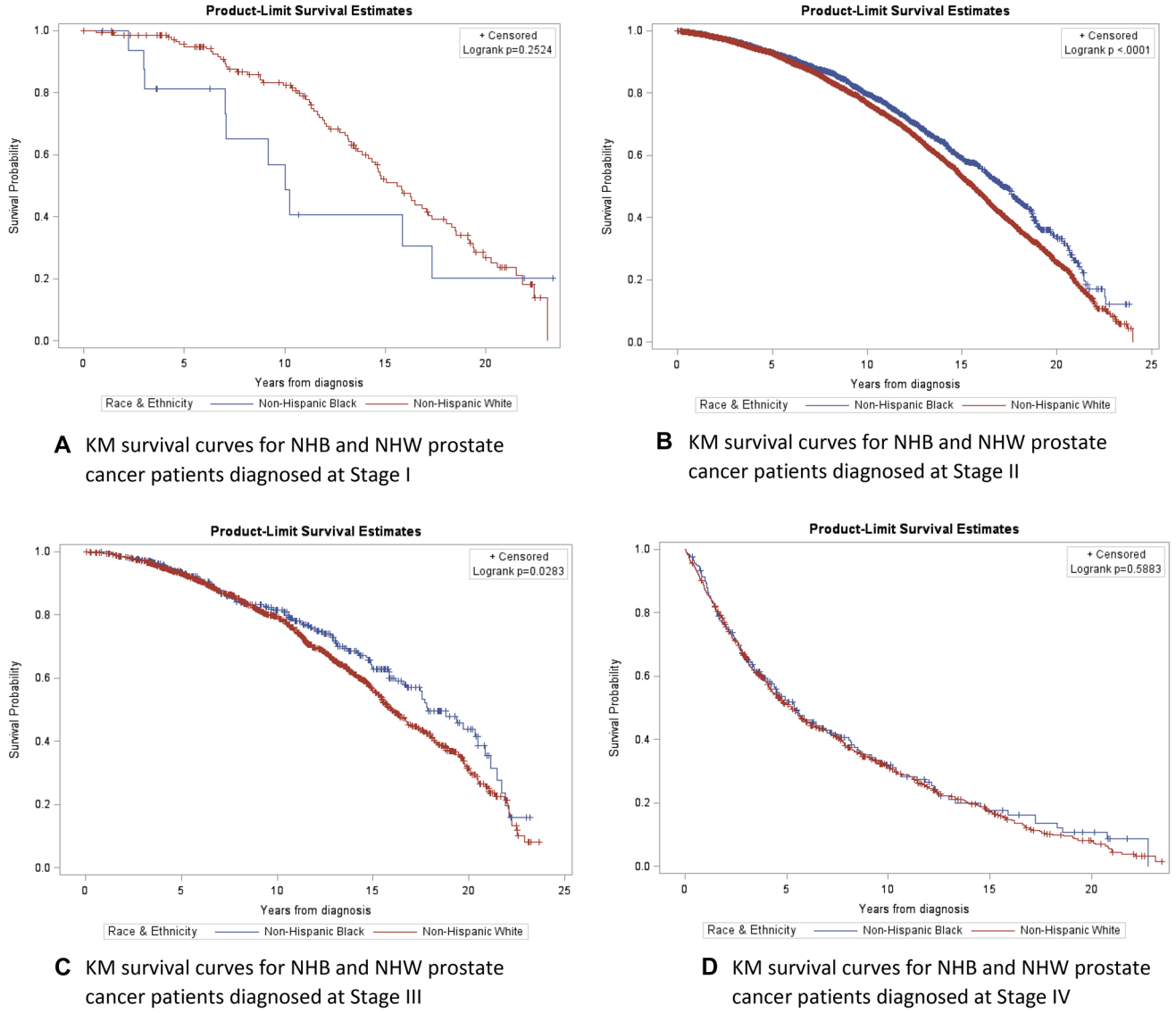

Fig. 2 Unadjusted Kaplan–Meier (KM) survival curves of OS among Non-Hispanic black (NHB) and Non-Hispanic white (NHW) prostate cancer patients diagnosed between 1990 and 2010 in the Automated Cancer Tumor Registry (ACTUR), stratified by tumor stage

men ≤ 50 years of age at diagnosis. To date, differences in OS had not been examined in an equal access setting in men diagnosed with CaP under the age of 50. In a prior study in the U.S. general population that examined CaP outcomes in men of similar age, an increased risk for fatal CaP was observed for black men aged 45 to 49 years compared to white men of the same age group [3]. Lack of consistency in findings between this other study in the general population and ours could be attributed to healthcare access. Considering the paucity in literature of survival in men diagnosed with CaP under the age of 50, future studies will need to be carried out to consider the roles of genetics and access to care in this age group.

