Does a prior cancer diagnosis impact PSA testing? Results from the National Health Interview Survey

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Introduction: *Prostate-specific antigen (PSA) testing remains a controversial issue. However, most urological guidelines recommend PSA testing in men aged 55-69 through a shared decision-making process with the patient. The impact of prior cancer diagnosis on PSA testing is not well-known. To compare PSA testing in men aged 55-69 years with and without a history of cancer (excluding prostate cancer patients).*

Materials and methods: *Utilizing the National Health Interview Survey (NHIS), a retrospective cross-sectional study during the year 2018 was carried out. Multivariable logistic regression analysis was implemented to demonstrate potential associations with PSA testing and assess the association of cancer history.*

Results: *A total of 2,892 men aged 55-69 years from the NHIS survey who met the inclusion criteria were analyzed. A total of 308 (10.7%) men had a history of cancer (non-prostate). Men with a cancer history had a higher number of PSA tests and more recent testing than men with no previous cancer history. On multivariable analysis, men who were previously diagnosed with cancer had a higher likelihood of undergoing PSA testing compared to men with no history of cancer (OR: 1.87, 95% CI 1.39-2.52, $p < 0.0001$).*

Conclusions: *Our data suggest that men aged 55-69 with a history of cancer are more likely to undergo PSA testing than men with no cancer history.*

Key Words: prostate cancer, prostate-specific antigen, cancer

Introduction

Cancer screening for various malignancies has been shown to enable early cancer diagnosis, allow higher rates of cure and save lives. However, screening can potentially lead to overdiagnosis and overtreatment. This has been a controversial issue, especially in prostate cancer.[1]

Prostate cancer is the most common cancer and the second leading cause of cancer death among men in the United States.[2] The American Cancer Society estimates the numbers of new cancer cases and deaths in the United States and compiles the most recent data on population-based cancer occurrence.[3]

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In 2021, 1,898,160 new cancer cases and 608,570 cancer deaths are projected to occur in the United States alone. After continuing to rise during most of the 20th century, the cancer death rate has fallen continuously from its peak in 1991 through 2018, demonstrating a decline rate of 31%.[2] This is proposed to be due to reductions in smoking and improvements in early detection and treatment. This translates to 3.2 million fewer cancer deaths than would have occurred if peak rates had persisted.[2]

Prostate-specific antigen (PSA) testing is the most commonly utilized tool for prostate cancer screening.[4] Since the introduction of PSA testing in the 1980s, the incidence of prostate cancer has risen, with 70% of prostate cancers being diagnosed shown to be localized disease.[5] However, overdiagnosis of low-risk low-volume prostate cancer may unnecessarily lead to overtreatment. Hence, PSA screening remains a controversial issue.[5]

In 2012, the US Preventive Task Force (USPSTF) published recommendations on the use of PSA testing and assigned it a level D recommendation due to concerns about overdiagnosis and overtreatment.[6] Later on, in 2018, the USPSTF softened their recommendations and assigned PSA screening a level C recommendation.[7] Despite these controversial recommendations, the leading urological associations (American Urological Association and European Association of Urology) support and recommend PSA testing in men aged 55-69 years through a shared decision-making.[8,9] This is partly based on the results of the European randomized study of screening for prostate cancer (ERSPC), showing prostate cancer mortality reduction among men who had PSA screening.[10]

It is reasonable to assume that patients with a history of any type of cancer have structured frequent routine medical follow ups and are potentially more prone to be screened for additional cancers. However, there is little data specifically on PSA testing in men with a history of any cancer compared to men with no cancer history. Using a US national healthcare-based survey, our goal was to assess the rate of PSA testing in men with and without a history of cancer (excluding prostate cancer).

Materials and methods

Study design and data source

This was a cross-sectional study utilizing the National Health Interview Survey (NHIS), which is the principal source of information on the health of the civilian non-institutionalized population of the USA.[11] It is one of the major data collection for the Centers for Disease Control and Prevention (CDC). We used survey-based data collected between the 2015-2018 cycles to identify all men living in the US who were included in the annual national survey during this period. Prior cycles were not included, as questions assessing this study's outcomes of interest were not included or phrased differently. This survey is conducted by computed assisted face to face interview or by telephone if the road conditions or travel distances prevented a face-to-face interview. The NHIS data are de-identified and are freely available on the web (https://cdc.gov/nchc/nhis/), waiving the need for institutional review board approval.

Inclusion criteria and endpoint

The study inclusion criteria included all men aged 55-69 years who submitted a response to the question regarding PSA testing in their past and answered the question of a previous history of any cancer. Exclusion criteria included men with a previous history of prostate cancer. The primary endpoint of the study was the self-reported prevalence of PSA testing, which was compared in men with and without a history of any cancer. The PSA data was available only for 5.4% of men who completed the survey.

