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PROSTATE SPECIFIC ANTIGEN SCREENING IN TEXAS MEDICARE POPULATION: THE ROLE OF PATIENT CHARACTERISTICS

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PROSTATE SPECIFIC ANTIGEN SCREENING IN TEXAS MEDICARE POPULATION: THE ROLE OF PATIENT CHARACTERISTICS

by

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THESIS

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Dedication

Dedicated to my parents and sister who supported and encouraged me to complete this Master of Science.

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PROSTATE SPECIFIC ANTIGEN SCREENING IN TEXAS MEDICARE POPULATION: THE ROLE OF PATIENT CHARACTERISTICS

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Supervisor: James Goodwin

The objectives of this study were to 1) determine the prevalence of prostate specific antigen (PSA) testing in the Texas Medicare population and 2) assess which patient characteristics are associated with receipt of PSA screening. The 100% Texas Medicare claims data and 2009 population estimates from the Dartmouth Institute were used to examine temporal trends in PSA testing from 2000-2009. Chi Square statistics and logistic regression were used to estimate the association between patient characteristics and the likelihood of receiving a PSA test. PSA testing rates increased steadily in the Texas Medicare population from 2001-2007, without major changes in 2008-2009. Among the 449,976 men in the study population, 46.8% received a PSA test. PSA testing rates were lower in Blacks compared to Whites (OR .64; 95% CI: 0.63-0.66) and those in age group categories 76-80 (OR .88; 95% CI: .86-.89) and 81-85 (OR .66; 95% CI: 0.64-0.67). PSA testing rates increased as median income at zip code level (quartile) increased. Beneficiaries with one or two comorbidities were more likely to

receive a PSA test compared to those with none. No association was found between rural/ urban area and PSA testing. This analysis may provide clinicians with more information on how to optimize PSA testing and increase its benefit in the Texas Medicare population.

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INTRODUCTION

Carcinoma of the prostate is the second leading cause of cancer death in men in the United States. The American Cancer Society estimates that there will be 241,740 new cases and 28,170 deaths from prostate cancer in 2012.[1] The value of using prostate specific antigen (PSA) testing to screen for prostate cancer remains a topic of controversy. Although PSA testing used in combination with digital rectal exam improves the detection rate of prostate cancer, it is associated with high false positive rates leading to overdiagnosis and overtreatment in men whose tumors would have never threatened their health.

The issue of using PSA testing to screen for prostate cancer is further complicated by the fact that it may not improve mortality. Two of the most well designed clinical trials assessing the effect of screening on prostate cancer mortality reported conflicting results. The European Randomized Study of Screening for Prostate Cancer (ERSPC) found that screening was associated with a 19% reduction in prostate cancer mortality.[2] However, no reduction in the primary outcome of prostate cancer mortality was found in the Prostate, Lung, Colorectal and Ovarian (PLCO) screening trial.[3] Based on the outcome of these trials and others, the American Cancer Society recommends the use PSA testing to screen for prostate cancer in a setting where patients are informed by their physician of the potential risks and benefits.[4] The US Preventive Services Task Force, however, has recently revised the recommendation to state there is insufficient evidence to recommend routine prostate screening.[5]

Given the uncertainty and confusion among clinicians and patients regarding the usefulness of PSA screening for prostate cancer, it is important to identify patient factors associated with receipt of PSA testing. Knowledge of which patient characteristics influence PSA screening rates may be useful to assess the feasibility of implementing interventions and developing educational material that may be useful to providers, policy markers, and the general public. This information may also help improve screening practices in Texas Medicare population by identifying differences and disparities in cancer screening. The ultimate goal is for PSA testing to reflect a balance between its risks and benefits.

The data for this research were obtained from 100% Texas Medicare claims database. Medicare provides health insurance benefits for persons 65 years of age or older, persons under 65 with certain disabilities, and persons with end stage renal disease. Over the past two decades, Medicare enrollment has been increasing with approximately 48 million enrollees in 2010.[6] Medicare provides data in the form of claims submitted by providers for reimbursement, which include information on diagnoses, service, testing, or procedures performed. Since Medicare claims are tied to reimbursement, there is an incentive from both the provider and the federal government to ensure the completeness and validity of the information.

The study objectives were to:

1) Determine the prevalence of prostate specific antigen (PSA) screening in the Texas Medicare population from 2000-2009.

2) Examine the effect of patient characteristics (age, race, ethnicity, zip code income and education, rural or urban residence and comorbidity) on likelihood of receipt of PSA testing for prostate cancer screening.

