

# Trends in Prostate-Specific Antigen Test Use, 2000–2005

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## SYNOPSIS

**Objective.** This study examined prostate-specific antigen (PSA) test use among men and identified sociodemographic and health-related characteristics associated with its use over time.

**Methods.** The National Health Interview Survey collected information on PSA test use among 16,058 men  $\geq 40$  years of age in 2000 and 2005. We examined two outcomes: (1) having had a recent (within two years) screening PSA test and (2) having had three or more PSA tests in the past five years (to indicate frequent use).

**Results.** Marital status, family history of prostate cancer, and having seen a doctor in the past year differed over time in the unadjusted model. In the adjusted model, recent PSA screening decreased from 2000 to 2005 for single, never-married men, but increased for men with chronic diseases. Frequent PSA test use increased for men with a family history of prostate cancer, men with chronic diseases, and men who had seen a physician in the past year. Significant correlates of higher recent PSA test use included being older, married, and of black race/ethnicity; having higher levels of education and income, health-care coverage, and a usual place of health care; and increased comorbidity.

**Conclusion.** Major organizations are not in agreement about the efficacy of prostate cancer screening; however, men  $\geq 40$  years of age continue to use the PSA test. Both recent screening and frequent testing showed variability during the study period and may have implications for the ongoing randomized clinical trials that are expected to clarify whether early detection of prostate cancer with PSA testing increases survival.

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Prostate cancer is the most common cancer among men in the United States and the second-leading cause of cancer deaths in this population after lung cancer.<sup>1,2</sup> The disease poses a burden for older men in general and black men in particular. Additionally, there are often morbidity-related issues from this disease and its treatment that affect men's quality of life.<sup>3,4</sup>

The prostate-specific antigen (PSA) test is routinely used as a screening tool to assist in the diagnosis of prostate cancer, and routine PSA-based screening has led to a dramatic increase in prostate cancer detection.<sup>5</sup> There is, however, some disagreement about the efficacy of such screening, as it has not been demonstrated in randomized clinical trials to improve survival.<sup>6</sup> In spite of the disagreement, PSA remains an important prognostic marker among men diagnosed with prostate cancer. While its sensitivity and specificity in detecting prostate cancer may not be optimal, it has reported clinical validity and is an important predictor of outcome.<sup>7,8</sup> Testing for PSA has profoundly affected the diagnosis, treatment, and monitoring of prostate cancer and has allowed physicians to detect prostate tumors while they are small, typically low-grade, and treatable.<sup>9,10</sup> There is, however, some debate that screening for these types of prostate cancer contributes to overdiagnosis or finding and treating cancers that may be insignificant compared with the risk of possible side effects from the treatment.<sup>9,11,12</sup>

Prostate cancer screening using the PSA test has varied by race/ethnicity, and some studies have suggested that black men have lower screening rates for prostate cancer than white men.<sup>13,14</sup> However, recent studies have found that PSA test use for screening has increased, especially among younger black men.<sup>15,16</sup> In addition to race/ethnicity, correlates of PSA test use include older age, higher socioeconomic status, being married, having a family history of prostate cancer, having health insurance coverage, and having a usual source of health care.<sup>17,18</sup>

The purpose of this study was to examine the use of the PSA test among men from a national survey conducted in 2000 and 2005 by sociodemographic and health characteristics. This analysis explored use of the PSA test for screening purposes within the past two years and the number of PSA tests during the past five years to determine correlates of both recency and frequency of PSA testing among men in the U.S.

## METHODS

We examined data from the National Health Interview Survey (NHIS), an annual health survey conducted by the National Center for Health Statistics. The sur-

vey includes core questions about the respondents' health, access to and use of health services, as well as demographic and socioeconomic characteristics. It also contains one or more annual supplements addressing particular health issues. In 2000 and 2005, the survey collected information related to cancer prevention and control.<sup>19,20</sup> Trained U.S. Census Bureau interviewers conducted in-person interviews. Black and Hispanic households were oversampled to obtain more precise estimates.<sup>19,20</sup> Response rates for the core survey and the cancer control supplement were 88.9% and 72.1%, respectively, in 2000, and 86.5% and 69.0%, respectively, in 2005.

## Study population

Only NHIS respondents who were male and  $\geq 40$  years of age were asked about their PSA test use. We focused on these men for our analysis. Many organizations that support prostate cancer screening recommend that annual testing begin at 50 years of age.<sup>21</sup> However, because black men and men with a family history of prostate cancer are at higher risk at younger ages, some organizations recommend offering PSA testing at an earlier age for these men.<sup>2</sup> Prior studies related to physician practices also indicate that many physicians begin prostate cancer screening at earlier ages,<sup>16,22</sup> and this sample allowed for examination of this pattern. We excluded men who self-reported a previous diagnosis of prostate cancer, as they were likely to have had PSA testing as part of their routine care.

The NHIS 2000 sample included 32,374 respondents, and the NHIS 2005 sample included 31,428 respondents. Participants were excluded if they were not male (2000:  $n=18,388$ ; 2005:  $n=17,666$ ), if they were  $< 40$  years of age (2000:  $n=5,889$ ; 2005:  $n=5,272$ ), or if they reported a diagnosis of prostate cancer (2000:  $n=225$ ; 2005:  $n=304$ ). Therefore, the analysis sample included a total of 16,058 respondents—7,872 men in 2000 and 8,186 men in 2005—weighted to represent more than 55 million men.

