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Racial Disparities in Prostate Cancer: Evaluation of Diet, Lifestyle, Family History, and Screening Patterns

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Abstract

Background: Racial disparities in prostate cancer incidence and mortality rates are considerable. We previously found in the Health Professionals Follow-up Study (HPFS) that African American men had an 80% higher prostate cancer risk than white men. With 21 additional years of follow-up and four-fold increase in cases, we undertook a contemporary analysis of racial differences in prostate cancer incidence and mortality in HPFS.

Methods: For 47,679 men, we estimated hazard ratios (HR) and 95% confidence intervals (CI) for the association between race and risk of prostate cancer through 2016 using Cox proportional hazards regression. Multivariable models adjusted for lifestyle, diet, family history, and PSA screening collected on biennial questionnaires.

Results: 6,909 prostate cancer cases were diagnosed in white, 89 in African American, and 90 in Asian American men. African Americans had higher prostate cancer incidence (mHR 1.31, 95% CI 1.06–1.62) and mortality (mHR 1.67, 95% CI 1.00–2.78), and lower PSA screening prevalence than white men. The excess risk was greater in the pre-PSA screening era (HR 1.68, 95% CI

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1.14–2.48) than the PSA screening era (HR 1.20, 95% CI 0.93–1.56). Asian Americans had lower prostate cancer risk (mHR 0.74, 95% CI 0.60–0.92), but similar risk of fatal disease compared to white men.

Conclusions: Racial differences in prostate cancer incidence and mortality in HPFS are not fully explained by differences in lifestyle, diet, family history, or PSA screening.

Impact: Additional research is necessary to address the disproportionately higher rates of prostate cancer in African American men.

Keywords

race; ethnicity; PSA testing; lifestyle factors; prostate cancer; risk

INTRODUCTION

There are profound population-level racial disparities in prostate cancer incidence and mortality in the United States.[1–8] African American men are 76% more likely to be diagnosed with—and 120% more likely to die from—prostate cancer compared to white men.[9] Conversely, Asian American men are 55% less likely to be diagnosed with prostate cancer than white men, but in some studies, have a higher incidence of high-grade prostate cancer.[1,10,11] Understanding these health disparities is important to inform both clinical practice and health policy.

The reasons for these considerable differences are not fully understood,[4,8,12–17] although racial differences in lifestyle factors, access to care, screening, and inherited genetic factors have been suggested.[3,18–20] A prior analysis within the Health Professionals Follow-up Study (HPFS) through 1996 showed that, even after accounting for racial differences in epidemiologic factors, African American men had an 81% higher incidence of prostate cancer compared to white men.[4] We also noted differences by European ancestry, with highest risk in men who reported their ancestry as Scandinavian, a finding consistent with observed higher prostate cancer incidence and mortality in Scandinavian countries compared to other European countries.[21]

With 21 additional years of follow-up, 5,096 additional prostate cancer cases to study clinical subtypes, e.g., fatal, lethal, advanced, and high-grade disease, and changing patterns of screening, we provide a contemporary analysis in HPFS to assess whether racial and ancestry differences in prostate cancer incidence and mortality remain after accounting for differences in lifestyle, family history, and PSA screening history.

MATERIALS AND METHODS

The prospective HPFS cohort includes 51,529 male health professionals aged 40–75 years at baseline in 1986 when men completed a baseline questionnaire regarding demographics, medical history, family history, and lifestyle. They have been followed via questionnaires[22] every two years to update medical history, lifestyle, and PSA-based prostate cancer screening history (starting in 1994), and every four years to update diet. We excluded men who were diagnosed with prostate cancer prior to baseline (N=328),

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died before 1986 (N=12), or were missing diagnosis date (N=21) or birthdate (N=34). Men were also excluded if they did not report their major ancestry (N=2,591) or selected “other ancestry” (N=864). 47,679 men were followed prospectively for cancer incidence through January 2017 and mortality through January 2019 (Figure 1).

The Institutional Review Board of Harvard T.H. Chan School of Public Health approved the HPFS.

Self-Reported Ancestry

Participants self-reported their major ancestry(ies) at baseline with the option to choose one or more of the following categories: Asian American, African American, Scandinavian, southern European, other European, or other origin. For men reporting multiple ancestries, we classified for this analysis those reporting white and African American (N=35) as African American, and as white and Asian American (N=28) as Asian American. The 864 men who reported “other origin” were excluded from this analysis.

Prostate Cancer Incidence and Mortality

Incident prostate cancer was identified by self-report and confirmed through standardized review of medical records.[23] Gleason score at biopsy and prostatectomy (if surgically treated), tumor stage, and PSA at diagnosis were extracted from medical records. Gleason score was available from a centralized histopathologic re-review of hematoxylin and eosin slides for one-third of prostate cancer cases.[24] Prostate cancer-specific mailed questionnaires collect updated information on treatment, disease recurrence, and metastasis. HPFS is followed for death through reports by next-of-kin and linkage with the National Death Index. Cause of death, including for prostate cancer, is adjudicated by the Endpoints Committee. Follow-up for cancer incidence is 96% and for mortality is >99%.

The main outcomes for this analysis were incident prostate cancer, defined as first primary prostate cancer diagnosis, and fatal prostate cancer, defined as a death from prostate cancer as the underlying cause. We also investigated: lethal prostate cancer, defined as distant metastases or death from prostate cancer; advanced disease defined as lethal or stages T3b, T4, N1, or M1 at diagnosis; and high-grade prostate cancer defined as Gleason score of 4+3 and above. Men with missing data on stage or grade were only included in the analyses of overall and fatal prostate cancer.