BACKGROUND AND SIGNIFICANCE

Patient Characteristics:

This study analyzes whether patient characteristics are associated with receipt of PSA screening among Texas Medicare beneficiaries. African Americans, younger age, lower education and rural residency tend to be associated with lower cancer screening rates.[7-10]

Race and ethnicity can play a major role in influencing participation in cancer screening. A case-control study of racial differences among Medicare beneficiaries in New Jersey found that elderly Blacks are substantially less likely to under go PSA screening compared to Whites after controlling for age, socioeconomic status, and comorbidity.[7]

Age is also an important predictive factor in cancer screening participation. A study evaluating the relationship between age and cervical screening reported that elderly women were significantly less likely to have ever had or to have recently had Pap smears

compared to younger women. In addition, being elderly tended to be an independent predictor of mammography use, after controlling for other variables.[8]

Income level and education are also related to higher rates of cancer screening. A study evaluating racial differences in prostate cancer screening according to age and socioeconomic status found higher income and education to be positively associated with prostate cancer screening, particularly among African Americans.[9]

Place of residence has also been reported as a contributing factor in cancer screening participation. One study reported that the prevalence of screening mammography utilization was significantly lower among women living in rural areas of Tennessee compared to women living in urban areas.[10]

Prostate Cancer:

Prostate cancer is the most common noncutaneous cancer among men in the United States. It is the second leading cause of cancer death in men. Prevalence data from SEER reported there were approximately 2,355,464 men alive in the US on January 1, 2008 who had a history of prostate cancer. The lifetime risk of being diagnosed with prostate cancer is 16.5%, and the lifetime risk of dying from the disease is 2.8%.[11] The risk of prostate cancer increases with age, with 2.30%, 6.62%, and 8.50% of men who are now aged 50, 60, and 70 respectively expected to get prostate cancer in the next 10 years.[12]

The age adjusted incidence rate of prostate cancer based on cases diagnosed in 2004-2008 is 156.0 per 100,000 men per year.[11] Incidence rates increased in frequency from the mid 1970's to 1992, due to the widespread use of PSA testing. However, the

number of new cases has declined 2.4% per year from 2000-2006.[12] Age adjusted mortality rates also increased from the mid 1970's to early 1990s, followed by a decline in the number of deaths by 4.1% per year from 1994 to 2006.[11, 12]

The natural history of prostate cancer is not completely understood. It is often diagnosed while asymptomatic due to the introduction of PSA testing. Potential risk factors of prostate cancer are age, race, family history and alcohol consumption. African American men have a higher incidence and mortality from prostate cancer compared to all other races.[1]

A prostate biopsy indicated by elevated serum PSA, abnormal rectal examination, or clinical symptoms is required to establish diagnosis. The American Joint Committee on Cancer (AJCC) system and Gleason scoring system are commonly used for staging and histological grading respectively. The proportion of disease found to be localized at diagnosis (confined to primary site) was 81% from 2001-2007 for all races.[11] Furthermore, most prostatic lesions found at autopsy remain clinically undetected. Studies performed by Frank et al report that roughly 30% of men in their 50s and 60s, 50% of men in their 70s, 75% in their 80s, and nearly 100% of men in their 90s where found to have not previously diagnosed prostate cancer at autopsy.[13]

PSA Testing

Prostate specific antigen (PSA) is a glycoprotein found primarily in prostatic tissue and seminal fluid.[14] PSA testing measures the amount of prostate specific antigen in the blood. PSA levels normally increase with age. Other causes of elevated PSA levels include inflammation, prostate enlargement, prostate cancer, and injury. Screening with

prostate specific antigen has resulted in a shift to a higher proportion of earlier stage cancers at diagnosis. However, screening has also increased the risk of overdiagnosis and overtreatment of indolent disease that would have otherwise been of no clinical significance.

There are a number of different assays that measure serum PSA. The traditional cut off point of 4.0ng/mL has become the most widely used value above which prostate cancer is suspected.[14] A case control study, nested in a prospective study evaluating the use of serum PSA for detection of prostate cancer, reported a sensitivity of 71% for PSA levels above 4.0 ng/mL.[15] Prior to the discovery of PSA, practitioners were limited to prostatic acid phosphatase (PAP), digital rectal exams, and transrectal ultrasound (TRUS) for the detection of prostate cancer, all of which offered lower than desired detection rates for cancer.[14] Although the use of PSA has improved the ability of urologists to monitor recurrence of residual disease, its use for screening and early detection of prostate cancer remains controversial.

Observational Studies

Ecological studies of prostate screening have examined mortality changes over time in relation to prostate cancer screening rates. One US study comparing aggressive screening rates in the Seattle area (11,803 per 100,000 person years) with lower screening rates in Connecticut (2,199 per 100,000 person years) found that mortality rates were virtually the same after 11 and 15 years of follow-up.[16] Similar findings were reported in a Canadian study which found no association between intensity of screening and subsequent decline in prostate cancer mortality.[17] Not all studies have yielded negative

findings. Shaw et. al conducted an ecological analysis of prostate specific antigen (PSA) screening and prostate cancer mortality across nine geographic cancer registries in the United States.[18] They found a modest decline in prostate cancer mortality in areas with greater PSA screening rates.[18]

In addition to ecological studies, there have been several case-control and cohort studies that evaluated the effectiveness of prostate-specific antigen screening for prostate cancer. A nested case control conducted at 10 Veterans Affairs Medical Centers in New England found no benefit in PSA screening or digital rectal examination for reducing mortality (adjusted OR 1.08; 95% CI 0.71-1.64;P.72).[19] However, the results of a smaller case control study of US Kaiser Permanente members found an inverse association between prostate cancer screening and mortality, suggesting that men who are screened more frequently have a reduced risk of dying from prostate cancer.[20]

Randomized Controlled Trials

Two randomized controlled trials were published in 2009 that addressed whether prostate cancer screening provides a mortality benefit.[2,3] However, the two studies reported conflicting results, leading to more uncertainty and confusion among providers and men considering prostate cancer screening.