Covariates

Socioeconomic and demographic data were obtained from the NHIS database. These included current age, race, sexual orientation, marital status, geographic region, working status, and smoking status. Important clinic factors were included as well, including a history of cancer and the number of PSA tests in the last 5 years.

Statistical analysis and missing data

Descriptive statistics included means and standard deviations for continuous variables and proportions for categorical variables. For the comparison of discrete and continuous variables, the Chi-square and the student's T-test were employed, respectively. Multivariable logistic regression analysis was used to evaluate the association between all relevant covariates and PSA testing. These a-priori included variables were: history of cancer, age, race (White, Black, American Indian/Alaskan natives, Asians, Multiple races), sexual orientation (heterosexual, homosexual, bisexual, other), marital status, working status, USA geographical region (Northeast, Midwest, South, West) and smoking status (never smoker, current every day, former smoker).

Statistical tests were two-tailed, and a p-value of < 0.05 was considered significant. Statistical analyses

were performed using SPSS software version 23.0 (SPSS Inc., Chicago, IL, USA).

For missing variables, Hot-deck imputation was used.[12] This is a data processing method in which a missing response is assigned the corresponding response of a "similar" value in the same imputation class.

Results

Of the 118,859 individuals who completed the NHIS survey during 2018, a total of 53,708 (45.2%) were men. A total of 2,892 (5.4%) of them met the inclusion criteria, as can be seen in the consort diagram shown in Figure 1.

Of the 2,892 men meeting inclusion criteria, 308 (10.7%) had a history of cancer (non prostate). Table 1 highlights the main demographic characteristics of the included men. On average, men who were previously diagnosed with cancer were older, living with a spouse, with white predominance, with a higher rate of former smokers, and with a higher rate of unemployment.

Table 2 highlights the differences in PSA testing between individuals with and without a history of cancer. Men with a history of cancer had a higher rate of PSA testing and were more likely to report having discussed the advantage and disadvantages of PSA testing with their physician.

Table 3 shows the multivariable logistic regression analysis assessing possible associations with undergoing PSA testing. This analysis showed that those with a history of cancer were more likely to undergo PSA testing than those without a history of cancer (OR 1.87, 95% CI 1.39-2.52, $p < 0.001$). Other factors associated with an increased likelihood of undergoing PSA testing included: age (OR 1.06, 95% CI 1.04-1.08, $p < 0.001$), homosexual compared to heterosexual orientation (OR 1.78, 95% CI 1.05-3.01, $p = 0.032$), and men living with a spouse compared to men living alone (OR 1.76, 95% CI 1.49-2.08, $p < 0.001$). In contrast, current everyday smokers (OR 0.59, 95% CI 0.47-0.74, $p < 0.001$), American Indians and Alaskan Natives (OR 0.48, 95% CI 0.24-0.97, $p = 0.04$) and Asians (OR 0.62, 95% CI 0.42-0.92, $p = 0.018$), were all shown to be associated with a lower likelihood of undergoing PSA testing.

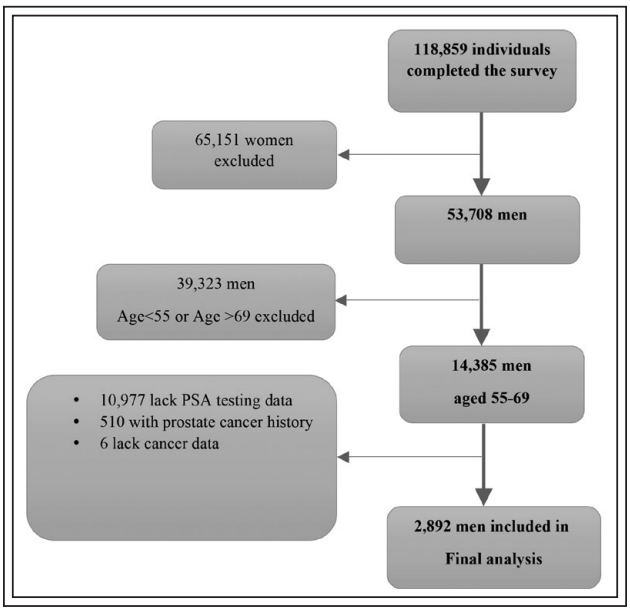

Figure 1. Case inclusion criteria.