Statistical Analysis

Statistical analyses were undertaken using SAS version 9.4.[25] P-values were two-sided with statistical significance set at $p < 0.05$. Each participant contributed person-time from the return date of the baseline questionnaire until prostate cancer diagnosis, death, or end of the study. Participants were followed until January 2017 for cancer incidence and until January 2019 for cancer mortality. For analyses of clinical subtypes, e.g., with advanced or high-grade prostate cancer as the endpoint, men with localized prostate cancer were censored at date of diagnosis as a competing risk.

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Age-standardized baseline descriptive characteristics by race/ancestry were computed. Cox proportional hazards models with age as the time scale and stratified by calendar time were used to estimate HRs and 95% confidence intervals (CI) for the associations of race/ancestry with prostate cancer endpoints. These models are equivalent to the population-level assessment of potential differences in prostate cancer rates by race/ancestry in HPFS.

Multivariable models were adjusted for prostate cancer risk factors: height (≤68, >68–70, >70–72, >72 inches), body mass index (BMI, <21, 21 to <25, 25 to <30, ≥30 kg/m^2), cigarette smoking (never, former smoker who quit >10 years ago, former smoker who quit ≤10 years ago, current smoker), vigorous physical activity (quartiles of MET hours/week), family history of prostate cancer in father or brother, recent PSA screening (PSA testing in the two years prior to the questionnaire date, lagged by one questionnaire to avoid diagnostic screening), history of PSA screening (PSA testing in >50% of possible time periods, also lagged by one questionnaire period), and dietary factors: total energy (quartiles, kcal/day), tomato sauce (quartiles, servings/week), calcium from diet and supplements (quartiles, mg/day), and coffee (none, <1, 1 to <2, 2 to <3, ≥3 cups/day). Time-varying variables were updated based on biennial questionnaires. Multivariable models provide an assessment of the extent to which racial/ancestry differences in prostate cancer incidence and mortality at the population level can be explained by racial/ancestry differences in lifestyle, family history, and screening.

Given the potential influence of PSA screening, including racial/ancestry differences in PSA screening history, we stratified analyses by the pre-PSA (1986–1994) and the PSA (1994–2016) eras.

Data Availability

The data generated in this study are available upon request from the corresponding author.

RESULTS

At baseline, 46,281 men reported their ancestry as white, 523 as African American, 875 as Asian American, and 864 as other ancestry. Among white men, 12,080 reported their ancestry as Southern European, 5,195 Scandinavian, and 29,006 other European ancestry. Table 1a provides a comparison of baseline lifestyle factors, diet, and screening patterns in men across races/ancestry. African American men had higher vigorous physical activity but were more likely to be current or recent former smokers than white men. Asian American men were of shorter height on average, were less likely to be overweight, and had a lower prevalence of prostate cancer family history compared to their white and African American counterparts. White men reported higher intakes of energy, tomato sauce, coffee, and total calcium than African American and Asian American men. Compared to Southern European men, Scandinavian men were slightly taller and somewhat less likely to engage in vigorous physical activity. Asian American men also had a substantially higher mean PSA at time of diagnosis (26.3 ng/ml) compared to both African American (13.9 ng/ml) and white men (17.8 ng/ml) (Table 1b).

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During follow-up (1,100,482 person-years), 7,088 men were diagnosed with prostate cancer: 6,909 white, 89 African American, and 90 Asian American translating to crude incidence rates (per 100,000 person-years) of 647, 785, and 410, respectively. Of the cancers, there were 910 fatal, 1,094 lethal, 1,337 advanced, and 1,605 high-grade. The corresponding prostate cancer mortality rates were 82 (white), 141 (African American), and 68 (Asian American) per 100,000 person years. Adjusting for age and calendar time, African American men had a higher prostate cancer incidence (HR 1.21, 95% CI 0.98–1.49) compared to white men, whereas Asian American men had a lower incidence (HR 0.67, 95% CI 0.54–0.82). These differences were essentially unchanged after accounting for racial differences in epidemiologic factors, with African American men having 31% higher (1.31, 95% CI 1.06–1.62) incidence and Asian American men having a 26% lower (0.74, 95% CI 0.60–0.92) incidence compared to white men.

The risk of clinically significant cancers also differed. African American men had a higher incidence of fatal, lethal, and advanced (but not high-grade) prostate cancers compared to white men in both age- and multivariable-adjusted models. There were no statistically significant relative risk estimates for clinically significant cancers among Asian American men, although there was a suggestion of increased risk of high-grade cancer in both age- and multivariable-adjusted models compared to white men.

Among white men, 1,677 prostate cancer cases were diagnosed in Southern Europeans, 777 in Scandinavians, and 4,455 in men of other European ancestry, translating to incidence rates (per 100,000 person-years) of 591, 638, and 674, respectively. Scandinavian men and men of other European ancestry had a slightly higher prostate cancer incidence and mortality compared to Southern European men; however, this difference was non-significant after multivariable adjustment (Table 2).

