# How family history and race influence prostate cancer screening

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## Abstract

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**Background**: Most major U.S. medical organizations recommend that screening for prostate cancer using the prostate-specific antigen (PSA) test should be based on individual patient preferences. Men with risk factors for prostate cancer diagnosis and mortality may have different preferences for screening than men without any risk factors.

**Methods**: We used nationally-representative survey data from the 2005 and 2010 National Health Interview Survey to assess PSA-screening patterns by age, family history of prostate cancer and race among men in the United States over 40 years old using bivariate and multivariable logistic regression.

**Results**: Men with any family history of prostate cancer were more likely to be screened using the PSA test in the last two years at any age (OR=2.2, 95% CI 1.8-2.6), and men with a father and brother diagnosed were more likely to be screened than men with only a father diagnosed, after adjustment (p=0.019). Younger (40-54 year old) African-American or black men had a higher odds of being screened than White, non-Hispanic men of the same age, after adjustment (OR=1.5, 95% CI=1.2-1.9), but this same adjusted comparison within other age groups indicated

no significant difference in screening rates by race (age 55-69 years old: OR=1.0, 95% CI=0.8-1.3; age 70 years or more: OR=-0.9, 95% CI=0.7-1.3).

**Conclusion**: There is considerable heterogeneity in PSA-screening practices. A family history of prostate cancer, and to a limited degree black or African-American race, both contribute to increased odds of undergoing screening. Understanding how to discuss risk factors with men to ensure individual patient preferences are appropriately integrated into screening decisions should be a priority for providers.

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## ACKNOWLEDGEMENTS

I am deeply grateful for the insight, support and encouragement of my committee, Steve Zeliadt and John Gore, and my family, Neeta, Fran, John and Lucinda.

## DEDICATION

This work is dedicated to my mother, Frances L. Williams Dunlap (1944-2015), whose unwavering support will always be with me.

## Introduction

Recent studies have found utility in risk stratification for identifying men who may be at higher risk for dying from prostate cancer and may therefore benefit from prostate cancer screening, while simultaneously protecting low-risk men from unnecessary and harmful screening and procedures[1,2]. The most common risk factors associated with an increase in prostate cancer mortality include age, an individual's family history of prostate cancer including the number of relatives diagnosed, and their age at diagnosis, and black or African-American racial heritage[3–5]. In their 2012 recommendation against prostate cancer screening in the general population, the U.S. Preventative Services Task Force (USPSTF) stated that "currently, available evidence does not allow us to know with any certainty whether the balance of benefits and harms is different for men at increased risk"[6]. The American Urological Association (AUA) currently recommends that patients with risk factors for prostate cancer discuss the issue with their health care providers[7], but does not provide a clear indication on whether testing is appropriate.

In this environment, men at elevated risk for prostate cancer may have difficulty making decisions about screening for prostate cancer that best reflect their preferences, and their primary care providers may have difficulty advising them about PSA-testing. This paper seeks to understand how risk factors for prostate cancer incidence and mortality are associated with prostate cancer screening preferences.

## Methods

### a) Data sources

Data for this study were extracted from the National Health Interview Survey (NHIS). The NHIS is a national cross-sectional household interview survey representative of the U.S. population (excluding institutionalized and military personnel) conducted annually with families

and individuals in all 50 U.S. states and the District of Columbia. As part of this annual survey, randomly selected adult members from surveyed households are asked supplementary questions which gather additional detail. In 2005 and 2010, these supplementary questions included the NHIS Cancer Screening supplement and questions related to cancer prevention and screening behaviors[8]. We used the Integrated Health Interview Series (IHIS), which consists of NHIS data recoded for consistency across survey years to facilitate analysis[9].

**b) Sample and population**

The NHIS Sample Adult Surveys conducted in 2005 and 2010 included a total of 15,816 men age 40 years old and older (8,490 men in 2005 and 7,326 men in 2010). From this total, we excluded respondents who reported that they had a prostate cancer diagnosis (569 men); required help with activities of daily living (ADL) (359 men); did not know or did not report their PSA-testing status (1,489 men); and did not know (or did not report) the approximate date of their most recent PSA test, or had a recorded testing date that was prior to the date of their survey (20 men). These exclusions were made in the order presented above. After exclusions, our sample for analysis consisted of 13,379 men (7,220 from NHIS 2005 and 6,159 from NHIS 2010).

**a) Outcome variable**

Our outcome of interest was whether or not men reported having a PSA test in the two years prior to their survey response date. In the 2005 and 2010 NHIS Sample Adult Health Interview Surveys men who responded "yes" to the question "Have you ever had a PSA-test?" were subsequently asked, "When did you have your most recent PSA test?" Men who reported having a PSA test, but did not offer a complete date for their most recent PSA test, or who responded "years ago" when asked about the date of their most recent test, were subsequently asked to approximate the years elapsed since their most recent PSA-test. Response categories to

this prompted approximation were (1) a year ago or less (2) greater than 1 year ago but not more than 2 years ago (3) greater than 2 years ago but not more than 3 years ago (4) greater than 3 years ago but not more than 5 years ago, (5) over 5 years ago, (6) unknown or (7) refused. To construct this study's binary outcome variable, we first calculated the difference between the survey administration date and the date of the most recent PSA-test, in days, for those individuals who answered with a specific date of their most recent test. We then converted this difference to years elapsed, without rounding, and recoded all differences of 2 years or less as having a PSA-test in the last 2 years. Survey respondents who (1) could not provide the date of their most recent PSA-test, and (2) who responded with either "a year ago or less" or "greater than 1 year ago but not more than 2 years ago" when asked to provide an approximate date of their most recent PSA-test, were also included in our outcome variable as individuals who had a PSA-test in the last 2 years. Individuals who did not know or refused to answer both the initial question and follow up prompts above were excluded from analysis, as described above in our exclusion criteria.

