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Regional trends in average years of potential life lost (AYPLL) secondary to prostate cancer deaths among Caucasians and African Americans treated by surgery or radiation

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Abstract

Purpose To study regional trends in average years of potential life lost (AYPLL) among Caucasians (CA) and African Americans (AA) with prostate cancer (Pca) who received radical prostatectomy or radiation therapy among four different regions in the US as well as across different tumor grades. Years of potential life lost is defined as the difference between a predetermined end-point age and the age at death for a death that occurred prior to that end age, hence the AYPLL is calculated by dividing the total YPLL by the total number of patients died.

Methods The surveillance epidemiology and end results (SEER) database was used to identify Pca patients who were CA or AA and who have received radical prostatectomy or radiation therapy. Study duration was divided into four decades; 1973–1982 (D1), 1983–1992 (D2), 1993–2002 (D3), 2003–2012 (D4). Examined regions were; North East (NE), North central (NC), South and West. Tumor grade was classified into; well/moderately differentiated (WD/MD) and poorly/undifferentiated (PD/UD) groups. Differences in AYPLL among CA and AA in each of these variables were compared.

Results Overall, compared to CA, AA were diagnosed and died earlier from Pca. AA had higher AYPLL to Pca than CA. In both tumor grade groups, progressive increase in AYPLL among AA compared to CA was noted over the last three decades. In the WD/MD group, except for the South region, the highest recorded difference in AYPLL between AA and CA was in D4. In the PD/UD group, a similar difference in AYPLL between AA and CA was noted in all regions. The difference in AYPLL was higher in the PD/UD group than the WD/MD group.

Conclusions Racial disparity between AA and CA existed across the examined regions. It is more pronounced in advanced tumor grades. The differences were more significant in the last decade.

Keywords Prostate cancer · Race · Years of life lost · Regional · Racial disparity

Abbreviations

AA	African Americans
AYPLL	Average years of potential life lost
CA	Caucasians
GS	Gleason score
MD	Moderately differentiated tumor
NC	North Central
NE	North East
Pca	Prostate cancer
PD	Poorly differentiated tumor
PSA	Prostate-specific antigen

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UD	Undifferentiated tumor
WD	Well-differentiated tumor
YPLL	Years of potential life lost

Introduction

Approximately, 11.2% of men will be diagnosed with prostate cancer (Pca) during their lifetime. The mortality rate per 100,000 populations for Pca is 19.5 for all races and 18.2 and 40.8 among Caucasians (CA) and African Americans (AA), respectively [1]. There are regional differences in Pca incidence and mortality. The incidence of Pca per 100,000 populations in the North East (NE) region is 104.7, Midwest, 96.7, South 96.4 and West 85.5. Death rates from Pca also vary by region and are highest in West region 19.5, followed by Midwest 19.4, South 19 and NE 18.6 [2]. Research on geographic variations in Pca care among races is usually conducted at state level and such reports commonly include patients who did not receive any form of treatment. This further intensifies the impact of the natural history of the disease on Pca mortality [3, 4].

Outcome of Pca treatment is commonly described as crude and age-adjusted mortality. While these outcomes are essential, they often fail to tell the entire story of temporal changes in mortality. Most cancer deaths occur among persons in older age groups and consequently these mortality measures are dominated by the underlying disease processes of the elderly. To provide more accurate picture on mortality trends among young patients, years of potential life lost (YPLL) emerged as an alternative that weighs deaths occurring at younger ages more heavily than those occurring in older populations [5]. Research examining regional racial disparities in average years of potential life lost (AYPLL) in patients who have received definitive treatment for Pca has not been conducted before.