In age- and multivariable-adjusted models, the higher prostate cancer risk in African American compared to white men was greater in the pre-PSA than in the PSA era, while the lower prostate cancer risk in Asian American men was slightly augmented in the PSA era. Among white men, the higher prostate cancer risk in men of Scandinavian and other European ancestry compared to men with southern European ancestry was similar in the pre-PSA and PSA eras (Table 3).

Figure 2 shows the percent of men who underwent PSA screening in each 2-year questionnaire period by race. There was substantial variation in the proportion of African American, white, and Asian American men who had a PSA test over time. While each group exhibited similar patterns—a rise from 1994–2000, followed by a steady decline—there were also differences in the proportion of each group screened: white men were most likely to be screened, while African American men were the least likely. Figure 3 shows trends over time in aggregate prostate cancer screening in our study cohort, demonstrating that there is a steady rise followed by a plateau in men who reported ever having received a PSA test; rates continue to be higher in white men compared to both Asian American and African American men.

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DISCUSSION

In this large prospective cohort with 30 years of follow-up, we observed a higher prostate cancer incidence and mortality in African American men and a lower incidence in Asian American men. These differences were not explained by differences in lifestyle, diet, family history, or PSA screening. The higher risk of overall prostate cancer in African American men was seen despite lower PSA screening uptake, a key determinant of prostate cancer incidence in the population.

That the higher risk in African American men was only minimally attenuated by multivariable adjustment suggests that differences in the prevalence of known lifestyle and dietary factors measured in this study has only a small contribution to this excess incidence. This is consistent with prior studies suggesting that disparities remain after controlling for many of the factors long thought to contribute to these differences.[20,26,27] Notably, our cohort of health professionals is a unique population in which to examine this question among men with similarly high educational attainment and mid-life socioeconomic status. The 31% higher risk of prostate cancer in HPFS for African American men compared to white men is lower than population estimates which, from 2011–2015, showed African American men were 76% more likely to be diagnosed with prostate cancer than white men [9]. This difference may reflect a role for adult socioeconomic status or could indicate differences in PSA screening with the aging of the population.

Nationally, the age-adjusted prostate cancer mortality rate in African American men is 2.3 times higher than in white men.[9] In the HPFS, we observed a 67% higher risk of fatal prostate cancer in African American men compared to white men after multivariable adjustment, though this estimate had wide confidence intervals. Despite attenuation of this mortality difference in our population, the remaining disparity is concerning, especially considering that other non-cancer causes of mortality are not substantially increased in African American men in HPFS.[28] While socioeconomic status may play a role in attenuating disparate outcomes in prostate cancer mortality,[29] the large remaining racial difference in our cohort of men with uniformly high educational attainment disputes this as the only explanation, and its lack of attenuation after multivariable adjustment argues against a significant role for lifestyle factors.

A crucial missing piece not accounted for in our study is an investigation of systemic inequities in healthcare access and quality. There are profound differences in prostate cancer treatment between African American and white men. For example, one study showed that a lower proportion of African American men were offered radical prostatectomy compared to white men[30] and indeed, in our study, both African American and Asian American men were less likely to receive radical prostatectomy. Notably, overtreatment of prostate cancer is persistent across race groups; however, one study demonstrated that in groups with highest potential treatment benefit, African American men were significantly less likely to receive treatment compared to white men.[31] Further, chronic exposure to racism as a form of psychosocial stress is associated with changes in immune and endocrine function [32], while molecular mechanisms for the relationship between chronic stress and cancer have also been elucidated[33]. Several studies have even directly linked residential segregation with cancer

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disparities[34–36]—including prostate cancer[37]—in African Americans. While we are not able to control for these factors in the present study, further work should continue to explore the complex interactions between patients and their social environments.

There was lower PSA screening in African American compared to white men in HPFS throughout the study period. It follows that when they are diagnosed, it is more likely to be with aggressive prostate cancer.[38] While racial differences in screening patterns have been previously reported,[39] it is notable that these differences persist in the setting of higher socioeconomic status. Given these differences, we assessed the impact of the introduction of PSA screening on the racial difference in prostate cancer risk and noted an attenuation of the racial disparity in the PSA era. However, it is important to note here that we were unable to parse risk of aggressive cancer by pre-PSA vs. PSA era due to small sample sizes. It is likely that the increase in screening leads to an increase in diagnosis of indolent cancers across race groups—a well-documented effect of PSA screening[40,41] —thereby diluting the difference in the PSA era.

Among men of white ancestry, our results show a modest increase in risk of total and advanced prostate cancer in Scandinavian compared to Southern European men; however, this result was non-significant after multivariable adjustment. This is comparable to prior studies of men of European ancestry living in the U.S.[42] and to international cancer statistics[21,42]. Previous data in our cohort showed that Scandinavian men consume more dairy and calcium[4] (associated with increased risk of total and aggressive prostate cancer[43]) while Southern European men consume more tomato sauce[4] (associated with decreased risk[43]), which may partially explain the attenuation after multivariable adjustment.

In contrast, Asian American men had a lower overall incidence of prostate cancer compared to white men; however, while non-significant, there was a suggestion of increased risk of high-grade cancer. This is consistent with current literature suggesting that tumor grade is higher in Asian American men at time of diagnosis[44]. This may be due in part to lower screening prevalence observed in our cohort. Importantly, as with all race groups, Asian Americans are a vastly diverse cohort, and our inability to characterize risk by specific subtype is a limitation of this study.