**c) Exposure variables**

We constructed our primary exposure variable, family history of prostate cancer, using response data to several questions that asked survey participants whether a first-degree biological male family member (i.e. biological father, brothers, or sons) ever had cancer of any kind, and recoding responses if the survey participant mentioned prostate cancer. Data on prostate cancer in more distant male relatives (e.g. uncles) was not available. In the NHIS surveys conducted in 2005 and 2010, respondents who affirmed that they had any full brother(s) or biological son(s) were subsequently asked if these specific individuals had cancer of any kind. A family history of prostate cancer was determined only if the respondent volunteered this specific diagnosis when

asked general questions about family history of cancer in a given first-degree relative. For example, if a respondent had a son, then the interviewer would ask if the son had ever been diagnosed with cancer of any kind. For our study, survey respondents who did not mention prostate cancer when asked whether their father, son or brother had cancer of any kind were assumed to not have a family history of the disease.

In order to better understand the importance of types of family history for PSA screening patterns, we also constructed an alternate exposure variable for family history with different combinations of first-degree relatives diagnosed with prostate cancer. This variable is based on the same response data for family history of prostate cancer in immediate male relatives as described above, but provides greater detail regarding whether the individual had a father, son, and/or brother who had a been diagnosed with prostate cancer. The five response categories in this alternate exposure variable are: (1) no mention of prostate cancer in father, son(s) or brother(s); (2) son(s) diagnosed with prostate cancer, with or without diagnosis in father or brother(s); (3) father diagnosed with prostate cancer but son(s) and brother(s) have not been diagnosed; (4) brother(s) diagnosed with prostate cancer but son(s) and father(s) have not been diagnosed; and (5) father and brother(s), but not son(s), have been diagnosed with prostate cancer.

We used self-reported race and Hispanic-ethnicity to construct a combined race and ethnicity variable with the following categories: (1) white, non-Hispanic; (2) white, Hispanic; (3) black or African-American, non-Hispanic; (4) black or African-American, Hispanic; (5) East Asian / Pacific Islander (Hispanic and non-Hispanic combined), and (6) a category for "other race and ethnicity" which included all other combinations of self-reported race and Hispanic-ethnicity.

Our analyses included two different specifications for age. For descriptive statistics and our initial bivariate and unadjusted logistic analyses, we grouped age into 5-year increments starting at age 40 and top coded this variable at 85+ years of age. For adjusted analyses, we used three categories for age: (1) 40-54 years old; (2) 55-69 years old; and (3) 70 years old or more.

**d) Adjustment variables**

We included respondent's reported achieved level of education, insurance status, marital status, body mass index (BMI), smoking status, as well as the NHIS survey year, as adjustment variables. A respondent's level of education was defined as (1) Less than high school, or no GED, (2) High school graduate or GED, (3) Some college, (4) College graduate, or (5) "unknown". The category "Less than high school, or no GED" was used as the reference category.

Survey respondents were asked whether they currently had coverage under any health insurance policy, inclusive of Medicare, Medicaid, private and employer-based insurance policies. We recorded responses as a binary adjustment variable indicating if the individual was currently covered by any type of health insurance policy or did not have any health insurance coverage.

To adjust for marital status, we created a binary variable in which individuals reporting that they were legally married and living with their husband, wife or partner, or were not married but were living with their partner, were combined into a single category. All others not meeting any of the above conditions, including individuals with unknown marital or partner status, were marked as "not married and/or not cohabitating" with a spouse or partner.

Our adjustment for body mass index (BMI) categorized respondents as having a (1) BMI of 25-29, (2) BMI less than 24.9, or (3) BMI of greater than 30. This variable was created using the NCHS-calculated values for BMI as available in NHIS 2005 and 2010 data extracts, and

which was based on the questions "How tall are you without shoes?" and "What is your weight without shoes?" For analysis purposes, individuals with a BMI of 25-29 were set as the reference group.

In 2005 and 2010, the NHIS asked respondents about their current and past cigarette smoking behavior. For our analysis, we re-coded responses on smoking behavior into the categories (1) never smoked, (2) former smoker or unknown smoking behavior and (3) current smoker, with "never smoked" as the reference group.

To adjust for survey year, we constructed a binary variable distinguishing between surveys administered in 2010 and in 2005. We used 2005 as the reference year.

**b) Statistical analysis**

Our initial bivariate analysis compared the unadjusted population percent of men within each covariate in 2005 to 2010 (Table 1). To test for overall differences between survey years, we used a design-based adjusted Wald F-statistic with survey-design specific degrees of freedom. The details of this test are described elsewhere[10].

To understand differences in the proportion of men reporting PSA-testing between 2005 and 2010 in more detail, we compared PSA-testing rates between survey years by five-year age groups. For each age group, we conducted a two-sample test of proportions to assess for differences in PSA-testing by survey year, adjusting for multiple comparisons using a Šidák-adjustment to protect from inflated type I errors due to multiple comparisons[11] (Figure 1).