YPLL is defined as the difference between a predetermined end-point age and the age at death for a death that occurred prior to that end age. YPLL assumes a value of zero for any death occurring after the end age. Average years of potential life lost (AYPLL) is then calculated by dividing the total YPLL by the total number of patients died. YPLL can be used to assess the "value" of life lost secondary to cancer death [6]. It can help with the allocation of health and research funds [7]. It can also be used to evaluate the effectiveness of program interventions [5]. YPLL is not affected by the point of time in the disease process where prostate cancer is diagnosed. It is an outcome, which does not suffer from lead time bias.

We aim to investigate the regional trends in AYPLL secondary to Pca mortality among AA and CA who received treatment in the form of radical prostatectomy or radiation therapy. The trends were examined across tumor grades. We hypothesized that racial disparity in AYPLL existed among the different geographic regions among the examined tumor grades.

Materials and methods

Data source

The Surveillance, Epidemiology and End Results (SEER) program was used as the data source. The SEER has cancer statistics on 24.9% of the CA and 25.6% of the AA populations of the United States [8]. It is considered the principal database in terms of data quality among cancer registries in the United States and globally. Cancer data such as vital status, survival time and cause of death are updated annually. In addition, confirmation of vital status is done through linking to the National Death Index as well as supplemental data on the last contact date obtained by medical record abstraction [9].

Inclusion/exclusion criteria

Patients included in the study were Pca patients identified in the SEER as AA or CA, diagnosed between the years 1973–2012, aged 18 years or older, and had at least one of surgery or radiation as first course of treatment. Radiation therapy refers to any form of radiation (external beam/brachytherapy). Patients born before the year 1900 or with incomplete or unavailable survival date were excluded from this study (Supplementary Fig. 1).

Data collection

Patients who fit the inclusion criteria, were classified into four groups based on the decade of diagnosis; 1973–1982 (D1), 1983–1992 (D2), 1993–2002 (D3) and 2003–2012 (D4). Patient demographics and tumor characteristics were collected. The examined regions were; North East (NE) (Connecticut, New Jersey), South (Kentucky, Louisiana, Atlanta, Greater Georgia, Rural Georgia), North Central (NC) (Detroit, Iowa) and West (Hawaii, New Mexico, Seattle-Puget Sound, Utah, San Francisco-Oakland, San Jose-Monterey, Los Angeles and Greater California). For tumor stage, the SEER summary stage was used. Patients were classified as having localized disease if the cancer was confined to the prostate gland; regional if it extended to adjacent organs/regional lymph nodes or both and; distant if it extended to distant lymph nodes, discontinuous metastasis or organs other than adjacent ones [10]. Tumor stage was available for patients who were diagnosed on or after 1998. Regarding tumor grade, in SEER, Pca was graded as well/moderately differentiated (WD/MD) and poorly

differentiated (PD) and this corresponds to Gleason scores (GS) of 2–4, 5–7 and 8–10, respectively. There was undifferentiated group (UD) as well that was added to the PD group. As of January 1st, 2003 (D4), GS 7 was moved to the poorly differentiated group [11].

Study outcomes

The primary outcome of the study was to assess the disparity in AYPLL secondary to Pca in the examined regions over the last four decades among CA and AA. For patients who died of prostate cancer, the survival years post age at diagnosis was used to determine age at death. Since data from the National Vital Statistics reports showed that the average life expectancy in the US was 70.2 years in 1970 and 78.2 years in 2009 [12], we choose 75 years as reference age as other investigators used [13]. YPLL was computed as the maximum of (0, 75—Age at death).

Statistical analysis

Descriptive statistics were reported as mean (standard deviation) for continuous variables and as percentage for categorical variables. Kruskal–Wallis test (continuous variables) or Chi-Square test (categorical variables) was used to assess for differences across the two races. Association between AYPLL and races was assessed after adjusting for the effect of geographical regions and grade. Stratified analysis was carried to examine the association between race and AYPLL. Differences in distribution of YPLL between AA and CA were assessed using non-parametric Kruskal–Wallis test. A two-sided alpha level of 0.05 was used to determine statistical significance. The analysis was performed using SAS 9.4® (NC, USA). The study was granted exemption from review by the Institutional Review Board (IRB) as no patient or institute identifiers were used.