Discussion

Our data showed that almost 11% (308 men) in the analysis had a previous history of cancer (non-prostate). These men had a higher rate of PSA testing and were more likely to discuss the advantages and disadvantages of PSA testing with their physicians. Lastly, the performed multivariable analysis demonstrated that a history of cancer potentially predisposes men to undergo PSA testing.

There is very little data in the published literature regarding the rate of PSA testing in men with a previous history of cancer. Leong et al utilized the USA health information national trends survey from 2011 to 2014 to assess predictors of PSA testing. In their analysis, consistent with our own findings, they found that any previous history of cancer increased the likelihood of undergoing PSA testing (OR 2.667, 95% CI 1.835–3.878, $p < 0.0001$) and discussion about PSA testing with their physician (OR 2.399, 95% CI 1.768–3.256, $p < 0.0001$).[13]

Interestingly, our data show that 51.3% of men with a history of cancer had previously discussed the advantages of PSA testing with their physician compared to 42.1% of men with no cancer history ($p < 0.001$). This is higher than a previously reported rate in another survey-based study by Turini et al.[14] This study showed that 37% of men talked to their physicians about the advantages of PSA testing. This again could demonstrate that the men with a previous cancer history might have a better rapport and closer relationship with their physician (due to their history), enabling a better setting for discussing the pros and cons of PSA testing.

The USPSTF recommendations issued in 2018 on prostate cancer screening described two special sub-populations: African American men and men with a family history of prostate cancer.[7] For both sub-populations, the PSA testing recommendations did

TABLE 1. **Patient demographic characteristics**

Parameter	Cancer (n = 308) (10.7%)	No cancer (n = 2584) (89.3%)	p value
Age, (mean, years, SD	63.4 (4.0)	61.8 (4.2)	< 0.001
Race, n (%)			< 0.001
White	283 (91.1)	2085 (80.7)	
Black	13 (4.2)	298 (11.5)	
American Indian/ Alaskan native	1 (0.3)	34 (1.3)	
Asian	4 (1.3)	113 (4.4)	
Unknown	0	4 (0.2)	
Multiple races	7 (2.3)	50 (1.9)	
Sexual orientation, n (%)			0.643
Heterosexual	294 (95.5)	2455 (95)	
Gay	9 (2.9)	66 (2.6)	
Bisexual	0	11 (0.4)	
Other/don't know	5 (1.6)	52 (2)	
Marital status, n (%)			0.002
No spouse	98 (31.8)	1080 (41.8)	
With spouse	210 (68.2)	1499 (58)	
Missing	0	5 (0.2)	
Region, n (%)			0.054
Northeast	55 (17.9)	413 (16)	
Midwest	69 (22.4)	641 (24.8)	
South	130 (42.2)	935 (36.2)	
West	54 (17.5)	595 (23)	
Currently working? n, (%)			0.003
Not working	163 (52.9)	1103 (42.7)	
Working	145 (47.1)	1480 (57.3)	
Missing	0	1 (0)	
Smoking status, n (%)			0.006
Current everyday	33 (10.7)	414 (16)	
Current some days	10 (3.2)	87 (3.4)	
Former smoker	126 (40.9)	842 (32.6)	
Never smoker	137 (44.5)	1237 (47.9)	
Missing	2 (0.6)	4 (0.2)	

not differ from the recommendations for the general population due to lack of evidence. The USPSTF did not mention patients with previous cancer as a special sub-population who need a different strategy for PSA testing.[7] The leading urological associations recommend PSA testing for men with a life expectancy longer than 10 years.[8,9] It is reasonable to assume that men with a history of cancer are more health-conscientious and are being more frequently followed, either by their primary care providers, medical oncologists, or oncology-focused specialists, enabling them to adhere more appropriately to the urological guidelines and to undergo PSA testing. A reference to that can be found in Table 2, which shows that 66.9% of men with a history of cancer were offered to undergo PSA testing by their primary physician versus 53% of men without a history of cancer ($p < 0.001$).

Other noteworthy findings in our multivariable analysis include the associations between age, homosexual orientation, and living with a spouse

TABLE 2. **Prostate-specific antigen (PSA) characteristics in patients with and without a previous history of cancer**