Similarly, we compared PSA-testing rates by age group and year of survey within subgroups of men with a family history of prostate cancer, as well as men who self-reported as black or African-American, again using a Šidák-adjustment to adjust for multiple comparisons. No figures or tables are presented for these subgroup analyses.

We then pooled the 2005 and 2010 NHIS survey response data and used logistic regression to estimate the unadjusted odds of undergoing PSA-screening in the last two years by each level of covariate for this pooled sample. These results are presented in Table 2.

We also used logistic regression to calculate the adjusted odds of PSA-screening on our exposures of interest – family history and race/ethnicity - after adjusting for achieved level of education, health insurance coverage status, marital or partner status, BMI, smoking behavior, and survey year (Table 3).

Because we were interested in whether the effect of these risk factors varied by age, we used three separate logistic regression models to characterize differences in PSA-screening by each covariate for the age groups 40-54, 55-69, and 70 or more years of age (Table 4).

We completed all analyses using Stata 13 statistical software and adjusted for NHIS's over-sampling of racial minorities using NHIS supplied probability weights and Stata's "svy" command[12]. All statistical tests were evaluated at the alpha=0.05 level. Institutional review was not required because analyses using publically available NHIS survey data are not considered human subjects research by the authors' home institution.

**Results**

The characteristics of our study population are described in Table 1. Of the 7,220 men in 2005 and 6,159 men in 2010 in our sample, 37.4% (2005) and 37.2% (2010) reported undergoing PSA screening in the prior two years, 6.3% (2005) and 6.6% (2010) men reported a family history of prostate cancer, 11.7% (2005) and 14.8% (2010) self-identified as African-American or black and non-Hispanic, 0.2% (2005) and 0.6% (2010) self-identified as black and Hispanic, and 71.6% (2005) and 62.3% (2010) identified as White and non-Hispanic. The age distribution of the samples from 2005 and 2010, are: 3,606 and 2,936 men age 40-54 years old; 2,373 and

2,220 men age 55-69 years old; and 1,241 and 1,003 men age 70 or more years old, respectively. Table 1 shows the estimated population percent for all covariates of interest after weighting to account for the NHIS sample design.

Because of this study's large sample size, small changes in the population distribution within each covariate were, in several cases, statistically significant between survey years (Table 1). Although the unadjusted proportion of the estimated population ever having a PSA test declined significantly when comparing data from 2010 to 2005 ($p=0.005$), the estimated population percent of men reporting a PSA test in the last two years did not change between the two survey years ($p=0.672$). Comparing the unadjusted difference in the estimated population percentage of men reporting a family history of prostate cancer in 2005 compared to similar men in 2010 also revealed no significant difference ($p=0.879$).

Other changes in the distribution of sample respondents between survey years reflect known demographic trends[13,14]. Changes in the age distribution of our population of interest between 2005 and 2010 were significant when testing for overall differences between survey years and five-year age groups, with population estimates of some age groups increasing and others decreasing ($p=0.002$). Overall differences in the distribution of self-identified race and ethnicity between were highly significant between survey years ($p<0.001$) with more U.S. men reporting their race and ethnicity as something other than White and non-Hispanic in 2010 than in 2005.

Figure 1 shows greater detail of the patterns of PSA screening in the last two years within our population of interest, stratified by five-year age group and survey year. Comparisons across years demonstrated no significant differences after adjustment for multiple comparisons: among men 40-59 years old within our sample, PSA screening decreased across all 5-year age groups

when comparing 2010 to 2005, but pair-wise comparisons within 5-year age groups did not reach significance after accounting for multiple comparisons using a Šidák-adjustment (Fig. 1). In contrast, among men 60-74 years old, the rate of PSA testing within the last two years was generally higher in 2010 than 2005, but these differences were also not significant after adjustment for multiple comparisons (Fig. 1). Men age 75 and over had very little difference in PSA-screening over the two survey years, and these differences were also not significant. Our subgroup analyses comparing the percent of respondents reporting PSA-testing in the last two years in 2005 to those in 2010, among black or African American men, and separately among men with a family history of prostate cancer, did not reach significance at any age group.

Table 2 shows the association of each covariate with PSA-screening in the last two years, without adjustment. Of the variables selected in Table 2, increasing age held the strongest association with PSA-screening in the last two years. When compared with men age 40-44 years old, the odds of PSA-screening in the prior two years increased with every five-year increment of age, from age 45 through 79 years old, and the greatest difference in odds observed was among men age 75-79 years old (OR=12.6, 95% CI 10.0-15.8). Without adjustment, a reported family history of prostate cancer, as well the constituent responses indicating prostate cancer in fathers, brothers or sons, were all independently associated with an increased odds of PSA-screening in the prior two years, and the association was significant for all indicators of family history of prostate cancer except prostate cancer in sons when compared with individuals that had no family history of prostate cancer (Any immediate male family member diagnosed: OR=2.39, $p<0.001$; Father diagnosed: OR=2.08, $p<0.001$; Brother(s) diagnosed: OR=4.18, $p<0.001$; Son(s) diagnosed: OR=2.65, $p=0.129$).

The positive association between PSA-screening in the last two years and any family history of prostate cancer remained significant after controlling for potential confounders including age, race, education, insurance, body mass index (BMI), marital-status and survey year (Table 3).