Results

Patient and tumor characteristics

A total of 621,568 patients fulfilled the inclusion criteria. Of these patients, 528,349 (85%) were CA and 93,219 (15%) were AA. Of 621,568 patients, 48,744 (7.84%) died from Pca. Of these patients, 40,073 (82.21%) were CA and 8671 (17.79%) were AA. In both overall (Table 1) and in patients who died from Pca (Table 2), compared to CA, AA were diagnosed earlier, less likely to be married, more likely to develop distant metastasis and to have a tumor grade that is PD/UD ($p < 0.01$) (Table 1). When classified by regions, the same findings were observed except for tumor grade in West region, in patients who died from Pca where PD/UD Pca prevailed more among CA than AA (Supplementary Tables 1 and 2).

Years of potential life lost

Overall, AA had greater AYPLL than CA. This disparity was augmented in the PD/UD tumor grades among all four studied regions and was worse in the last decade.

WD/MD tumor grades (Table 3)

NC Racial disparity existed across the four decades with the AYPLL higher among AA than CA. Differences in AYPLL reached significance ($p < 0.05$) in D2 and D3. NC region reported the lowest difference in AYPLL in D4 among the four regions (1.25 years).

NE The region had racial disparity in AYPLL with AA having more AYPLL than CA across the four decades ($p < 0.05$). NE region recorded the greatest difference in AYPLL among the four regions in D4 (3.19 years).

South In D1, CA had higher but non-significant AYPLL than AA. In the remaining three decades, AA had higher AYPLL than CA and was significant in D2 and D3. The South region reported the second lowest difference in AYPLL in D4 (1.35 years).

West The region had progressive racial disparity in AYPLL with AA reporting more AYPLL than CA in the last three decades ($p < 0.05$). West region recorded the second highest difference in AYPLL between AA and CA among the four regions in D4 (2.94 years).

PD/UD tumor grades (Table 3)

NC In D1 there was almost no difference in AYPLL between AA and CA. However, racial disparity progressively occurred in D2 through D3. It was highest in D4 with a difference in AYPLL of 2.72 years between the two races ($P < 0.01$).

NE The region had the highest racial disparity in D1 with AA losing 3.92 years more than CA. This improved in D2 (1.83 years) then increased in D3 (2.31 years) and D4 (2.66 years).

South Racial disparity existed with AA having higher AYPLL than CA in the last 3 decades. In D4 the racial disparity gap widened with the South region reporting the second highest difference in AYPLL between AA and CA (2.84 years).

Table 1 Patient and tumor characteristics

Variable	CA ($n=528,349$)	AA ($n=93,219$)	p value
Age at diagnosis: mean (SD)	66.53 (8.77)	63.85 (8.86)	< 0.01
Marital status			
Single/never married	39,073 (7.4)	14,609 (15.67)	< 0.01
Married/partner	398,743 (75.47)	55,912 (59.98)	
Divorced/separated/widowed	59,566 (11.27)	16,671 (17.88)	
Unknown	30,967 (5.86)	6027 (6.47)	
Diagnosis period			
1973–1982	16,791 (3.18)	3676 (3.94)	N/A
1983–1992	52,854 (10)	8245 (8.84)	
1993–2002	156,661 (29.65)	27,594 (29.6)	
2003–2012	302,043 (57.17)	53,704 (57.61)	
SEER geographical			
North East	103,606 (19.61)	14,362 (15.41)	< 0.01
South	96,731 (18.31)	32,985 (35.38)	
North Central	65,986 (12.49)	19,989 (21.44)	
West	262,026 (49.59)	25,883 (27.77)	
SEER summary stage[a]	$n=409816$[a]	$n=72377$[a]	< 0.01
Localized	337,705 (82.4)	59,892 (82.75)	
Regional	61,915 (15.11)	10,117 (13.98)	
Distant	7195 (1.76)	1782 (2.46)	
Unknown/un-staged	3001 (0.73)	586 (0.81)	
Tumor grade			
Well differentiated	33,420 (6.33)	5381 (5.77)	< 0.01
Moderately differentiated	274,519 (51.96)	45,666 (48.99)	
Poorly differentiated	199,992 (37.85)	37,636 (40.37)	
Undifferentiated/unknown	20,418 (3.86)	4536 (4.87)	