Other limitations of the present study are the small number of African American and Asian American men and events in these groups; as such, our estimates for fatal, lethal, and advanced disease have wide confidence intervals. Still, we observed statistically significant findings and clinically meaningful effect estimates. Our study lacked data on Hispanic ethnicity or specific ancestries in Asian American men. Very few in our cohort born from 1911–1946 self-identified more than one race, so we are unable to comment on risk in multiracial persons. Although we adjusted for family history, we did not consider inherited genetic factors to explain differences in risk across groups. This is important since the distribution of a multiethnic polygenic risk score is higher in men of African ancestry[46]. Further, while this is a longitudinal cohort, this study only accounts for adult modifiable factors and does not consider early life exposures or social factors which may have substantial differences across race groups. Additionally, while this cohort of health

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professionals allows us to control for adult socioeconomic status, results may not be generalizable to the entire population. Finally, these data deal with self-reported race and ethnicity as these are socially constructed. While there is a correlation between self-reported race and ancestry, we cannot draw conclusions about underlying genetic risk due to ancestry, which should be a focus of future investigations.

Notable strengths of our study include its prospective design, use of validated prostate cancer cases, and extensive nature of the biennial questionnaires, which allowed us to finely adjust for PSA testing and a range of lifestyle factors. Still, given the strong impact of PSA screening on prostate cancer diagnosis, there is the possibility that residual differences might be explained by screening. The long-term follow-up of the cohort over the course of three decades allows an investigation of prostate cancer risk across the lifespan. Finally, we were able to investigate not only prostate cancer overall, but clinically relevant and fatal disease.

In summary, our updated analysis of the HPFS demonstrates that African American men have persistent, disproportionately higher rates of prostate cancer incidence and mortality that are not explained by differences in lifestyle factors, family history of prostate cancer, or PSA testing. Conversely, we found that Asian American men have a lower risk of overall prostate cancer. While biological differences may partly account for the racial disparities in prostate cancer incidence, ultimately, race is socially constructed, and etiology of disparities in prostate cancer aggressiveness and mortality are likely multifactorial, including the socioeconomic and non-socioeconomic facets of healthcare access, treatment, and outcomes.

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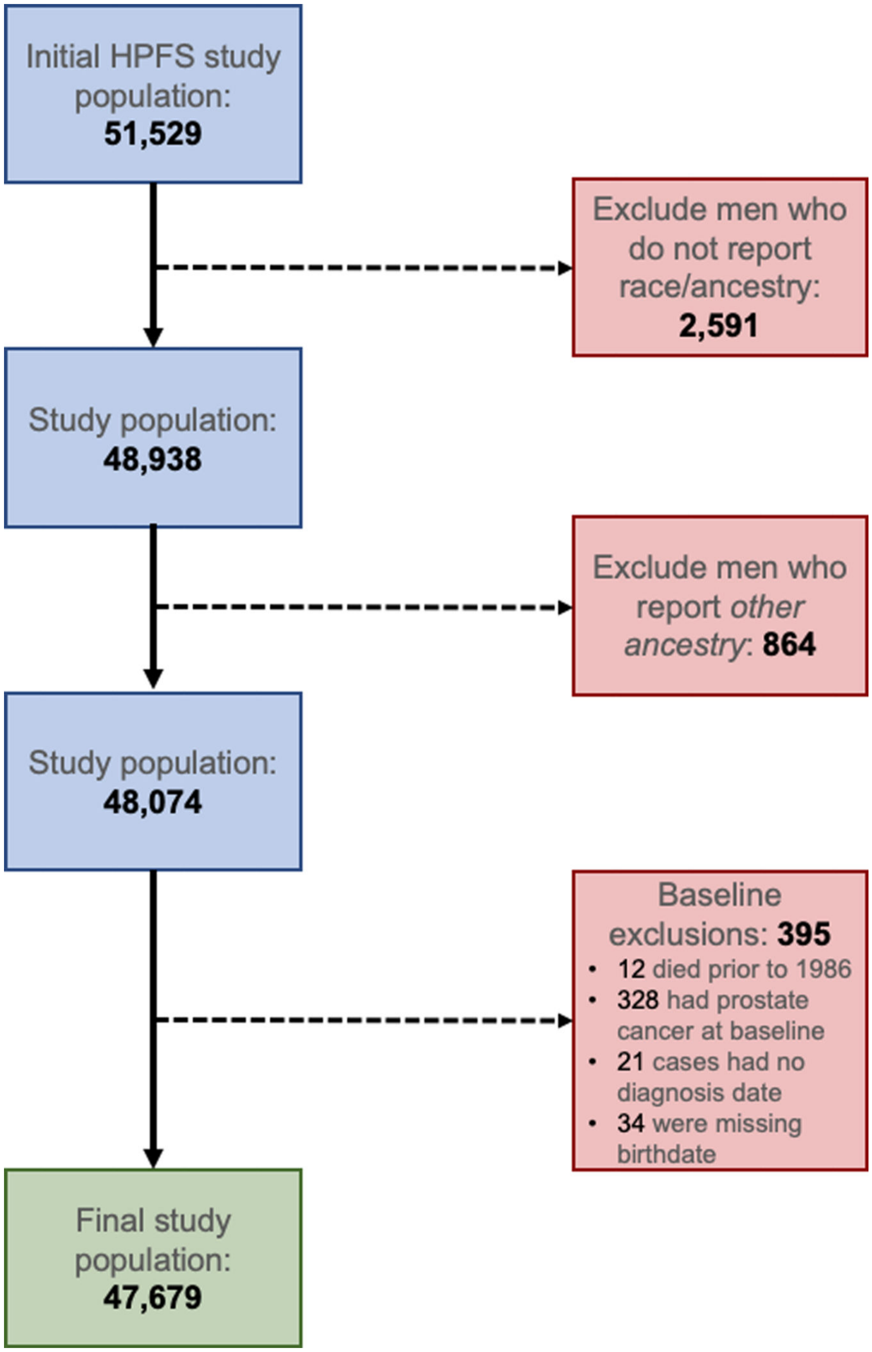

Figure 1:
Exclusions to create the final study population within the Health Professionals Follow-up Study.