## Data collection

During both survey years, respondents were asked if they had ever undergone a PSA test and, if they had, the length of time since their most recent test. They were also asked how many PSA tests they had received in the past five years. From these questions, we created two PSA test use measures indicating (1) recent PSA test for screening purposes (as a routine test or screening test, or because of family history of prostate cancer) and (2) frequent use of the PSA test, defined as having had three or more tests in the previous five years. Recent PSA tests included tests within two years

prior to each survey. PSA tests for any purpose were included in the frequent-use measure, as respondents were not asked the reasons for having a PSA test other than for the most recent one.

We also used several variables in our analyses that were identified in the literature as possibly being related to PSA test use. They included age of respondent, race/ethnicity, marital status, education and income levels, region of the U.S., self-reported physical health, body mass index (BMI), health-care coverage, number of chronic diseases, family history of prostate cancer, usual place of health care, and having seen a doctor in the past year (Table 1).

### Data analysis

The NHIS used a stratified, multistage cluster sample.<sup>19,20</sup> We analyzed data using the SURVEYFREQ and SURVEYLOGISTIC procedures in SAS<sup>®</sup> version 9.2<sup>23</sup> to account for the stratified sampling design. We obtained sample weights from the NHIS public-use data file and divided by two for the combined years of data.<sup>19,20</sup> We examined the weighted percentages of men who reported a screening PSA test within the past two years (recent screening) and men who had undergone three or more PSA tests within the past five years (frequent testing) by sociodemographic, health, and health-care characteristics. Odds ratios (ORs) and 95% confidence intervals (CIs) were used to assess variability in the estimates of the percentages and to make general comparisons within and across groups.

We also examined interactions between each factor and time to determine whether PSA test use varied over time by specific characteristics. Overall statistical significance of the factors in predicting PSA test use was determined using the Wald Chi-square test. We conducted multivariate logistic regression analysis of the combined 2000 and 2005 data to obtain adjusted estimates of odds of each PSA test use measure by year and by sociodemographic and health-related factors. All statistical tests were two-sided with a significance level of  $\alpha=0.05$ .

### RESULTS

The combined number of men in the sample was 16,058. The large majority of these men were non-Hispanic white, married, had health-care coverage and a usual source of health care, and had seen a doctor within the past year (Table 1). For the recent-screening outcome (having had a screening PSA test in the past two years), we noted statistically significant differences across categories within year, age, race/ethnicity, marital status, education and income levels,

geographic region, BMI, number of chronic diseases, family history of cancer, having health-care coverage, having a usual place of health care, and having seen a doctor in the past year.

For the frequent-testing outcome (having had three or more PSA tests in the past five years), differences across categories within variables were similar to the recent-screening outcome, except for self-reported physical health, which was found to be significant for this variable, and income, which was not significant (Table 1).

Table 2 examines both outcomes by year to determine trends by specific characteristics. From 2000 to 2005, we noted variations in receipt of a recent screening PSA test for the variable marital status. Recent screening PSA tests declined in the single, never-married category from 20.6% in 2000 to 15.2% in 2005, while use among those married increased from 29.9% to 32.6% in the same periods.

Similarly, the receipt of three or more PSA tests in the past five years increased among those with a known family history of prostate cancer and those who had seen a doctor in the past year, while remaining relatively stable among those without these characteristics. For this outcome, no other variables were found to differ significantly from 2000 to 2005.

After adjusting for all characteristics in the multivariate model (Table 3), higher odds of having had a recent PSA screening were associated with being 50–64 years of age (OR=3.94; 95% CI 3.46, 4.49), 65–79 years of age (OR=6.74; 95% CI 5.73, 7.93), and  $\geq 80$  years of age (OR=4.09; 95% CI 3.18, 5.26); black race/ethnicity (OR=1.35; 95% CI 1.13, 1.61); higher levels of education and income; living in the southern region of the U.S. (OR=1.31; 95% CI 1.13, 1.51); good and better self-reported health status; two or more chronic diseases (2000) and one or more chronic diseases (2005); having a family history of prostate cancer (2000) (OR=1.97; 95% CI 1.63, 2.39); having a usual place of health care (OR=2.20; 95% CI 1.74, 2.80); and having seen a doctor in the past year (OR=2.81; 95% CI 2.48, 3.18). Non-Hispanic men of other race/ethnicity (OR=0.73; 95% CI 0.55, 0.95), widowed men (OR=0.75; 95% CI 0.59, 0.95), never-married men (2005) (OR=0.59; 95% CI 0.46, 0.76), and men without health-care coverage (OR=0.54; 95% CI 0.43, 0.68) had lower odds of having had a recent screening compared with their referents.