Using our adjusted model with the alternate specification of family history described above, with no family history of prostate cancer as the reference group, we found that men who reported both a father and brother(s) diagnosed with prostate cancer had more than twice the odds of undergoing screening when compared with men who reported only a father diagnosed with prostate cancer, and that this difference was significant (Brother & father: OR=4.73, p=0.002; Father only: OR=2.05, p<0.001; Wald test comparing the two groups: p=0.019). There was also a stronger association between PSA-screening and a family history of prostate cancer among men with only (a) diagnosed brother(s) than among men with only a diagnosed father, but the difference between these groups was not significant (Brother only: OR=2.53, p<0.001; Wald test comparing the two: p=0.324).

We also examined the association of PSA-screening in the last two years among individuals with positive family history for prostate cancer and various racial and ethnic backgrounds, separately by the age groups (1) 40-54 years old (2) 55-69 years old, and (3) 70 or more years old (Table 4). In this analysis, family history of prostate cancer remained associated with a significant increase in probability of screening across all age groups (40-54 years old: OR=2.5, p<0.01; 55-69 years old: OR=1.9, p<0.01; 70 years or more: OR=2.1, p<0.01). Among men self-reporting as African-American or black and non-Hispanic, only those age 40-54 years old were more likely to be screened in the last two years when compared with White, non-Hispanic men, after adjustment (OR=1.5, p<0.01).

## Discussion

This study shows that there was significant heterogeneity in screening practices among all U.S. men age 40 years old and older prior to the USPSTF recommendations made in 2012[6]. A family history of prostate cancer was strongly associated with having a PSA-test sometime the last two years in both 2005 and 2010 at all ages among men age 40 or older after adjustment for age, race and ethnicity, education, health insurance, marital status, BMI, smoking and survey year (Table 3). In addition, an increased number of relatives diagnosed with prostate cancer increased the odds of screening: men with both their father and brother(s) diagnosed with prostate cancer had higher odds of being screened than men reporting only a diagnosis of their father, and this difference was significant (p=0.019). Although men with only (a) brother(s) diagnosed with prostate cancer had higher odds of being screened, the difference was not significant when compared to men whose father was diagnosed.

Screening rates by age also varied among different racial/ethnic groups, though the differences were not as striking. Younger (i.e. 40-54 year old) African American or black men had a higher odds of undergoing PSA-screening when compared to White non-Hispanic men, after adjustment, and although this difference was highly significant this pattern did not hold true for men 55 years old and older (Table 4). Furthermore, adjustment for age, education, insurance status and marital status reversed the relatively small effect that self-reported African American or black race appears to exert on screening behavior, indicating that education, insurance status and marital status also alter PSA-screening behavior (Table 3).

Prior studies have indicated that asymptomatic men with a family history of prostate cancer are screened at higher rates than men without a family history, and that screening rates vary when comparing blacks with whites[15]. Our findings are consistent these studies, and also

highlight differences in screening based on the relationship (e.g. brother versus father) of the family history which to our knowledge had not previously been described[16].

Increased odds of PSA-screening could be expected among men with risk factors that are associated with increased mortality from prostate cancer. Prior studies have shown that a family history of prostate cancer, an earlier age of relatives' diagnosis, and a greater number of relatives diagnosed are all associated with increased cancer-specific morbidity and mortality. A study using data from the Swedish Family-Cancer Database, found that out of 175,828 men whose father or brother(s) were diagnosed with prostate cancer, 5,263 (3.0%) were themselves diagnosed with prostate cancer and 491 (18.9%) died from the disease. By comparison, out of 3,750,134 men without a family history of prostate cancer, 21,028 (0.56%) were diagnosed and 2,113 (0.056%) died from the disease. Among men diagnosed, the hazard of death from prostate cancer was highest among men diagnosed when they were less than 65 years old and who had brothers with the condition[17,18].

Men with African American ancestry also have higher rates of prostate cancer incidence and mortality than their White counterparts[19,20]. However, prior studies indicate that screening rates do not necessarily track this increased risk of mortality when comparing African American and White men: data from the Behavioral Risk Factor Survey (BRFSS) indicate that in 2002, younger (age 40-49) black men had higher PSA screening rates than white men of the same age[21]. Other studies found no difference in PSA testing rates between "high risk" African American men and Whites over age 50 years old[22]. Consistent with both of these findings, a more recent study indicates that younger (age 40-49) African American men have higher screening rates than Whites of the same age, yet older (age 60-69) African American men were found to have lower screening rates than Whites of the same age, and no differences were found by race between men

age 50-59 or over 70 years old[15]. Our study supports these conclusions, while also highlighting the critical importance of contributing factors such as education, insurance coverage and marital status for understanding racial variation in PSA-screening.

In our unadjusted bivariate analysis, insurance status appeared to be more strongly associated with PSA screening than family history (Table 1). Insurance status remained associated with PSA-screening in adjusted models as well (Table 3). As rates of insurance coverage in the US continue to rise as a result of the implementation of the Affordable Care Act (ACA), there may be large changes in routine screening for prostate cancer, particularly among men who were not insured before the ACA.

The controversy about the value of PSA testing that emerged from the randomized trials and the USPSTF recommendation has prompted providers and patients to carefully consider the available evidence and make decisions about PSA testing based on individual preferences. As we move forward in counseling patients about PSA testing, understanding how risk factors influence personal preferences for testing at different ages and across different racial/ethnic groups will be important for clinicians and policy makers.