In the present study, NHB men who were ≥ 75 years of age had poorer survival compared to NHW men. Since OS was the study outcome of interest, deaths from other comorbidities to CaP may have partially accounted for study results in elderly men. Prior studies on men diagnosed with CaP in other equal access settings have reported higher rates of comorbidities among NHB men compared to NHW men [14, 28]. Life expectancy for NHB is lower than for NHW populations in the U.S [33]. Thus it can be expected that rates of conditions comorbid to CaP for NHB would be higher than for NHW.

A major strength of this study is that it was based on a large, DOD-wide cancer registry with demographic,

Table 2 Overall survival (OS)[a] cox regression model for patients diagnosed with prostate cancer in the DoD Tumor Registry (ACTUR), 1990–2010

Variable	*n* (%)	Adjusted hazard ratio	95% CI	*p* value
Race ethnicity				
Non-Hispanic White	14,065 (76.09)	Ref	–	–
Non-Hispanic Black	4419 (23.91)	1.02	0.95–1.08	0.63
Age				
≤ 50	1219 (6.59)	Ref	–	–
51–54	1632 (8.83)	1.10	0.85–1.43	0.47
55–59	2841 (15.37)	1.39	1.09–1.78	< 0.01
60–64	4527 (24.49)	1.93	1.52–2.45	< 0.01
65–69	3376 (18.26)	2.62	2.06–3.33	< 0.01
70–74	2740 (14.82)	4.04	3.18–5.13	< 0.01
75–79	1432 (7.75)	5.53	4.33–7.06	< 0.01
≥ 80	717 (3.88)	11.54	8.97–14.83	< 0.01
Marital status				
Married	14,891 (80.56)	Ref	–	–
Other	1626 (8.8)	1.37	1.26–1.48	< 0.01
Single	666 (3.6)	1.29	1.14–1.47	< 0.01
Unknown	1301 (7.04)	1.11	1.02–1.20	0.02
Military Sponsor Branch[b]				
Army	6508 (35.21)	Ref	–	–
Air force	5970 (32.3)	0.89	0.84–0.94	< 0.01
Marines	824 (4.46)	0.86	0.76–0.97	0.01
Navy	3911 (21.16)	0.89	0.84–0.95	< 0.01
Other	1266 (6.85)	1.09	0.97–1.21	0.13
Active duty status				
No	17,329 (93.75)	Ref	–	–
Yes	1155 (6.25)	0.59	0.45–0.76	< 0.01
Tumor stage				
Stage II	13,571 (73.42)	Ref	–	–
Stage I	168 (0.91)	1.10	0.88–1.37	0.40
Stage III	1589 (8.6)	1.02	0.93–1.11	0.69
Stage IV	865 (4.68)	2.88	2.64–3.15	< 0.0001
Unknown	2291 (12.39)	1.05	0.94–1.17	0.37
Tumor grade				
Well differentiated	1969 (10.65)	Ref	–	–
Moderately differentiated	9366 (50.67)	1.10	1.02–1.19	0.02
Poorly differentiated/undifferentiated	3827 (20.7)	1.43	1.30–1.57	< 0.01
Unknown	3322 (17.97)	1.24	1.10–1.39	< 0.01
Surgery				
No	9829 (53.18)	Ref	–	–
Yes	8655 (46.82)	0.71	0.67–0.75	< 0.01
Hormone therapy				
No	15,218 (82.33)	Ref	–	–
Yes	3266 (17.67)	1.34	1.26–1.42	< 0.01
Chemotherapy				
No	18,368 (99.37)	Ref	–	–
Yes	116 (0.63)	1.53	1.19–1.97	< 0.01
Radiation therapy				
No	13,229 (71.57)	Ref	–	–
Yes	5255 (28.43)	0.98	0.93–1.04	0.50

Estimates are mutually adjusted for all other variables

[a]A HR > 1.0 indicates poorer survival

[b]No deaths occurred among those with an unknown military sponsor branch; therefore, hazard ratios are not presented

Table 3 Adjusted hazards ratios (HRs) for OS among men diagnosed with prostate cancer in the DoD Tumor Registry (ACTUR), 1990–2010, stratified by age and stage