Results for the frequent-testing outcome (having had three or more PSA tests in the past five years) mirrored those for the recent-screening outcome (having had a screening PSA test in the past two years) with a few exceptions. Frequent PSA test use was lower for

**Table 1. PSA test use among men  $\geq 40$  years of age with no prostate cancer (n=16,058), by demographic and health characteristics: NHIS 2000 and 2005**

Characteristic	Screening PSA test in past two years (recent screening) <sup>a</sup>			$\geq 3$ PSA tests in past five years (frequent testing)			
	N <sup>b</sup>	Percent <sup>c</sup>	OR (95% CI) <sup>d</sup>	P-value <sup>d</sup>	Percent <sup>c</sup>	OR (95% CI) <sup>d</sup>	P-value <sup>d</sup>
Year							
2000	7,872	28.2	Ref.	<0.001	18.0	Ref.	0.001
2005	8,186	29.8	1.15 (1.06, 1.25)		19.6	1.17 (1.07, 1.29)	
Age (in years)							
40–49	5,651	12.7	Ref.	<0.001	4.5	Ref.	<0.001
50–64	6,132	35.7	4.04 (3.61, 4.52)		22.3	6.45 (5.54, 7.51)	
65–79	3,334	48.0	7.07 (6.24, 8.02)		39.1	15.72 (13.40, 18.45)	
$\geq 80$	941	32.5	3.90 (3.26, 4.67)		27.4	9.55 (7.77, 11.73)	
Race/ethnicity							
White non-Hispanic	11,534	30.6	Ref.	<0.001	20.7	Ref.	<0.001
Black non-Hispanic	1,883	29.3	0.95 (0.82, 1.09)		16.0	0.73 (0.62, 0.86)	
Hispanic	2,087	18.8	0.51 (0.44, 0.58)		9.5	0.39 (0.33, 0.47)	
Other race (non-Hispanic)	554	20.4	0.58 (0.46, 0.74)		11.6	0.50 (0.37, 0.69)	
Marital status							
Married/unmarried couple	10,086	31.3	Ref.	<0.001	20.5	Ref.	<0.001
Divorced/separated	3,026	21.9	0.62 (0.56, 0.70)		13.1	0.59 (0.53, 0.67)	
Widowed	1,120	30.9	1.09 (0.94, 1.27)		24.5	1.41 (1.20, 1.66)	
Never married	1,746	17.6	0.46 (0.40, 0.54)		8.8	0.37 (0.31, 0.45)	
Education							
<High school	3,230	21.9	Ref.	<0.001	13.3	Ref.	<0.001
High school graduate	4,564	25.5	1.22 (1.08, 1.38)		16.3	1.26 (1.08, 1.47)	
Attended college or technical school	2,559	30.7	1.60 (1.38, 1.84)		20.6	1.69 (1.43, 1.99)	
College or technical school graduate	5,513	34.9	1.92 (1.71, 2.17)		23.0	1.94 (1.68, 2.23)	
Total family income							
<\$35,000 <sup>e</sup>	7,894	27.4	Ref.	<0.001	18.0	Ref.	0.051
\$35,000–\$74,999	4,089	28.1	0.98 (0.88, 1.09)		18.7	0.99 (0.88, 1.12)	
$\geq$ \$75,000	3,113	33.3	1.29 (1.16, 1.44)		20.6	1.14 (1.01, 1.29)	
Region							
Midwest	3,727	27.7	Ref.	<0.001	17.2	Ref.	<0.001
Northeast	2,977	30.5	1.19 (1.04, 1.35)		20.9	1.33 (1.14, 1.55)	
South	5,709	31.3	1.19 (1.08, 1.32)		20.6	1.25 (1.10, 1.42)	
West	3,645	25.5	0.91 (0.80, 1.05)		16.0	0.93 (0.79, 1.11)	

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**Table 1 (continued). PSA test use among men  $\geq 40$  years of age with no prostate cancer (n=16,058), by demographic and health characteristics: NHIS 2000 and 2005**

Characteristic	Screening PSA test in past two years (recent screening) <sup>b</sup>			$\geq 3$ PSA tests in past five years (frequent testing)			
	N <sup>b</sup>	Percent <sup>c</sup>	OR (95% CI) <sup>d</sup>	P-value <sup>d</sup>	Percent <sup>c</sup>	OR (95% CI) <sup>d</sup>	P-value <sup>d</sup>
Self-reported physical health				0.199			<0.001
Excellent	3,776	27.9	Ref.		16.7	Ref.	
Very good	4,858	30.2	1.13 (1.01, 1.26)		20.0	1.26 (1.11, 1.42)	
Good	4,610	29.1	1.10 (0.98, 1.24)		18.6	1.18 (1.04, 1.33)	
Fair/poor	2,794	28.7	1.11 (0.97, 1.26)		20.7	1.39 (1.21, 1.59)	
Body mass index				0.002			<0.001
Underweight to normal: <25.0 kg/m <sup>2</sup>	4,655	27.3	Ref.		16.9	Ref.	
Overweight: 25.0–29.9 kg/m <sup>2</sup>	7,197	30.6	1.16 (1.05, 1.28)		20.3	1.24 (1.11, 1.39)	
Obese: $\geq 30.0$ kg/m <sup>2</sup>	3,815	30.5	1.17 (1.06, 1.29)		20.1	1.22 (1.09, 1.38)	
Health-care coverage				<0.001			<0.001
Yes	14,013	31.6	Ref.		20.8	Ref.	
No	1,983	8.6	0.19 (0.16, 0.24)		3.3	0.13 (0.09, 0.17)	
Number of chronic diseases				<0.001			<0.001
0	7,897	21.5	Ref.		11.8	Ref.	
1	4,218	34.0	1.92 (1.75, 2.11)		22.3	2.17 (1.93, 2.45)	
2	2,001	38.0	2.45 (2.16, 2.78)		28.3	3.21 (2.80, 3.68)	
$\geq 3$	1,942	41.4	2.81 (2.48, 3.19)		32.2	3.86 (3.37, 4.42)	
Family history of prostate cancer				<0.001			<0.001
No	15,167	27.9	Ref.		18.0	Ref.	
Yes	891	46.8	2.07 (1.76, 2.45)		32.8	2.05 (1.74, 2.42)	
Usual place of health care				<0.001			<0.001
No	2,072	7.8	Ref.		3.0	Ref.	
Yes	13,854	32.1	5.96 (4.88, 7.27)		21.2	9.13 (6.96, 11.97)	
Seen doctor in past year				<0.001			<0.001
No	4,876	12.6	Ref.		7.1	Ref.	
Yes	10,992	36.4	4.16 (3.74, 4.63)		24.1	4.33 (3.80, 4.93)	

<sup>a</sup>Screening PSA test indicates that the reason for most recent PSA test within two years was routine screening.