AA African Americans, *CA* Caucasians

[a]Summary stage is available for years of diagnosis 1998–2012. Reported percentage is based on total count of stage available for patients diagnosed in 1998–2012

West Progressive racial disparity was noted starting from D2 to D4. The West region recorded the highest difference in AYPLL between AA and CA among all regions (3.32 years) in D4.

Discussion

Our results demonstrate that overall, compared to CA, AA patients were diagnosed and died from Pca at an earlier age, were less often to be married and more likely to develop distant metastasis and PD tumors. Across the tumor grades, AA lost more AYPLL than CA. The difference in AYPLL between AA and CA progressively increased over the examined study period. The last decade carried the highest difference in AYPLL between the two examined races across tumor grades and the difference was more significant in the PD/UD tumor grades.

Racial disparities between CA and AA have always been described in relation to one or more of three factors. First is a patient factor most notably genetic cause. Gene mapping for the human chromosome 8q24, that harbors risk variants for Pca revealed two risk variants only present in men with African ancestry [14]. Second factor is related to the biologic behavior of the disease among AA. Compared to CA, AA were four times more likely to develop metastasis at diagnosis and Pca volume and grade were higher in radical prostatectomy specimens in one study [15]. In a study on a predominantly AA population with equal access to medical care, AA race was an independent predictor of biochemical recurrence after radical prostatectomy [16]. The third factor is related to the healthcare system with poor access to screening tools, resources and treatments for Pca among AA [17, 18]. Mahal et al. showed that AA were 18% less likely than CA to receive treatment with curative intent for intermediate and high-risk Pca and such disparity did not improve with time [19]. Xu et al. recorded difference in the pattern of watchful waiting/active surveillance between CA and AA patients with localized Pca. Conservative management was

Table 2 Patient and tumor characteristics of patients who died from prostate cancer

Variable	CA ($n=40,073$)	AA ($n=8671$)	p value
Age at diagnosis: mean (SD)	69.86 (8.94)	67.35 (8.92)	<0.01
Age at death: mean (SD)	75.86 (9.22)	72.82 (9.55)	<0.01
Marital status			
Single/never married	2838 (7.08)	1272 (14.67)	<0.01
Married/partner	29,625 (73.93)	4918 (56.72)	
Divorced/separated/widowed	5917 (14.77)	2018 (23.27)	
Unknown	1693 (4.22)	463 (5.34)	
Diagnosis period			
1973–1982 (D1)	6080 (15.17)	1475 (17.01)	N/A
1983–1992 (D2)	12,015 (29.98)	2506 (28.9)	
1993–2002 (D3)	13,146 (32.81)	2934 (33.84)	
2003–2012 (D4)	8832 (22.04)	1756 (20.25)	
SEER geographical			
North East	8202 (20.47)	1045 (12.05)	<0.01
South	5185 (12.94)	2190 (25.26)	
North Central	7078 (17.66)	2984 (34.41)	
West	19,608 (48.93)	2452 (28.28)	
SEER summary stage[a]	$n=15925$[a]	$n=3325$[a]	<0.01
Localized	8053 (50.57)	1612 (48.48)	
Regional	3332 (20.92)	597 (17.95)	
Distant	4102 (25.76)	1039 (31.25)	
Unknown/un-staged	438 (2.75)	77 (2.32)	
Tumor grade			
Well differentiated	2920 (7.29)	651 (7.51)	0.01
Moderately differentiated	13,140 (32.79)	2756 (31.78)	
Poorly differentiated	18,316 (45.71)	3911 (45.1)	
Undifferentiated/unknown	5697 (14.22)	1353 (15.6)	