The odds of PSA-testing vary by both family history and race in ways that may or may not follow rational risk assessment. Men with a statistically elevated risk for prostate cancer need more tools to help them make informed and rational decisions about whether or not to screen for prostate cancer, and at what age. Physicians need more tools to help them understand that patients of different races and ethnicities may have different preferences.

More specific tests that identify deadly forms of prostate cancer, tools for informed decision-making, risk calculators and genetic studies may provide some resolution, but the effective use and interpretation of these important tools remains a work in progress: free-PSA

tests and decision making aids are in use; risk calculators which include family history and race are being refined[2]; and although genetic studies may improve prediction of deadly forms of prostate cancer, such tests are not yet widely available and their interpretation can be challenging[23].

These findings could help providers and health systems better anticipate the concerns of their specific patient populations, understand the norms of care these populations may expect, how they might react differently to the same information based on family history or race/ethnicity, and better support rational patient-provider conversations and informed decisions around PSA screening for higher-risk men.

**Limitations**

Men who have a family history of prostate cancer may be more likely to recall that they had a screening test than those men with no family history of prostate cancer. A published analysis seeking to quantify this concern found that self-reported screening data from the NHIS survey is reasonable when compared with other national surveys, though it may under-report screening when compared to registry data[24].

**Conclusion**

This study finds that, in the absence of clear recommendations, all men age 40 and older with a family history of prostate cancer, as well as younger (i.e. 40-54 year old) men identifying as African American or black and non-Hispanic, were being screened at higher rates in 2005 and 2010 when compared with men without a family history of prostate cancer and white non-Hispanic men, respectively, after controlling for education, health insurance coverage, marital status and other variables which may impact healthcare-seeking behavior. Given the potential harms of PSA screening, and of uncertainty surrounding screening men who are at elevated risk

for prostate cancer incidence and mortality, patients with elevated risks and their providers are deciding to screen for prostate cancer in the absence of definitive evidence regarding the harms and benefits of screening applicable to these specific populations. Additional rigorous evidence on the risks and benefits of screening using the PSA-test among men with risk factors for prostate cancer is clearly needed, and could help improve guidance for these men and their providers who appear to be attempting to mitigate the risk of prostate cancer mortality through screening for prostate cancer using the PSA-test.