<sup>b</sup>Numbers that do not add up to total indicate missing values.

<sup>c</sup>Percentages are weighted to reflect the entire population.

<sup>d</sup>Unadjusted ORs and p-values obtained from logistic regression using non-missing values. P-values compare percentages within levels of each category.

<sup>e</sup>Income level of <\$35,000 includes those who reported income as  $\geq$ \$20,000.

PSA = prostate-specific antigen

NHIS = National Health Interview Survey

OR = odds ratio

CI = confidence interval

Ref. = referent group

kg/m<sup>2</sup> = kilograms/meter squared

**Table 2. Comparison of 2000 and 2005 trends in PSA test use among men ≥40 years of age: NHIS 2000 and 2005**

Characteristic	2000			2005			P-value <sup>a</sup>
	N	Screening PSA test in past five years (frequent testing)		N	Screening PSA test in past two years (recent screening)		
		Percent (95% CI)	Percent (95% CI)		Percent (95% CI)	Percent (95% CI)	
Age (in years)							
40-49	2,874	12.6 (11.1, 14.1)	4.1 (3.4, 4.8)	2,777	12.9 (11.5, 14.2)	4.8 (3.9, 5.7)	0.380
50-64	2,864	34.7 (32.6, 36.8)	22.1 (20.1, 24.1)	3,268	36.5 (34.6, 38.4)	22.5 (20.9, 24.2)	
65-79	1,710	47.5 (44.8, 50.2)	37.4 (34.7, 40.1)	1,624	48.4 (45.8, 50.9)	40.8 (38.2, 43.5)	
≥80	424	29.4 (24.7, 34.1)	23.6 (19.1, 28.2)	517	34.9 (30.4, 39.3)	30.3 (26.2, 34.5)	
Race/ethnicity							
White non-Hispanic	5,682	29.5 (28.1, 30.9)	19.5 (18.3, 20.8)	5,852	31.7 (30.3, 33.1)	21.7 (20.5, 22.9)	0.496
Black non-Hispanic	898	30.0 (26.0, 33.9)	16.3 (13.0, 19.5)	985	28.8 (25.3, 32.2)	15.8 (12.9, 18.7)	
Hispanic	1,032	18.1 (15.4, 20.8)	9.4 (7.2, 11.7)	1,055	19.3 (16.3, 22.3)	9.5 (7.5, 11.4)	
Other race (non-Hispanic)	260	19.6 (13.9, 25.4)	10.2 (6.0, 14.4)	294	21.2 (14.8, 27.5)	12.8 (8.0, 17.7)	
Marital status							
Married/unmarried couple	4,997	29.9 (28.4, 31.3)	19.3 (18.0, 20.7)	5,089	32.6 (31.2, 34.0)	21.6 (20.3, 22.8)	<0.001
Divorced/separated	1,433	21.2 (18.5, 23.9)	12.7 (10.7, 14.7)	1,593	22.5 (20.2, 24.8)	13.4 (11.6, 15.2)	
Widowed	584	31.3 (27.2, 35.4)	23.5 (19.9, 27.2)	536	30.5 (26.2, 34.7)	25.4 (21.5, 29.3)	
Never married	827	20.6 (17.5, 23.8)	9.5 (7.2, 11.7)	919	15.2 (12.6, 17.8)	8.3 (6.6, 10.0)	
Education							
<High school	1,752	21.8 (19.4, 24.1)	13.4 (11.5, 15.3)	1,478	22.0 (19.5, 24.4)	13.2 (11.2, 15.2)	0.135
High school graduate	2,201	25.5 (23.3, 27.7)	15.7 (13.9, 17.5)	2,363	25.5 (23.6, 27.4)	16.8 (15.0, 18.5)	
Attended college or technical school	1,255	30.1 (27.3, 32.9)	19.6 (17.3, 21.9)	1,304	31.2 (28.3, 34.0)	21.4 (18.9, 24.0)	
College or technical school graduate	2,563	33.3 (30.9, 35.6)	21.9 (19.9, 23.8)	2,950	36.2 (34.3, 38.1)	23.9 (22.2, 25.6)	
Total family income							
<\$35,000	4,032	27.1 (25.3, 28.9)	17.8 (16.2, 19.5)	3,862	27.6 (25.9, 29.3)	18.1 (16.6, 19.6)	0.637
\$35,000-\$74,999	2,064	26.4 (24.2, 28.7)	17.4 (15.3, 19.4)	2,025	29.7 (27.4, 31.9)	19.9 (18.0, 21.8)	
≥\$75,000	1,314	32.3 (29.7, 34.9)	19.3 (17.1, 21.4)	1,799	34.0 (31.6, 36.5)	21.6 (19.4, 23.7)	
Region							
Midwest	1,846	27.4 (25.5, 29.4)	16.2 (14.4, 18.0)	1,881	27.9 (25.8, 30.0)	18.2 (16.1, 20.3)	0.759
Northeast	1,457	29.0 (26.0, 32.1)	19.9 (17.0, 22.9)	1,520	31.7 (29.0, 34.4)	21.8 (19.4, 24.2)	
South	2,810	30.5 (28.2, 32.8)	19.8 (17.8, 21.8)	2,899	32.1 (30.2, 34.1)	21.3 (19.6, 23.0)	
West	1,759	24.3 (21.7, 26.9)	15.3 (13.2, 17.4)	1,886	26.6 (23.9, 29.2)	16.7 (14.6, 18.8)	