AA African Americans, *CA* Caucasians

[a]Summary stage is available for years of diagnosis 1998–2012. Reported percentage is based on total count of stage available for patients diagnosed in 1998–2012

less likely to be selected by CA as cancer risk increased, while cancer risk was not related to AA electing this sort of management [20]. Wong et al. reported a significant proportion of younger AA men diagnosed with localized Pca, particularly with low- or high-risk disease, are not receiving definitive therapy [21].

To reduce the effect of lack of Pca treatment on patient mortality among AA, we elected to restrict our patient population to Pca patients who received definitive treatment in the form of surgery or radiation therapy. Socioeconomic status has been linked to poor Pca outcomes [22]. However, in equal access healthcare system, racial disparities in survival outcomes were reduced or even disappeared [23].

In our study, compared to CA, AA were diagnosed and died earlier from Pca and were less likely to be in a relation. These findings persisted among the four studied regions. Previous research showed, AA were diagnosed on average 2 years younger than CA [22]. Unmarried men with Pca had a 40% increase in the relative risk of dying from Pca [24]. AA, in our study, were more likely to develop distant metastasis and PD tumor grades. These findings were similar to those reported from the Texas cancer registry [25].

An interesting observation is the trend over the decades for greater diagnoses relative to number of deaths. This is likely to the introduction of the PSA screening in the late 80 s and early 90 s. This resulted in increased rates of low-risk Pca diagnoses. These indolent cancers are unlikely to affect patient survival [26].

The difference in AYPLL between AA and CA existed across the studied tumor grades and was more pronounced in the PD/UD compared to the WD/MD grades and worst in the last examined decade. (Table 3). Ethnicity is a risk factor for disease recurrence and progression after definitive therapy for high-risk Pca patients [27]. The management of high-risk Pca commonly involves multimodal therapies. In addition, there is evidence that outcomes of high-grade Pca treatment are better among higher volume and academic hospitals [28]. In recent years, AA patients, compared to other races were 30% less likely to receive combination therapy for Pca [29]. Compared to other races, in the modern era, AA patients were less likely to receive any androgen deprivation therapy or long-term androgen deprivation therapy following intensity-modulated radiation therapy for GS 8–10 Pca [30]. In addition, AA patients, in recent years, are less likely to receive definitive therapy for Pca in high volume/academic hospitals where comprehensive multimodal care can be provided to their high-risk Pca [31].

The low and intermediate-risk Pca carries good prognosis even in the untreated patients. In patients treated by expectant management, Bul et al. reported a 10-year disease-specific survival of 99.1% and 96.15% in low and intermediate-risk groups of Pca patients, respectively [32]. Prognosis of advanced Pca is worse among AA than CA. Thompson et al. compared the prognosis of metastatic Pca among AA and CA and concluded that AA has a worse prognosis than among CA [33]. The revision of tumor grade by SEER over the past 15 years might have contributed to the observed worse racial disparity particularly in the PD/UD tumors more than the observed racial disparity observed among the WD/MD group. Since 2003, GS 7 Pca is moved to the PD group. The WD/MD group comprised only GS ≤ 6 and PD group now contains all the clinically significant Pca. GS ≤ 6 tumors have good prognosis in both CA and AA in particular that all our patients received definitive treatment for these low-grade tumors. There are recent reports that support AA with GS ≤ 6 have comparable prognosis to CA treated by