**Table 1:** Demographic characteristics of population by survey year

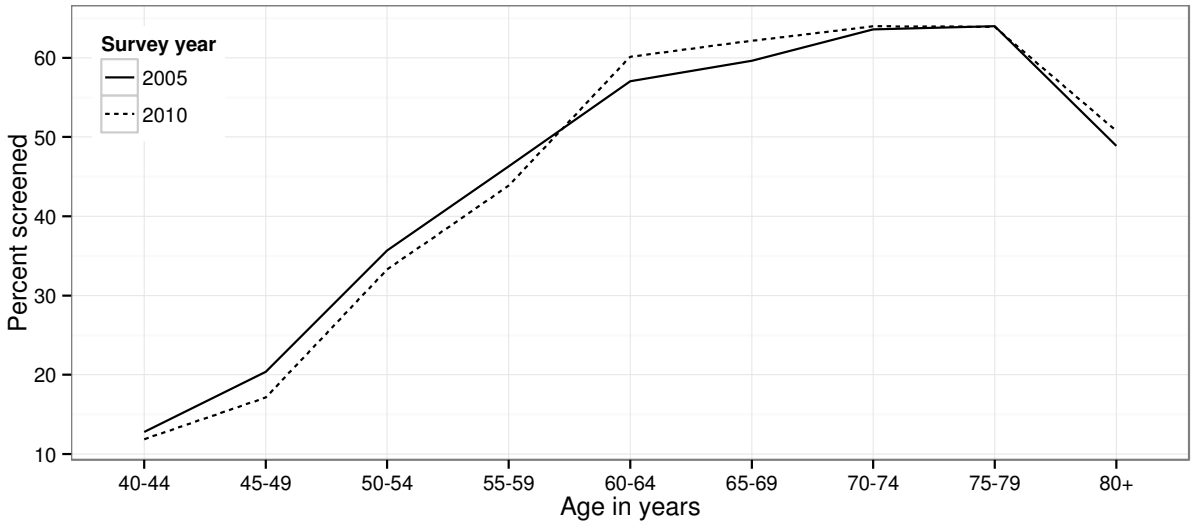
| **Survey year** | **2005** | **2010** | **Pooled** |
|---|---|---|---|
| Sample observations | 7,220 | 6,159 | 13,379 |
| Population estimate | 52,374,297 | 55,780,781 | 108,155,078 |
| Covariate | 2005 Pop% | 2010 Pop% | Pool. Pop% |
| **Age**** | | | |
| 40-44 | 18.56 | 16.79 | 17.65 |
| 45-49 | 18.90 | 17.65 | 18.26 |
| 50-54 | 16.24 | 16.69 | 16.47 |
| 55-59 | 13.74 | 13.72 | 13.73 |
| 60-64 | 10.63 | 12.50 | 11.60 |
| 65-69 | 7.05 | 8.56 | 7.83 |
| 70-74 | 6.07 | 5.73 | 5.89 |
| 75-79 | 4.26 | 4.09 | 4.17 |
| 80-84 | 3.02 | 2.66 | 2.83 |
| 85+ | 1.54 | 1.60 | 1.57 |
| **Race and Hispanic Origin***** | | | |
| White, non-Hispanic | 77.04 | 73.70 | 75.32 |
| White, Hispanic | 8.77 | 10.83 | 9.84 |
| Black, non-Hispanic | 9.12 | 9.24 | 9.18 |
| Black, Hispanic | 0.14 | 0.44 | 0.30 |
| Asian† | 3.41 | 4.28 | 3.86 |
| Other race | 1.51 | 1.50 | 1.51 |
| **Educational attainment**** | | | |
| K-12 | 15.29 | 14.50 | 14.88 |
| H.S. grad. or GED | 29.62 | 27.08 | 28.31 |
| Some college | 24.74 | 25.92 | 25.35 |
| College graduate | 29.58 | 32.04 | 30.85 |
| Unknown | 0.78 | 0.46 | 0.62 |
| **Family history of cancer (cn.)** | | | |
| Family history of any cancer◊** | 46.72 | 49.44 | 48.12 |
| Father, brother, or son had prostate cn. | 6.78 | 6.70 | 6.74 |
| Father had prostate cn. | 5.50 | 5.28 | 5.38 |
| Brother(s) had prostate cn. | 1.36 | 1.73 | 1.55 |
| Son(s) had prostate cn. | 0.10 | 0.07 | 0.08 |
| **Has insurance coverage***** | 88.16 | 85.63 | 86.86 |
| **Married or cohabitating*** | 76.72 | 74.13 | 75.38 |
| **Self-reported health status** | | | |
| Excellent or Very Good | 56.81 | 55.67 | 56.22 |
| Good | 28.59 | 29.45 | 29.04 |
| Fair or Poor | 14.60 | 14.88 | 14.75 |
| **BMI***** | | | |
| Less than 24.9 | 25.96 | 23.74 | 24.82 |
| 25.0-29.9 | 45.56 | 44.55 | 45.04 |
| 30.0 and up | 27.44 | 31.21 | 29.39 |
| Unknown | 1.04 | 0.50 | 0.76 |
| **Smoking behavior*** | | | |
| Never | 44.62 | 47.25 | 45.98 |
| Former or unknown | 33.69 | 33.13 | 33.40 |
| Current | 21.69 | 19.62 | 20.62 |
| **Ever had a PSA test**** | 49.40 | 46.52 | 47.91 |
| **PSA test in last 2 years** | 37.47 | 37.88 | 37.68 |
| **Years since most recent PSA test***** | | | |
| 1 year ago or less | 29.13 | 30.79 | 29.99 |
| >1 year but <=2 years ago | 8.34 | 7.09 | 7.70 |
| >2 year but <=3 years ago | 4.35 | 3.29 | 3.81 |
| >3 year but <=5 years ago | 3.44 | 2.56 | 2.98 |
| Over 5 years ago | 3.29 | 2.55 | 2.91 |
| Not applicable | 50.6 | 53.48 | 52.09 |
| Unknown | 0.86 | 0.24 | 0.54 |

**, **, *** Indicate that F-statistics for overall dependence between survey year and covariate are significant at $p < 0.05$, $p < 0.01$ or $p < 0.001$, respectively.*

*† Asian race includes those identifying as ethnically Hispanic and non-Hispanic.*

*◊ Includes any mention of any cancer in father, mother, brother(s), sister(s), son(s) or daughter(s).*

**Figure 1:** Unadjusted percent of U.S. men reporting PSA-testing in the last two years, by survey year and age group




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2005 95% CI Ub | 14.8 | 22.8 | 38.9 | 49.9 | 60.9 | 64.1 | 68.2 | 69.1 | 54.0 |
| 2005 Estimate | 12.8 | 20.4 | 35.7 | 46.3 | 57.1 | 59.6 | 63.6 | 64.0 | 48.9 |
| 2005 95% CI Lb | 10.8 | 17.9 | 32.4 | 42.7 | 53.2 | 55.2 | 59.0 | 58.9 | 43.8 |
| 2010 95% CI Ub | 14.2 | 19.9 | 36.8 | 47.9 | 64.3 | 66.6 | 70.1 | 70.0 | 57.1 |
| 2010 Estimate | 11.9 | 17.1 | 33.3 | 43.9 | 60.1 | 62.2 | 64.0 | 63.9 | 50.8 |
| 2010 95% CI Lb | 9.5 | 14.4 | 29.8 | 39.8 | 56.0 | 57.7 | 57.9 | 57.9 | 44.6 |
| adjust. P-value | 0.999 | 0.547 | 0.975 | 0.985 | 0.951 | 0.994 | 1.000 | 1.000 | 1.000 |
| 2005 samp. n | 1,263 | 1,238 | 1,105 | 1,008 | 779 | 586 | 494 | 342 | 405 |
| 2005 pop. N | 9,722,020 | 9,898,194 | 8,505,830 | 7,194,863 | 5,569,508 | 3,690,511 | 3,176,518 | 2,229,036 | 2,387,817 |
| 2010 samp. n | 1,003 | 979 | 954 | 848 | 770 | 602 | 392 | 291 | 320 |
| 2010 pop. N | 9,367,055 | 9,846,257 | 9,312,544 | 7,652,134 | 6,974,121 | 4,774,760 | 3,194,408 | 2,283,450 | 2,376,052 |