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**Table 2 (continued). Comparison of 2000 and 2005 trends in PSA test use among men  $\geq 40$  years of age: NHIS 2000 and 2005**

Characteristic	2000			2005			P-value <sup>a</sup>
	N	Percent (95% CI)	Screening PSA test in past two years (recent screening)	N	Percent (95% CI)	Screening PSA test in past two years (recent screening)	
Self-reported physical health							
Excellent	1,960	26.9 (24.9, 29.0)	15.9 (14.2, 17.6)	1,816	28.8 (26.2, 31.3)	17.5 (15.6, 19.3)	0.694
Very good	2,352	29.7 (27.4, 32.0)	19.4 (17.5, 21.3)	2,506	30.6 (28.6, 32.7)	20.6 (18.7, 22.4)	
Good	2,200	28.1 (25.8, 30.4)	17.3 (15.3, 19.2)	2,410	30.0 (27.8, 32.2)	19.7 (18.0, 21.4)	
Fair/poor	1,347	27.6 (24.7, 30.6)	20.1 (17.4, 22.9)	1,447	29.7 (26.7, 32.6)	21.2 (18.5, 23.8)	
Body mass index							
Underweight to normal: <25.0 kg/m <sup>2</sup>	2,405	26.3 (24.2, 28.4)	16.6 (14.9, 18.3)	2,250	28.3 (26.2, 30.5)	17.1 (15.4, 18.9)	0.357
Overweight: 25.0–29.9 kg/m <sup>2</sup>	3,555	29.6 (27.7, 31.5)	19.2 (17.7, 20.8)	3,642	31.5 (29.7, 33.2)	21.3 (19.7, 22.9)	
Obese: $\geq 30.0$ kg/m <sup>2</sup>	1,736	30.0 (27.3, 32.8)	18.9 (16.7, 21.0)	2,079	30.9 (28.6, 33.2)	21.0 (18.9, 23.0)	
Health-care coverage							
Yes	6,896	30.7 (29.4, 32.1)	19.8 (18.6, 21.1)	7,117	32.4 (31.1, 33.7)	21.7 (20.6, 22.8)	0.139
No	940	6.8 (4.8, 8.8)	2.7 (1.5, 4.0)	1,043	10.2 (8.1, 12.3)	3.8 (2.4, 5.3)	
Number of chronic diseases							
0	4,003	21.7 (20.2, 23.2)	12.2 (11.0, 13.4)	3,894	21.4 (19.9, 22.9)	11.5 (10.3, 12.6)	0.328
1	2,079	31.1 (28.8, 33.4)	19.3 (17.3, 21.2)	2,139	36.6 (34.3, 39.0)	25.0 (22.8, 27.2)	
2	899	41.5 (38.0, 45.1)	30.9 (27.2, 34.6)	1,102	35.4 (32.2, 38.6)	26.4 (23.5, 29.4)	
$\geq 3$	891	39.5 (35.8, 43.3)	30.5 (26.6, 34.3)	1,051	42.9 (39.4, 46.4)	33.5 (30.1, 37.0)	
Family history of prostate cancer							
No	7,441	27.2 (25.9, 28.5)	17.5 (16.4, 18.6)	7,726	28.6 (27.4, 29.7)	18.4 (17.4, 19.4)	0.489
Yes	431	44.0 (38.9, 49.2)	25.9 (21.3, 30.5)	460	49.1 (43.7, 54.6)	38.9 (33.9, 43.9)	
Usual place of health care							
No	1,047	7.3 (5.3, 9.2)	3.4 (2.1, 4.7)	1,025	8.3 (6.3, 10.4)	2.7 (1.6, 3.7)	0.175
Yes	6,780	31.3 (29.9, 32.6)	20.2 (18.9, 21.4)	7,074	32.9 (31.6, 34.2)	22.1 (20.9, 23.2)	
Seen doctor in past year							
No	2,456	12.9 (11.3, 14.5)	8.0 (6.7, 9.3)	2,420	12.4 (10.9, 13.8)	6.3 (5.3, 7.3)	0.001
Yes	5,350	35.2 (33.6, 36.9)	22.6 (21.2, 24.1)	5,642	37.4 (36.0, 38.9)	25.4 (24.0, 26.8)	

<sup>a</sup>P-value compares receipt of PSA test within subgroups in 2000 and 2005 from weighted logistic regression; test of interaction between characteristic and time.