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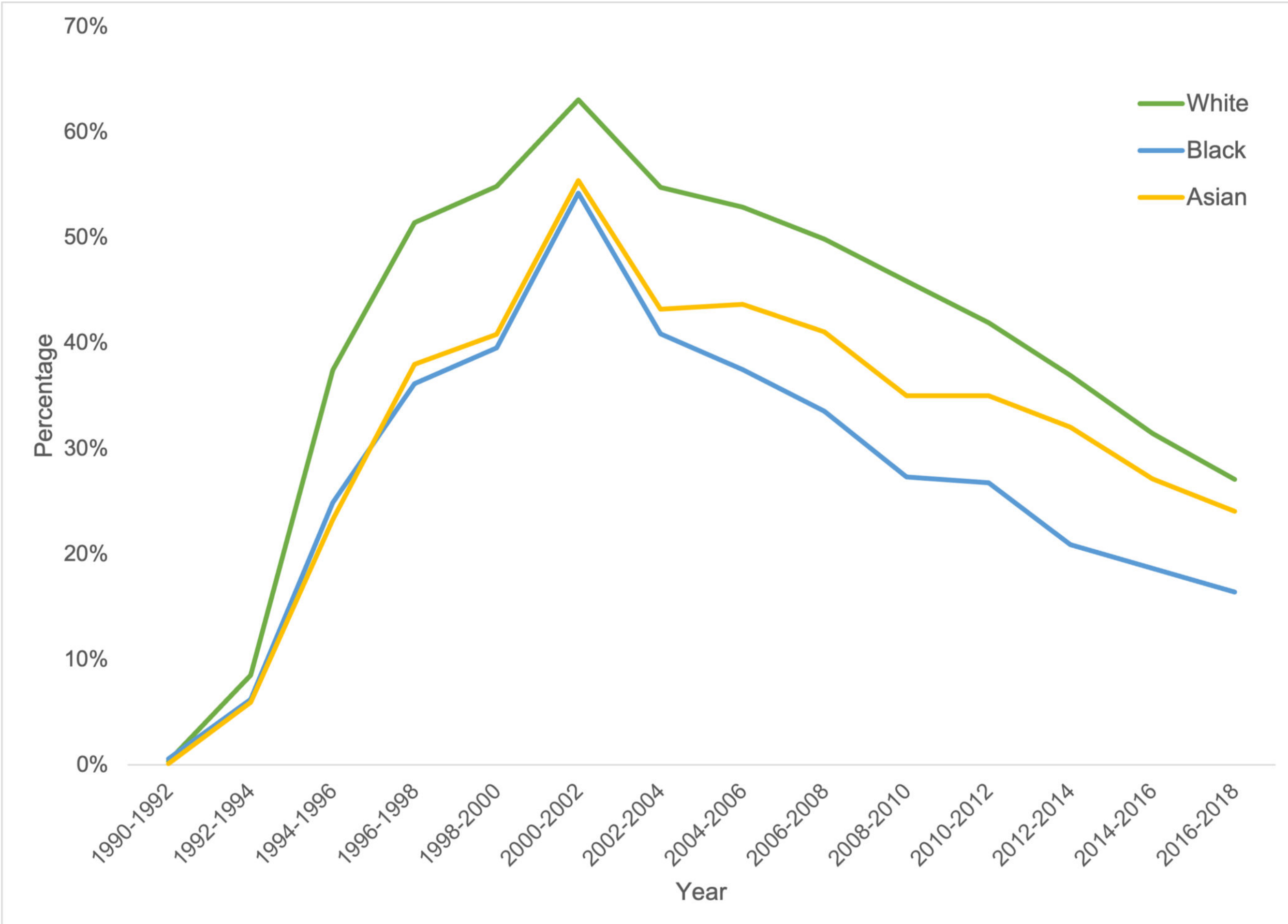

Figure 2:
Trends over time in prevalence of recent PSA screening (in the past two years) among white, African American, and Asian American men, Health Professionals Follow-up Study (n=48,074).