**Table 2:** Unadjusted population percent and odds of PSA-testing by covariate

| Sample observations = 13,379<br>Population = 108,155,078 | % of pop. tested | Unadjusted OR and 95% CI |
|---|---|---|
| **Survey year** | | |
| 2005 | 37.5% | (Ref.) |
| 2010 | 37.9% | 1.02 (0.94-1.11) |
| **Age** | | |
| 40-44 | 12.4% | (Ref.) |
| 45-49 | 18.8% | 1.64 (1.36-1.97)** |
| 50-54 | 34.4% | 3.73 (3.14-4.43)** |
| 55-59 | 45.1% | 5.82 (4.90-6.93)** |
| 60-64 | 58.8% | 10.12 (8.41-12.18)** |
| 65-69 | 61.1% | 11.13 (9.21-13.46)** |
| 70-74 | 63.8% | 12.51 (10.05-15.56)** |
| 75-79 | 64.0% | 12.60 (10.04-15.81)** |
| 80-84 | 55.1% | 8.70 (6.82-11.10)** |
| 85+ | 40.5% | 4.83 (3.59-6.48)** |
| **Race and ethnicity** | | |
| White, non-Hispanic | 40.7% | (Ref.) |
| White, Hispanic | 21.8% | 0.41 (0.35-0.47)** |
| Black, non-Hispanic | 35.6% | 0.81 (0.70-0.93)** |
| Black, Hispanic | 31.2% | 0.66 (0.33-1.32) |
| Asian | 27.0% | 0.54 (0.42-0.69)** |
| Other | 32.4% | 0.70 (0.60-0.96)* |
| **Father, brother, and/or son had prostate cancer** | | |
| Not mentioned or unknown | 36.2% | (Ref.) |
| Mentioned | 57.6% | 2.39 (2.03-2.81)** |
| **Father had prostate cancer** | | |
| Not mentioned or unknown | 36.7% | (Ref.) |
| Mentioned | 54.7% | 2.08 (1.73-2.51)** |
| **Brother(s) had prostate cancer** | | |
| Not mentioned or unknown | 37.2% | (Ref.) |
| Mentioned | 71.2% | 4.18 (2.99-5.84)** |
| **Son(s) had prostate cancer** | | |
| Not mentioned or unknown | 37.7% | (Ref.) |
| Mentioned | 61.6% | 2.65 (0.75-9.33) |
| **Any family history of any cancer** | | |
| Not mentioned or unknown | 30.6% | (Ref.) |
| Mentioned | 45.4% | 1.88 (1.73-2.05)** |
| **Education** | | |
| K-12 | 27.6% | (Ref.) |
| H.S. grad. or GED | 31.8% | 1.23 (1.08-1.40)** |
| Some college | 39.1% | 1.68 (1.48-1.92)** |
| College grad. | 46.9% | 2.32 (2.04-2.65)** |
| Unknown | 30.5% | 1.15 (0.67-1.99) |
| **Insurance status** | | |
| Not covered | 12.1% | (Ref.) |
| Covered | 41.6% | 5.19 (4.38-6.15)** |
| **Married or cohabitating** | | |
| No | 29.7% | (Ref.) |
| Yes | 40.2% | 1.57 (1.44-1.72)** |
| **Self-reported health status** | | |
| Excellent or Very Good | 37.1% | (Ref.) |
| Good | 37.9% | 1.03 (0.95-1.13) |
| Fair or Poor | 39.4% | 1.10 (0.98-1.24) |
| **BMI** | | |
| 25.0 - 29.9 | 39.1% | (Ref.) |
| Less than 24.9 | 35.6% | 0.86 (0.78-0.95)** |
| 30.0 and up | 37.9% | 0.95 (0.85-1.05) |
| Unknown | 12.8% | 0.23 |
| **Smoking behavior** | | |
| Never | 34.9% | (Ref.) |
| Former | 48.9% | 1.79 |
| Current | 25.8% | 0.65 |
| Unknown | 20.3% | 0.48 |

***** *Significant at $p < 0.05$*
*** Significant at $p < 0.01$*

**Table 3:** Comparison of odds of PSA-testing in adjusted models

| Covariate | Model 1<br>OR (95% CI)§ | Model 2<br>OR (95% CI)§ |
|---|---|---|
| **Age** | | |
| 40-54 years | (Ref.) | (Ref.) |
| 55-69 years | 4.1 (3.8 - 4.6)** | 3.9 (3.5 - 4.3)** |
| 70 years or more | 5.2 (4.6 - 5.9)** | 5.2 (4.5 - 5.9)** |
| **Fam. hist. pr.can.Δ** | 2.3 (1.9 - 2.7)** | 2.2 (1.8 - 2.6)** |
| **Race & ethnicity** | | |
| White, non-hisp | (Ref.) | (Ref.) |
| White, hisp. | 0.5 (0.4 - 0.6)** | 0.7 (0.6 - 0.8)** |
| Black, non-hisp. | 0.9 (0.8 - 1.1) | 1.2 (1.1 - 1.4)** |
| Black, hisp. | 0.7 (0.3 - 1.5) | 1 (0.5 - 2.0) |
| Asian | 0.6 (0.4 - 0.8)** | 0.6 (0.4 - 0.7)** |
| Other | 0.7 (0.5 - 1.0) | 0.9 (0.6 - 1.3) |
| **Education** | | |
| Less than H.S. | | (Ref.) |
| H.S. or GED | | 1.3 (1.1 - 1.5)** |
| Some college | | 2 (1.7 - 2.3)** |
| College grad. | | 2.5 (2.2 - 3.0)** |
| Edu. unknown | | 1.2 (0.7 - 2.1) |
| **Health insurance◊** | | 2.8 (2.4 - 3.4)** |
| **Married / cohab.** | | 1.4 (1.2 - 1.5)** |
| **BMI** | | |
| 25-29.9 | | (Ref.) |
| Less than 24.9 | | 0.8 (0.7 - 0.9)** |
| Greater than 30 | | 1.0 (0.9 - 1.2) |
| BMI unknown | | 0.2 (0.1 - 0.5)** |
| **Smoking** | | |
| Never | | (Ref.) |
| Former/unk. | | 1.4 (1.2 - 1.5)** |
| Current | | 0.9 (0.8 - 1.0) |
| **Survey year** | | |
| 2005 | | (Ref.) |
| 2010 | | 1.0 (0.9 - 1.1) |