PSA = prostate-specific antigen

NHIS = National Health Interview Survey

CI = confidence interval

kg/m<sup>2</sup> = kilograms/meter squared

**Table 3. Multivariate logistic regression model of PSA test use among men ≥40 years of age with no prostate cancer, NHIS 2000 and 2005**

Characteristic	Screening PSA test in past two years (recent screening) n <sup>a</sup> =3,581		≥3 PSA tests in past five years (frequent testing) n <sup>a</sup> =13,481	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Year (2000 vs. 2005) <sup>b</sup>				
Marital status				
Married/unmarried couple	1.05 (0.90, 1.22)	0.563	NA	
Divorced/separated	1.02 (0.77, 1.35)	0.867	NA	
Widowed	1.10 (0.78, 1.54)	0.594	NA	
Never married	0.53 (0.39, 0.73)	<0.001	NA	
Number of chronic diseases				
0	1.05 (0.90, 1.22)	0.563	0.68 (0.50, 0.92)	0.012
1	1.45 (1.21, 1.73)	<0.001	1.05 (0.76, 1.46)	0.777
2	0.89 (0.69, 1.14)	0.342	0.59 (0.40, 0.87)	0.008
≥3	1.31 (1.03, 1.67)	0.030	0.83 (0.56, 1.23)	0.359
Family history of prostate cancer				
No			0.68 (0.50, 0.92)	0.012
Yes			1.11 (0.70, 1.74)	0.663
Seen doctor in past year				
No			0.68 (0.50, 0.92)	0.012
Yes			0.96 (0.79, 1.17)	0.681
Age (in years)		<0.001		<0.001
40–49	Ref.		Ref.	
50–64	3.94 (3.46, 4.49)		5.86 (4.94, 6.94)	
65–79	6.74 (5.73, 7.93)		15.07 (12.24, 18.56)	
≥80	4.09 (3.18, 5.26)		9.84 (7.52, 12.88)	
Race/ethnicity		<0.001		0.039
White non-Hispanic	Ref.		Ref.	
Black non-Hispanic	1.35 (1.13, 1.61)		1.08 (0.89, 1.30)	
Hispanic	0.97 (0.81, 1.15)		0.79 (0.64, 0.97)	
Other race (non-Hispanic)	0.73 (0.55, 0.95)		0.70 (0.49, 1.01)	
Marital status: 2000 <sup>c</sup>		0.026		0.003
Married/unmarried couple	Ref.		Ref.	
Divorced/separated	0.88 (0.72, 1.07)		0.86 (0.74, 1.00)	
Widowed	0.75 (0.59, 0.95)		0.85 (0.70, 1.03)	
Never married	1.16 (0.93, 1.45)		0.74 (0.59, 0.92)	
Marital status: 2005 <sup>c</sup>		<0.001		
Married/unmarried couple	Ref.		NA	
Divorced/separated	0.86 (0.71, 1.04)		NA	
Widowed	0.78 (0.61, 1.01)		NA	
Never married	0.59 (0.46, 0.76)		NA	
Education		<0.001		<0.001
<High school	Ref.		Ref.	
High school graduate	1.39 (1.21, 1.61)		1.59 (1.32, 1.91)	
Attended college or technical school	1.82 (1.53, 2.17)		2.23 (1.83, 2.72)	
College or technical school graduate	2.08 (1.78, 2.42)		2.46 (2.05, 2.96)	
Total family income		0.025		0.009
<\$35,000	Ref.		Ref.	
\$35,000–\$74,999	1.06 (0.93, 1.21)		1.18 (1.02, 1.36)	
≥\$75,000	1.23 (1.06, 1.43)		1.28 (1.08, 1.51)	
Region		<0.001		<0.001
Midwest	1.00 (0.85, 1.18)		1.04 (0.85, 1.28)	
Northeast	1.09 (0.92, 1.29)		1.25 (1.02, 1.54)	
South	1.31 (1.13, 1.51)		1.41 (1.18, 1.69)	
West	Ref.		Ref.	

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**Table 3 (continued). Multivariate logistic regression model of PSA test use among men  $\geq 40$  years of age with no prostate cancer, NHIS 2000 and 2005**

Characteristic	Screening PSA test in past two years (recent screening) n <sup>a</sup> =3,581		$\geq 3$ PSA tests in past five years (frequent testing) n <sup>a</sup> =13,481	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Self-reported physical health		<0.001		<0.001
Excellent	1.71 (1.43, 2.04)		1.49 (1.23, 1.80)	
Very good	1.51 (1.28, 1.77)		1.35 (1.13, 1.62)	
Good	1.28 (1.11, 1.49)		1.02 (0.86, 1.20)	
Fair/poor	Ref.		Ref.	
Body mass index		0.509		0.010
Underweight to normal: <25.0 kg/m <sup>2</sup>	Ref.		Ref.	
Overweight: 25.0–29.9 kg/m <sup>2</sup>	1.07 (0.95, 1.20)		1.22 (1.07, 1.39)	
Obese: $\geq 30.0$ kg/m <sup>2</sup>	1.04 (0.92, 1.19)		1.21 (1.04, 1.41)	
Health-care coverage		<0.001		<0.001
Yes	Ref.		Ref.	
No	0.54 (0.43, 0.68)		0.47 (0.34, 0.65)	
Number of chronic diseases: 2000		<0.001		<0.001
0	Ref.		Ref.	
1	1.11 (0.96, 1.30)		1.17 (0.97, 1.40)	
2	1.59 (1.28, 1.96)		1.88 (1.47, 2.40)	
$\geq 3$	1.34 (1.07, 1.67)		1.66 (1.26, 2.19)	
Number of chronic diseases: 2005		<0.001		<0.001
0	Ref.		Ref.	
1	1.54 (1.31, 1.81)		1.80 (1.47, 2.21)	
2	1.35 (1.09, 1.66)		1.63 (1.30, 2.05)	
$\geq 3$	1.68 (1.35, 2.09)		2.03 (1.58, 2.61)	
Family history of prostate cancer: 2000 <sup>d</sup>		<0.001		0.005
No	Ref.		Ref.	
Yes	1.97 (1.63, 2.39)		1.50 (1.13, 2.01)	
Family history of prostate cancer: 2005 <sup>d</sup>				<0.001
No			Ref.	
Yes			2.45 (1.89, 3.18)	
Usual place of health care		<0.001		<0.001
No	Ref.		Ref.	
Yes	2.20 (1.74, 2.80)		3.28 (2.40, 4.48)	
Seen doctor in past year: 2000 <sup>d</sup>		<0.001		<0.001
No	Ref.		Ref.	
Yes	2.81 (2.49, 3.18)		2.06 (1.67, 2.55)	
Seen doctor in past year: 2005 <sup>d</sup>				<0.001
No			Ref.	
Yes			2.92 (2.33, 3.67)	