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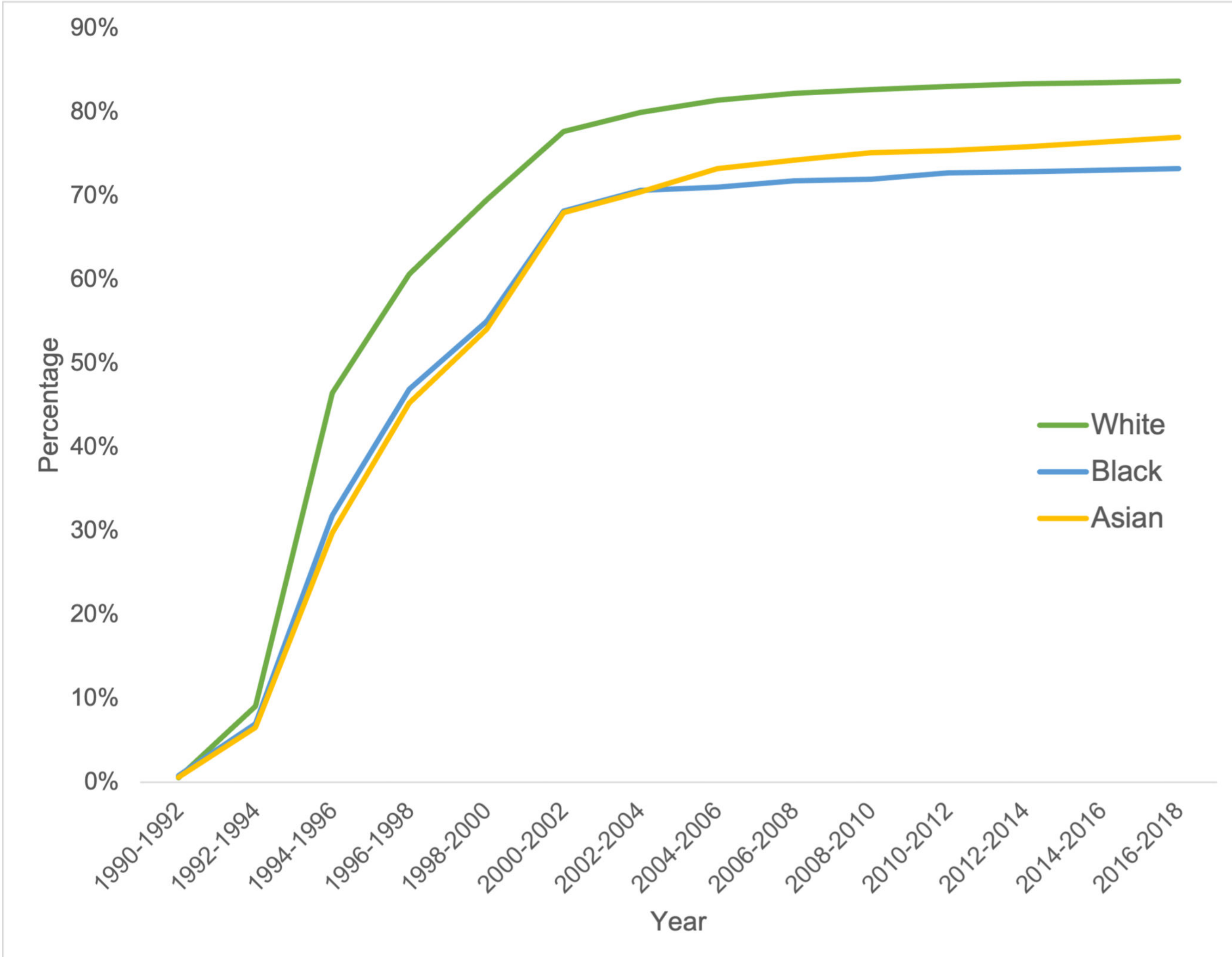

Figure 3:

Trends over time in prevalence of men with any PSA screening history in white, African American, and Asian American men, Health Professionals Follow-up Study (n=48,074).

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Table 1a.

Age-adjusted characteristics of baseline population by race and European ancestry, Health Professionals Follow-up Study 1986, (n=47,679)

	African American	Asian American	European American			
			All white	Southern European	Scandinavian	Other European
N	523	875	46,281	12,080	5,195	29,006
Mean age, years (SD)[a]	54.6 (8.9)	52.3 (9.0)	54.2 (9.8)	53.6 (9.7)	53.4 (9.7)	54.7 (9.9)
Mean height, inches (SD)	70.1 (3.4)	67.0 (3.1)	70.2 (2.8)	69.7 (2.9)	70.7 (2.8)	70.2 (2.8)
Mean BMI at age 21 years, kg/m2 (SD)	22.8 (3.6)	21.9 (3.2)	23.0 (3.0)	23.2 (3.1)	23.0 (2.9)	23.0 (3.0)
Mean current BMI, kg/m2 (SD)	26.0 (3.8)	24.2 (3.4)	25.5 (3.3)	25.7 (3.3)	25.5 (3.4)	25.5 (3.3)
Smoking status						
Never smoker, %	41.1	52.8	46.0	46.0	47.9	45.6
Past smoker quit >10 years, %	28.9	25.4	30.7	31.0	30.0	30.7
Past smoker quit ≤10 years, %	14.2	11.4	12.9	12.9	11.9	13.0
Current smoker, %	14.5	9.2	9.9	9.4	9.5	10.1
Unknown, %	1.2	1.2	0.6	0.7	0.7	0.6
History of diabetes, %	7.1	6.2	3.1	3.2	2.7	3.1
Family history of prostate cancer, %	12.2	7.2	12.0	11.5	13.3	12.0
PSA screening history						
Ever had a PSA test by 1994, %	31.1	32.2	46.5	46.3	44.0	47.0
Ever had a PSA test by 1996, %	46.2	46.8	60.8	60.6	57.8	61.3
Ever had a PSA test by 2016, %	73.4	75.8	84.0	83.4	83.4	84.2
PSA screening in last 2 years, 2016, %	17.3	20.8	27.4	27.6	26.0	27.4
Mean vigorous activity METs/week (SD)	8.1 (32.2)	6.1 (15.9)	6.0 (19.5)	6.2 (22.0)	5.7 (20.5)	5.9 (18.4)
Mean total energy intake kcal/day (SD)	1854 (654)	1844 (648)	1994 (609)	1951 (608)	2066 (614)	1998 (608)
Mean coffee, cups/day (SD)	0.9 (1.1)	1.5 (1.5)	1.9 (1.8)	1.9 (1.7)	2.0 (1.9)	2.0 (1.8)
Mean tomato sauce, servings/week (SD)	0.7 (1.4)	0.8 (1.1)	0.9 (1.1)	1.1 (1.3)	0.9 (1.0)	0.9 (1.1)
Mean calcium, mg/day (SD)	760 (407)	731 (365)	901 (421)	870 (412)	972 (443)	902 (419)