* Significant at p<0.05; ** Significant at p<0.01.

Referent categories for each covariate above are: (age) 40-54 years old; (Family history of prostate cancer) none reported; (Race/Ethnicity) White, non-hispanic; (Education) Less than high school (h.s.) or no GED; (Health insurance) not covered; (Marital status) not married or not cohabitating with partner; (BMI) 25-29.9; (Health status) excellent; (smoking behavior) never smoked.

§ Odds ratios for all covariates in each model, and 95% confidence interval for odds ratio.

Δ Family history of prostate cancer in any first-degree male relative, i.e. father, brother(s), or son(s).

◊ Reports current health insurance coverage of any type.

**Table 4:** Influence of covariates on PSA-testing, by age group

| Covariate | Model: Age 40-54 yrs OR (95% CI) | Model: Age 55-69 yrs OR (95% CI) | Model: Age 70+ yrs OR (95% CI) |
|---|---|---|---|
| **Fam. hist. pr.can.Δ** | 2.5 (1.9 - 3.3)** | 1.9 (1.4 - 2.4)** | 2.1 (1.4 - 3.2)** |
| **Race & ethnicity** | | | |
| White, non-hisp | (Ref.) | (Ref.) | (Ref.) |
| White, hisp. | 0.8 (0.7 - 1.0) | 0.6 (0.5 - 0.8)** | 0.6 (0.4 - 0.9)* |
| Black, non-hisp. | 1.5 (1.2 - 1.9)** | 1 (0.8 - 1.3) | 0.9 (0.7 - 1.3) |
| Black, hisp. | 0.9 (0.3 - 2.7) | 1.2 (0.4 - 3.5) | 0.9 (0.1 - 6.8) |
| Asian | 0.6 (0.4 - 0.9)* | 0.6 (0.4 - 0.9)** | 0.4 (0.2 - 0.6)** |
| Other | 1.1 (0.6 - 1.8) | 0.9 (0.5 - 1.4) | 0.8 (0.3 - 2.0) |
| **Education** | | | |
| Less than H.S. | (Ref.) | (Ref.) | (Ref.) |
| H.S. or GED | 1.1 (0.8 - 1.4) | 1.3 (1.0 - 1.6)* | 1.4 (1.1 - 1.9)* |
| Some college | 1.9 (1.4 - 2.4)** | 1.7 (1.3 - 2.1)** | 2 (1.5 - 2.8)** |
| College grad. | 1.9 (1.4 - 2.6)** | 2.7 (2.1 - 3.5)** | 3.2 (2.4 - 4.5)** |
| Edu. unknown | 1.2 (0.5 - 3.1) | 1.5 (0.6 - 3.7) | 0.8 (0.3 - 2.4) |
| **Health insurance◊** | 3 (2.3 - 3.9)** | 2.8 (2.2 - 3.6)** | 3.5 (0.9 - 14.0) |
| **Married / cohab.** | 1.3 (1.1 - 1.6)** | 1.2 (1.1 - 1.4)** | 1.7 (1.4 - 2.0)** |
| **BMI** | | | |
| 25-29.9 | (Ref.) | (Ref.) | (Ref.) |
| Less than 24.9 | 0.9 (0.7 - 1.1) | 0.9 (0.7 - 1.0) | 0.7 (0.6 - 0.9)** |
| Greater than 30 | 1 (0.9 - 1.2) | 1 (0.9 - 1.2) | 1.1 (0.9 - 1.5) |
| BMI unknown | 0.1 (0.0 - 0.4)** | 0.3 (0.1 - 1.1) | 0.4 (0.2 - 1.1) |
| **Smoking** | | | |
| Never | (Ref.) | (Ref.) | (Ref.) |
| Former/unk. | 1.3 (1.1 - 1.5)** | 1.4 (1.2 - 1.6)** | 1.3 (1.1 - 1.7)* |
| Current | 1 (0.8 - 1.2) | 0.8 (0.7 - 1.0) | 0.7 (0.5 - 1.0) |
| **Survey year** | | | |
| 2005 | (Ref.) | (Ref.) | (Ref.) |
| 2010 | 0.9 (0.8 - 1.1) | 1 (0.9 - 1.2) | 1 (0.8 - 1.3) |

***** Significant at $p < 0.05$
** Significant at $p < 0.01$

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