<sup>a</sup>Unweighted<sup>b</sup>No significant interactions with year for family history of prostate cancer and having seen a doctor in the past year for recent-screening outcome; no significant interactions with year for marital status for frequent-testing outcome<sup>c</sup>ORs for marital status for receipt of  $\geq 3$  PSA tests in the past five years were the same for 2000 and 2005; no significant interaction.<sup>d</sup>ORs for family history of prostate cancer and seen doctor in the past year for receipt of a screening PSA test in the past two years were the same for 2000 and 2005; no significant interaction.

PSA = prostate-specific antigen

NHIS = National Health Interview Survey

OR = odds ratio

CI = confidence interval

NA = not applicable

kg/m<sup>2</sup> = kilograms/meter squared

Ref. = reference group

Hispanic men (OR=0.79; 95% CI 0.64, 0.97) compared with non-Hispanic white men, and for never-married men (OR=0.74; 95% CI 0.59, 0.92) compared with married men. Frequent PSA test use was higher for both overweight (OR=1.22; 95% CI 1.07, 1.39) and obese (OR=1.21; 95% CI 1.04, 1.41) men compared with underweight men and men with a normal BMI. Men with a family history of prostate cancer had higher odds of frequent PSA testing than men without a family history of prostate cancer in both years; however, the magnitude was greater in 2005 (OR=2.45; 95% CI 1.89, 3.18) (Table 3).

Multivariate logistic regression revealed significant interactions with year (2000 vs. 2005, Table 3) for marital status and for number of chronic diseases when we examined the recent-screening outcome. Similarly, we found significant interactions with year for the frequent-testing outcome for number of chronic diseases, family history, and having seen a doctor in the past year. Therefore, all results for year trends are reported based on these categories.

Single, never-married men had a 47% decrease in odds of a recent screening PSA test from 2000 to 2005, while individuals with one chronic disease had a 45% increase in odds of a recent screening PSA test during the same period. Additionally, men with three or more chronic diseases had a 31% increase in odds of recent screening from 2000 to 2005. Trends were different for frequent PSA testing, which declined among individuals with no chronic disease (32% lower odds) and among individuals with two chronic diseases (41% lower odds) from 2000 to 2005. We also saw declines in frequent PSA testing for individuals with no family history of prostate cancer (32% lower odds) and those who had not seen a doctor in the past year (32% lower odds), while individuals with a family history of prostate cancer and those who had seen a doctor in the past year showed no change during the study period.

## DISCUSSION

Many studies have examined PSA test use patterns, but few have examined PSA test use over time.<sup>17,24,25</sup> The PSA test (along with the digital rectal examination) is associated with early detection of prostate cancer.<sup>2</sup> Some organizations, such as the American Cancer Society, recommend that prostate cancer screening tests—including the PSA test—be offered to men  $\geq 50$  years of age, and earlier for men at higher risk, such as black men and men with a positive family history of prostate cancer.<sup>2</sup> The U.S. Preventive Services Task Force (USPSTF) concluded that the evidence was insufficient to advocate for or against routine prostate

cancer screening using the PSA test and digital rectal examination.<sup>26</sup> Most organizations recommend some form of shared decision-making between physician and patient.<sup>21</sup>

Actual test use may not conform to the USPSTF's recommendation against screening in men  $\geq 75$  years of age.<sup>26</sup> In the adjusted model, both outcomes (recent screening and frequent PSA test use) increased for all age categories except  $\geq 80$  years of age. This pattern is expected, as more opportunities to discuss and undergo a PSA test present themselves with advanced age. For men  $\geq 80$  years of age, this pattern also shows lower screening and frequent PSA test use compared with men 65–79 years of age, but higher use than the referent group (i.e., men 40–49 years of age).

Black men were more likely to have had a recent screening PSA test compared with white men, but there was no difference between these racial/ethnic groups for the frequent-testing outcome. In a trend study that examined the period 1995–2004, primary care providers ordered PSA tests for age-appropriate men at an increase of 8% or more per year, with more dramatic increases seen in black men and men with health-care insurance.<sup>6</sup> This finding may mean, in part, that physicians are becoming aware of the higher incidence and mortality of prostate cancer among black men compared with white men.