Parameter	Cancer (n = 308) (10.7%)	No cancer (n = 2584) (89.3%)	p value
Ever had a PSA test? n (%)			< 0.001
Yes	245 (79.5)	1642 (63.5)	
No	63 (20.5)	942 (36.5)	
Number of PSA tests in last 5 years (mean, SD)	3.04 (2.5)	2.87 (2.47)	0.33
Time of most recent PSA test? n, (%)			< 0.001
<= 1 year	143 (46.4)	933 (36.1)	
1-2 years	50 (16.2)	296 (11.5)	
2-3 years	20 (6.5)	100 (3.9)	
3-5 years	13 (4.2)	149 (5.8)	
>= 5 years	15 (4.9)	149 (5.8)	
Missing	67 (21.8)	957 (37)	
Who suggested PSA test? n, (%)			< 0.001
Self	28 (9.1)	187 (7.2)	
Doctor	206 (66.9)	1373 (53.1)	
Someone else	10 (3.2)	69 (2.7)	
Missing	64 (20.8)	955 (37)	
Doctor talked to you about advantages of PSA test? n, (%)			< 0.001
Yes	158 (51.3)	1087 (42.1)	
No	137 (44.5)	1442 (55.8)	
Missing	13 (4.2)	55 (2.1)	
Doctor talked to you about disadvantages of PSA test? n (%)			0.001
Yes	107 (34.7)	691 (26.7)	
No	186 (60.4)	1815 (70.2)	
Missing	15 (4.9)	78 (3)	

and undergoing PSA testing. These findings have been previously shown in other work, including living with a spouse[15] and homosexual orientation.[16] It is reasonable to assume that men who live with a spouse are more influenced by the spouse to undergo screening. In contrast, current smokers, American Indians (AI), Alaskan natives (AN), and Asians were less likely to undergo PSA testing. This was also previously described in an update on cancer in AI and AN.[17]

Our study has several limitations. First, the utilized database is retrospective in nature, consisting of inherent selection and recall biases. Additionally, our sample size, selected from the entire cohort, meeting all inclusion criteria was relatively small. PSA testing was determined by self-reporting, and we cannot determine whether the testing was done as a screening test or as part of follow up, and it may be subject to misclassification bias. Additionally, the probability of incorrect or unreported data entry (non-response bias) must be considered. Other relevant clinical factors which may influence PSA testing were not available, including digital rectal examination findings, imaging tests, other prostate cancer biomarkers, history of previous prostate biopsies, and genetic risk factors.

We also do not have data on the diagnosis and date of the previous cancer and how much time had passed between cancer diagnosis and PSA testing. This brings another interesting point as we also lack data on the stage and grade of the previous cancer. It is reasonable to assume that a very aggressive metastatic cancer with poor prognosis would render these men and their physicians reluctant to send these men to undergo PSA screening due to their poor prognosis and a life

TABLE 3. **Multivariable logistic regression analysis assessing associations between various covariates and having a PSA blood test in men aged 55-69**

Parameter	Odds ratio	95% confidence interval	p value
Age	1.06	1.04-1.08	< 0.001
Race (White reference)			
Black	1.06	0.82-1.38	0.66
American Indian/ Alaska native	0.48	0.24-0.97	0.04
Asian	0.62	0.42-0.92	0.018
Sexual orientation (heterosexual reference)			
Gay	1.78	1.05-3.01	0.032
Bisexual	1.99	0.5-7.92	0.33
Other/I don't know	0.9	0.51-1.57	0.7
Marital status (yes vs. no)	1.76	1.49-2.08	< 0.001
Working status (yes vs. no)	0.98	0.82-1.16	0.79
Region (Northeast reference)			
Midwest	0.94	0.73-1.22	0.66
South	1.2	0.94-1.53	0.15
West	0.82	0.63-1.06	0.13
Smoking status (never smoker reference)			
Current everyday	0.59	0.47-0.74	<0.001
Current same day surgery	0.58	0.38-0.88	0.012
Former smoker	0.92	0.76-1.1	0.35
Ever been told you had cancer? (yes vs. no)	1.87	1.39-2.52	< 0.001

expectancy of less than 10 years. This is in complete contrast to localized and non-aggressive cancer, with good prognosis, and a high life expectancy rate of 10 years. Despite the lack of this important data and the rate of aggressive previous cancer, our data still demonstrated a higher association of PSA screening among men with previous cancer. It is reasonable to assume that if we had analyzed only men with a history of cancer and a life expectancy of more than 10 years, the association with PSA screening would have been stronger. Other strength of our study includes the fact that this study is based on a large national based survey consisting of real-world data.

Conclusion

Our findings suggest that men aged 55-69 years with a history of any cancer, regardless of its timing, grade, and stage, are more likely to undergo PSA testing than men with no cancer history. As the incidence of new cancer cases in the US is constantly rising,[18] this is an important finding. However, as physicians, we need tailor our approach to the patients, and male sure screening is offered in an appropriate manner, to all men aged 55-69 who are healthy with no previous history of cancer, or those with previous cancer history who have a life expectancy of at least 10 years. PSA testing advantages and disadvantages should be discussed with all men who are candidates to undergo screening and allow them to ask appropriate questions and understand the data supporting PSA screening. □

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