Table 3 Differences in AYPLL between African Americans and Caucasians

Region	D1 *N*: mean AYPLL (SD)	D2 *N*: mean AYPLL (SD)	D3 *N*: mean AYPLL (SD)	D4 *N*: mean AYPLL (SD)
Well/moderately differentiated prostate cancer				
NC				
AA	305: 4.45 (5.92)	592: 2.54 (4.55)	336: 3.24 (5.69)	25: 5.7 (7.36)
CA	724: 3.70 (5.24)	1503:1.94 (3.86)	781: 2.14 (4.5)	55: 4.45 (6.73)
DAYPLL	0.75 (*p* 0.10)	0.6 ($p < 0.01$)	1.1 ($p < 0.01$)	1.25 (*p* 0.34)
NE				
AA	40: 5.48 (7.02)	100: 3.74 (5.38)	159: 4.12 (5.64)	50: 6.11 (6.57)
CA	701: 3.04 (4.58)	1380: 1.87 (4.09)	1151: 2.29 (4.59)	182: 2.92 (4.68)
DAYPLL	2.44 (*p* 0.01)	1.87 ($p < 0.01$)	1.83 ($p < 0.01$)	3.19 ($p < 0.01$)
South				
AA	97: 3.46 (5.59)*	214: 3.78 (5.8)	346: 4.65 (6.38)	109:5.42 (6.66)
CA	255: 3.79 (5.47)	512: 2.44 (4.76)	762: 2.84 (4.87)	289: 4.07 (5.62)
DAYPLL	0.33 (*p* 0.4)	1.34 ($p < 0.01$)	1.81 ($p < 0.01$)	1.35 (*p* 0.09)
West				
AA	118:3.48 (4.96)	334: 3.22 (5.18)	505: 3.95 (5.74)	77: 6.31 (7.18)
CA	878: 2.7 (4.48)	2739:1.7 (3.65)	3468: 2.35 (4.59)	680: 3.37 (5.46)
DAYPLL	0.78 (*p* 0.13)	1.52 ($p < 0.01$)	1.6 ($p < 0.01$)	2.94 ($p < 0.01$)
Poorly/undifferentiated prostate cancer				
NC				
AA	195: 5 (5.41)[a]	457: 4.08(5.29)	332: 4.47 (6.19)	160: 7.73 (8.04)
CA	402: 5.04 (5.9)	1033: 3.28(5.35)	670: 3.31 (5.66)	542: 5.01 (6.64)
DAYPLL	0.04 (*p* 0.72)	0.8 ($p < 0.01$)	1.16 ($p < 0.01$)	2.72 ($p < 0.01$)
NE				
AA	18: 8.89 (5.46)	79: 4.92 (6.2)	168: 5.6 (6.72)	252: 7.21 (7.51)
CA	363: 4.97 (6.14)	889: 3.09 (5.04)	1009: 3.29 (5.83)	1070: 4.55 (6.61)
DAYPLL	3.92 (*p* 0.01)	1.83 (*p* 0.01)	2.31 ($p < 0.01$)	2.66 ($p < 0.01$)
South				
AA	81: 5.31 (5.8)[a]	151: 5.03 (6.65)	363: 5.48 (6.75)	531: 8.14 (8.01)
CA	138: 6.36 (6.66)	373: 3.63 (5.21)	747:4.61 (6.18)	1475:5.3 (6.87)
DAYPLL	1.05 (*p* 0.36)	1.4 (*p* 0.03)	0.87 (*p* 0.03)	2.84 ($p < 0.01$)
West				
AA	99: 4.35 (5.97)	244:4.36 (6.33)	465: 5.45 (6.66)	316: 7.89 (7.7)
CA	573:4.18 (5.48)	2081: 2.8 (4.93)	3514: 3.5 (5.77)	3437: 4.57 (6.52)
DAYPLL	0.17 (*p* 0.87)	1.56 ($p < 0.01$)	1.95 ($p < 0.01$)	3.32 ($p < 0.01$)

AA African Americans, *AYPLL* average years of potential life lost, *CA* Caucasians, *DAYPLL* difference in average years of potential life lost, *P* p value, *N* number, *SD* standard deviation, *D1* 1973–1982, *D2* 1893–1992, *D3* 1993–2002, *D4* 2003–2012, *NC* North Central, *NE* North East

[a]Denoted AYPLL was numerically higher among CA than AA

radical prostatectomy with implications that same outcomes may be achieved if offered active surveillance [34–36].