Variable	Level of variable	Race/ethnicity	*n* (%)	Adjusted hazards ratio	95% CI	*p* value
Age group	≤ 50 years[a]	Non-Hispanic White	817 (54.69)	Ref	–	–
		Non-Hispanic Black	677 (45.31)	1.28	0.85–1.92	0.23
	51 to 64 years[a]	Non-Hispanic White	6477 (74.23)	Ref	–	–
		Non-Hispanic Black	2248 (25.77)	0.98	0.88–1.08	0.64
	65 to 74 years[a]	Non-Hispanic White	4913 (80.33)	Ref	–	–
		Non-Hispanic Black	1203 (19.67)	1	0.91–1.10	0.98
	≥ 75 years[a]	Non-Hispanic White	1858 (86.46)	Ref	–	–
		Non-Hispanic Black	291 (13.54)	1.27	1.08–1.49	< 0.01
Tumor stage	Stage I[b]	Non-Hispanic White	150 (89.29)	Ref	–	–
		Non-Hispanic Black	18 (10.71)	2.06	0.92–4.61	0.08
	Stage II[b]	Non-Hispanic White	10,222 (75.32)	Ref	–	–
		Non-Hispanic Black	3349 (24.68)	1.02	0.94–1.11	0.58
	Stage III[b]	Non-Hispanic White	1220 (76.78)	Ref	–	–
		Non-Hispanic Black	369 (23.22)	0.89	0.72–1.11	0.31
	Stage IV[b]	Non-Hispanic White	658 (76.07)	Ref	–	–
		Non-Hispanic Black	207 (23.93)	1.04	0.86–1.26	0.7

[a]Model adjusted for marital status, military sponsor branch, active duty status, tumor stage and grade, surgery, hormone therapy, chemotherapy, and radiation therapy, with the exception of age

[b]Model adjusted for age, marital status, military sponsor branch, active duty status, tumor grade, surgery, hormone therapy, chemotherapy, and radiation therapy, with the exception of tumor stage

clinical, and treatment information, making it possible to conduct multivariable analysis, allowing for ascertainment of the independent role of race on OS among men diagnosed with CaP. Some limitations, however, should be discussed. Although to our knowledge this is the largest study of a military population within a healthcare system designed for equal access, sample size was limited for certain subgroup analyses (i.e., stage I). It is also important to consider that although the MHS is designed for equal access healthcare, it is difficult to ensure that this is guaranteed for all members, but within this system, comparability in healthcare delivery can be expected to be greater. Additionally, information on other factors, (i.e., comorbid medical conditions, diet, smoking status) was not available or incomplete and thus could not be evaluated. The possibility of differential follow-up by race for men in this study cannot be excluded, particularly those who were diagnosed while on active duty and then left the military with no military medical benefits (i.e., did not retire). However, the number of men in this study who were diagnosed while on active duty comprised only about 6% of the study population, and the percent of those who did not retire with medical benefits is likely smaller. Finally, overall survival, rather than disease-specific survival, was the outcome of the study, and causes of death not related to CaP diagnosis could potentially account for the results of this study. The ACTUR dataset currently does not obtain data on specific cause of death. However, studying OS as the outcome may avoid potential biases and inaccuracies inherent in identifying cause-specific mortality using death certificates. Also, the differential in age at CaP diagnosis between NHB and NHW men in the U.S. (reflected in our study) gave us further reason to evaluate OS rather than cause-specific mortality.

It has been proposed that biological differences (e.g., genetics and tumor microenvironment) potentially explain racial disparities for CaP susceptibility and progression [34–37]. Though biological differences have been detected by race, these differences cannot fully account for the observed differences in all-cause survival [7]. As demonstrated in this study, extrinsic factors such as access to care or best course of treatment in CaP play a critical role in closing the racial gap that has been observed in the U.S. general population.

In conclusion, no statistically significant difference by race in all-cause survival among men with CaP was observed in the MHS, a system designed for equal access to care, with the exception of findings for oldest age group (75 years of age or older) which is likely associated with a higher rate of comorbidities. Results from the present study suggested that unequal access to care may be playing a major role in the racial disparities in survival among men diagnosed with CaP in the U.S. general population. Early CaP detection and comparable access to treatment within equal access healthcare settings could potentially reduce the observed racial gap in CaP-specific and/or all-cause mortality in the general population.

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