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Table 1b.

Age-adjusted clinical characteristics of prostate cancer cases at the time of diagnosis, by race and European ancestry, Health Professionals Follow-up Study (n=7,088)

	African American	Asian American	European American			
			All white	Southern European	Scandinavian	Other European
N	89	90	6,909	1,677	777	4,455
Year of diagnosis						
1986–1989, %	4.2	3.4	4.9	4.5	5.5	4.9
1990–1994, %	30.2	18.9	19.1	18.4	18.9	19.3
1995–1999, %	20.0	20.2	21.7	21.8	22.0	21.6
2000–2004, %	24.4	23.1	22.7	23.0	22.0	22.7
2005–2009, %	13.8	20.6	19.7	19.2	19.1	19.9
2010–2014, %	5.3	11.8	10.0	10.6	10.4	9.6
2015–2016, %	2.2	2.0	2.0	2.4	2.1	1.9
Mean age at diagnosis, years (SD)[a]	70.3 (6.7)	70.7 (7.0)	70.1 (7.5)	69.8 (7.5)	69.2 (7.4)	70.4 (7.4)
Mean PSA at diagnosis, ng/mL (SD)	13.9 (17.7)	26.3 (99.8)	17.8 (152.3)	15.3 (141.2)	30.7 (269.0)	16.5 (127.0)
Primary treatment						
Radical prostatectomy, %	32.9	29.6	38.1	37.8	41.0	37.8
Radiation, %	23.4	31.3	30.9	30.5	29.0	31.3
Hormones, %	5.3	8.8	6.8	6.1	7.0	7.1
Active surveillance/no treatment, %	14.9	10.5	9.3	10.1	8.2	9.2
Other treatment, %	1.0	0	1.9	1.8	1.9	1.8
Unknown treatment, %	22.4	19.9	13.0	13.7	12.9	12.7
TNM Stage[b]						
T1/T2, %	86.9	80.0	82.9	84.4	81.2	82.7
T3a, %	1.3	8.5	8.1	7.7	7.3	8.4
T3b, %	2.6	1.6	3.1	2.8	4.2	3.1
T4/N1/M1, %	9.2	9.9	5.9	5.2	7.1	5.9
Missing TNM stage, %	20.3	18.6	10.5	12.5	10.1	9.8
Gleason grade[c]						

	African American	Asian American	European American			
			All white	Southern European	Scandinavian	Other European
Gleason 2–6, %	44.8	31.1	47.3	47.9	47.4	47.0
Gleason 7, 3+4 %	26.8	24.2	22.9	22.8	22.4	23.1
Gleason 7, 4+3 %	7.1	14.2	11.1	10.5	11.2	11.3
Gleason 7 (breakdown unknown), %	8.4	4.1	3.2	3.6	4.1	3.0
Gleason 8–10, %	12.9	26.3	15.5	15.2	14.8	15.7
Missing Gleason grade, %	26.5	21.2	15.0	16.8	15.1	14.3

MET: metabolic equivalent; PSA: prostate-specific antigen

Values are means (SD) and percentages for categorical variables are standardized to the age distribution of the study population.

[a] Value is not age-adjusted

[b] Combined clinical and pathologic stage (clinical stage used only if pathologic stage was unavailable)

[c] Combined clinical and pathologic Gleason (clinical Gleason used only if pathologic Gleason was unavailable)

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Table 2.

Incidence rates and hazard ratios (HR) and 95% confidence intervals (CI) for the association between race/ancestry and prostate cancer risk in the HPFS cohort, 1986–2017