Regional differences in Pca care among CA and AA were described before at the state level or among single regions. Dosemeci et al. reported 38% higher Pca death rate in the Southeastern region among AA than CA. The study suggested farm-related occupations may be a potential cause [37]. Blair et al. suggested the increased mortality from Pca among AA in NE and NC regions of the country could be related to increased exposure to textile and machinery industries [38]. Meliker et al. examined Pca survival differences among CA and AA using the Michigan Cancer Surveillance Program. The authors noted survival advantage for CA with Pca over AA through much of southern Michigan. When the analysis was repeated but on smaller communities, where there was homogeneity in socioeconomic parameters and access to care, these racial disparities disappeared [39]. Another factor that varies by region in Pca mortality is UV radiation from sun exposure. Sunlight exposure increases Vitamin D synthesis which

may have a protective role against high risk Pca (GS 7–10) [40].

In our study, the Western region was disproportionately represented. There are reported practice patterns in this region that might have affected our results. Reinstatler et al. reported on the regional variation in the intensity of Pca care using four intuitively related Pca events; PSA screening, prostate biopsy, Pca diagnoses, and Pca treatment. The authors provided maps describing the distribution of these individual Pca events in the United States. The results were interesting. Although some regions had concordant practices as low screening/low biopsy and high diagnosis/high treatment, there were regions with discordant counterintuitive practices such as high screening + low biopsy. By visually examining the maps provided by the authors, one can see that the majority of the Western region except for some regions in southern California has unique practice patterns. There are large areas where the rates of PSA screening were high while the rates of prostate biopsies were low. Other large areas would show higher rates of Pca diagnoses but, in the meantime, lower rates of Pca treatment [41]. In addition, Moses et al. studied the odds of receiving Pca treatment across the SEER sites. The authors reported AA men had significantly lower odds of receiving treatment among men diagnosed in nine SEER sites (Connecticut, Metro Detroit, Seattle/Puget Sound, Metro Atlanta, Los Angeles, Greater California, Louisiana, New Jersey, and Greater Georgia). AA men had non-significantly lower odds of receiving treatment among men diagnosed in four SEER sites (San Francisco/Oakland, Iowa, Utah, Kentucky), of these reported 13 regions, 4 (30.7%) belonged to the Western region [42].

Our study has several strengths. We examined racial trends over prolonged periods of time. The study cohort was large and from several regions in the country. We used AYPLL which is not affected by lead time bias. Our selected patient population received definitive treatment for Pca which helps to mitigate the impact of failure to receive treatment on natural history of the disease [26]. Our study also has limitations. Information on comorbidities was not reported in the SEER; however, we calculated the AYPLL based on cancer specific mortality. We did not include insurance and other socioeconomic status information as this information was incomplete in the SEER. However, all our patients received definitive treatment in the form of surgery or radiation. We were unable to assess racial differences among urban and rural areas within the regions. However, reports that considered Pca outcomes in urban versus rural areas acknowledged the high un-staged tumor rate among AA. This reflects less rigorous medical record documentation in rural medical facilities, particularly among AA [26]. We also acknowledge lack of exact type of diagnostic and therapeutic procedures, type of adjuvant therapy and type of institution that provided medical treatment are inherent limitations to the SEER dataset.

Conclusions

Our results demonstrate existent regional racial disparities in AYPLL among CA and AA. The disparity was worse among AA with PD/UD tumor grades. The racial disparity did not seem to have improved over the years and was highest in the most recent examined decade. The current study should help future research dedicated to investigating racial disparities within specific regions. It can help with fund allocation and potential collaboration between health authorities or academic institutions of bordering states in an effort to close this racial disparity gap.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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