Although no difference was found between white and Hispanic men for the recent-screening outcome, Hispanic men were less likely to have had frequent PSA test use compared with white men. Presently, Hispanic men are at lower risk of both prostate cancer incidence and mortality compared with white men.<sup>2</sup>

Findings from this study also offered information about marital status and PSA test use. Recent PSA test use declined from 2000 to 2005 for men who were single and never married. This pattern of decline in recent PSA screening among single, never-married men suggests that men in this group should discuss PSA testing with their physicians. The pattern of unmarried men having low PSA test use has also been found in other studies.<sup>27,28</sup> It appears that marriage may be associated with higher use of preventive health-care services.<sup>29</sup>

In our study, both the recent-screening and frequent-testing outcomes were associated with higher levels of education and income. Also, the variables residing in the southern region and having health-care coverage, one or more chronic diseases, good or better health status, a usual place of health care, a known family history of prostate cancer, and seen a doctor in the past year were associated with both higher recent PSA screenings and more frequent test use compared with

their referents. In a different national study, older age, higher levels of education, and having health insurance and a usual source of care were positively associated with having a PSA test.<sup>17</sup>

Overall, the number of chronic diseases played an important role for both recent PSA screening and frequent PSA testing during 2000 and 2005. During the five-year period, the number of chronic diseases was associated with an increase in recent PSA screening; however, it was associated with a decrease in the frequent-testing outcome. For the recent-screening outcome, having one or more chronic diseases may have provided greater opportunity for more interaction with the health-care system and, thus, more opportunities for screening.

Our study also found that men who were overweight (BMI 25.0–29.9 kilograms/meters squared [ $\text{kg}/\text{m}^2$ ]) or obese (BMI  $\geq 30.0 \text{ kg}/\text{m}^2$ ) reported more frequent PSA tests than men with normal BMI ( $< 25.0 \text{ kg}/\text{m}^2$ ). Similar positive associations between PSA testing and BMI have been shown in prior studies of black and white men.<sup>30,31</sup> High BMI has been associated with higher-grade tumors, poorer outcomes, and higher mortality due to prostate cancer;<sup>32</sup> yet, the reason for higher testing or screening use among overweight and obese men has not been clearly established.<sup>33</sup> It may be that more frequent testing in these men may be driven by more visits to health-care providers, due to other existing comorbid conditions.

Our finding of a positive association between family history of prostate cancer and PSA testing has also been confirmed in other studies.<sup>17,18</sup> However, one recent study examining the probability of ever having a PSA test found an association for white men but not black men; that is, black men with a family history of prostate cancer were not more likely to have ever had a PSA test than black men with no family history of prostate cancer.<sup>34</sup> Also, another study found that there was a significant association between both age and family history and recent PSA testing; that is, the association between family history of prostate cancer and recent PSA testing was significant for men  $\geq 50$  years of age but not for younger men.<sup>35</sup> In our study, more frequent PSA test use decreased during the study period among men with no family history of prostate cancer.

### Strengths and limitations

This study had several strengths. Data were from large, nationally representative surveys. These cross-sectional surveys, conducted five years apart, collected information on several aspects of PSA test use, including recent (within the past two years) PSA test use for screening purposes, as well as the number of PSA tests taken in the past five years. These categories allowed examina-

tion of more than one form of utilization. The NHIS 2000 and 2005 data collections oversampled both black and Hispanic populations to produce more precise estimates of use among these understudied populations. We were also able to examine interactions between year and factors that may help to clarify the use of PSA tests.

The study also had several limitations. The main limitation was the reliance on self-report of PSA test use. Studies have shown less reliability of self-report when compared with medical records.<sup>36,37</sup> Despite the lower reliability, self-reports are useful and show great potential in conducting health research.<sup>38</sup> There also may have been an underestimation of how much time had passed since a respondent's last PSA test.<sup>39</sup> Also, the NHIS questions asked the reason for the most recent PSA test only, so we do not know for sure if the previous tests were used for PSA screening or for some other purpose.

Additionally, we were able to offer little information on the other race (non-Hispanic) group, which included Asian Americans, American Indians/Alaska Natives, Hawaiian/Pacific Islanders, and other groups, due to small sample sizes. Findings reflected a five-year pattern only, and these results may be subject to change when additional years of data are examined. Finally, the survey response rates declined slightly from 2000 (72.1%) to 2005 (69.0%). Sampling weights reflective of the national population were used during both years of data collection; therefore, this slight decline in response rates should have had no effect on our results.

### CONCLUSIONS

Findings from this study could have important implications for medical and public health professionals. Using nationally representative data, the study adds some clarity to PSA test use among men of black, white, and Hispanic race/ethnicity (the latter of which has been understudied in the prostate cancer literature) and other factors, including having seen a doctor in the past year and having a family history of prostate cancer. The fact that there has been variability in factors (increases in some and decreases in others) associated with recent screening PSA test use and frequent PSA test use alerts us that PSA testing is highly complex and invokes us to examine this variation in different ways for better understanding. Results from ongoing randomized, controlled trials may help to clarify the importance of the increase or decrease in PSA test use.

Despite inconclusive evidence that PSA test use is beneficial, physicians and patients may be recognizing that (1) frequent visits, especially preventive health

visits, are important, and (2) men with a known family history of prostate cancer are at increased risk for the disease. Both factors provide opportunity for discussions about prostate cancer and decisions about screening.

This research was supported by the Department of Defense, U.S. Army Medical Research and Materiel Command, contract #W81XWH-07-1-0350 and grant #PC060224.

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Department of Defense, U.S. Army Medical Research and Materiel Command.

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