			HR (95% CI)	
	No. of cases	**Crude Incidence / 100,000 PY**	**Age/calendar time-adjusted**	**Multivariable-adjusted***
All Prostate Cancer	7,088	644		
Race				
White	6,909	647	ref	1.00 (ref)
African American	89	785	1.21 (0.98, 1.49)	1.31 (1.06, 1.62)
Asian American	90	410	0.67 (0.54, 0.82)	0.74 (0.60, 0.92)
European ancestry				
Southern European	1,677	591	ref	1.00 (ref)
Scandinavian	777	638	1.10 (1.01, 1.20)	1.07 (0.98, 1.17)
Other European	4,455	674	1.09 (1.03, 1.16)	1.07 (1.01, 1.14)
Fatal Cancer	910	83		
Race				
White	879	82	ref	1.00 (ref)
African American	16	141	1.74 (1.05, 2.87)	1.67 (1.00, 2.78)
Asian American	15	68	1.07 (0.64, 1.80)	1.25 (0.74, 2.11)
European ancestry				
Southern European	194	68	ref	1.00 (ref)
Scandinavian	98	80	1.20 (0.94, 1.53)	1.10 (0.86, 1.42)
Other European	587	89	1.17 (0.99, 1.37)	1.13 (0.95, 1.33)
Lethal Cancer	1,094	99		
Race				
White	1,059	99	ref	1.00 (ref)
African American	16	141	1.41 (0.86, 2.33)	1.36 (0.82, 2.25)
Asian American	19	87	1.10 (0.70, 1.75)	1.24 (0.78, 1.98)
European ancestry				
Southern European	231	81	ref	1.00 (ref)
Scandinavian	126	103	1.29 (1.04, 1.61)	1.21 (0.97, 1.52)
Other European	702	106	1.17 (1.01, 1.37)	1.14 (0.98, 1.33)
Advanced Cancer	1,337	121		
Race				
White	1,297	122	ref	1.00 (ref)
African American	20	177	1.42 (0.91, 2.22)	1.39 (0.88, 2.18)
Asian American	20	91	0.91 (0.59, 1.43)	1.04 (0.66, 1.63)
European ancestry				
Southern European	291	102	ref	1.00 (ref)
Scandinavian	156	128	1.27 (1.04, 1.54)	1.18 (0.97, 1.44)

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	No. of cases	Crude Incidence / 100,000 PY	HR (95% CI) Age/calendar time-adjusted	HR (95% CI) Multivariable-adjusted*
Other European	850	129	1.14 (1.00, 1.31)	1.11 (0.97, 1.27)
High Grade Cancer, Gleason 4+3 or higher	1,605	146		
Race				
White	1,562	146	ref	1.00 (ref)
African American	14	124	0.82 (0.48, 1.39)	0.89 (0.52, 1.51)
Asian American	29	132	0.97 (0.67, 1.41)	1.14 (0.78, 1.67)
European ancestry				
Southern European	357	126	ref	1.00 (ref)
Scandinavian	172	141	1.14 (0.95, 1.37)	1.06 (0.88, 1.27)
Other European	1,033	156	1.20 (1.06, 1.35)	1.15 (1.01, 1.29)

Abbreviations: CI: confidence interval; PY: person years

*Models adjusted for age, calendar time, height (≤68, >68–70, >70–72, >72 inches), body mass index (<21, 21 to <25, 25 to <30, 30+ kg/m^2), vigorous physical activity (MET-hours/week, quartiles), smoking status (never, former/quit <10 years ago, former/quit 10+ years ago, or current), time-updating family history of prostate cancer, PSA testing in the two years prior to the questionnaire date (lagged by one period to avoid counting diagnostic PSA tests as screening), PSA testing in >50% of possible time periods (lagged by one period), total energy intake (kilo-calories/day, quartiles), coffee intake (none, <1, 1 to <2, 2 to <3, 3+ cups/day), tomato sauce intake (servings/week, quartiles), and calcium intake (mg/day, quartiles)

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Table 3.

Incidence rates and hazard ratios (HR) and 95% confidence intervals (CI) for the association between race/ancestry and incident prostate cancer in HPFS cohort by pre-PSA era and PSA era

			HR (95% CI)	Multivariable-adjusted*
	No. of cases	Crude Incidence / 100,000 PY	Age/calendar time-adjusted	
Pre-PSA era (1986–1994)	1,556	134		
Race				
White	1,511	134	ref	1.00 (ref)
African American	28	234	1.63 (1.11, 2.39)	1.68 (1.14, 2.48)
Asian American	17	75	0.76 (0.47, 1.22)	0.86 (0.53, 1.39)
European ancestry				
Southern European	353	118	ref	1.00 (ref)
Scandinavian	175	136	1.19 (0.99, 1.43)	1.11 (0.92, 1.34)
Other European	983	141	1.02 (0.90, 1.16)	0.97 (0.86, 1.10)
PSA era (1994–2016)	5,532	743		
Race				
White	5,398	748	ref	1.00 (ref)
African American	61	817	1.08 (0.84, 1.40)	1.20 (0.93, 1.56)
Asian American	73	476	0.65 (0.51, 0.82)	0.72 (0.57, 0.92)
European ancestry				
Southern European	1,324	684	ref	1.00 (ref)
Scandinavian	602	726	1.07 (0.97, 1.18)	1.06 (0.96, 1.17)
Other European	3,472	780	1.12 (1.05, 1.19)	1.10 (1.03, 1.17)

Abbreviations: CI: confidence interval; PY: person-years

*Models adjusted for age, calendar time, height (≤68, >68–70, >70–72, >72 inches), body mass index (<21, 21 to <25, 25 to <30, 30+ kg/m^2), vigorous physical activity (MET-hours/week, quartiles), smoking status (never, former/quit <10 years ago, former/quit 10+ years ago, or current), time-updating family history of prostate cancer, PSA testing in the two years prior to the questionnaire date (lagged by one period to avoid counting diagnostic PSA tests as screening-excluded from pre-PSA model), PSA testing in >50% of possible time periods (lagged by one period-excluded from pre-PSA model), total energy intake (kilo-calories/day, quartiles), coffee intake (none, <1, 1 to <2, 2 to <3, 3+ cups/day), tomato sauce intake (servings/week, quartiles), and calcium intake (mg/day, quartiles)