The European Randomized Study of Screening for Prostate Cancer (ERSPC) was initiated in the early 1990's to evaluate the effect of screening on prostate cancer mortality. The study included 162,243 men aged 50 to 74, identified in population registries of seven European countries: Belgium, The Netherlands, Spain, Switzerland, Finland, Sweden, and Italy.[2] After nine years, the authors report that PSA based screening

reduced the rate of death from prostate cancer by 19%.[2] They also report a number needed to treat of 48 to save one prostate cancer death and a high risk of overdiagnosis and overtreatment associated with screening.[2] A recent 2012 update of the ERSPC trial after 11 years of follow-up reports a relative risk reduction of 21% in prostate cancer mortality in the screening group.[21] This data further supports their original findings that PSA testing significantly reduces mortality from prostate cancer.

In contrast, the US Prostate, Lung, Colorectal, and Ovarian (PLCO) trial did not find a statistically significant reduction in mortality with PSA screening. In this study, 73,693 men at 10 US study centers were randomly assigned to receive either annual screening or usual care as the control.[3] The screening group was offered annual PSA testing and digital rectal examination. After 7 to 10 years of follow-up, the rates of death from prostate cancer were very low and did not significantly differ between both groups.[3]

RESEARCH DESIGN AND METHOD

Conceptual Framework

The primary goal of this study is to describe the patient characteristics of men undergoing PSA screening in Texas and assess whether these characteristics influence PSA screening rates. In addition, how PSA testing rates change over time are described. Figure 1 provides a conceptual model of patient factors that may influence receipt of screening. This model is based on one developed for the Comparative Effectiveness Research in Texas grant (RP101207, J. Goodwin, M.D., PI). It shows that patient characteristics are one of many factors that influence receipt of screening.

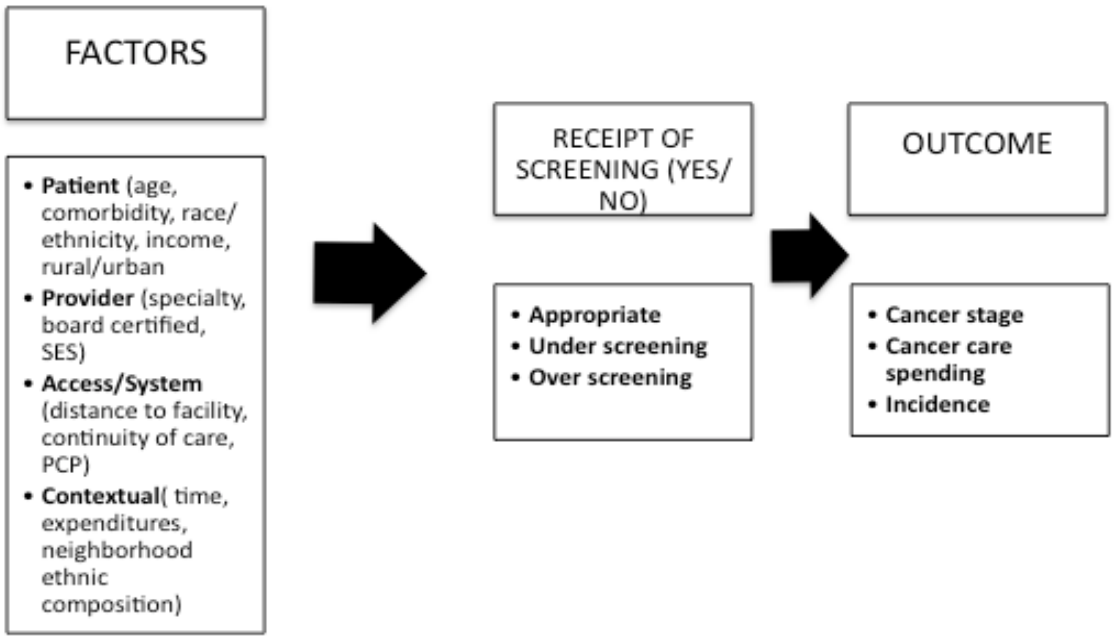

Figure 1. Conceptual Model of Role of Patient Characteristics in Screening

Data Source

Data were obtained from 100% Medicare claims data for Texas residents, including Medicare enrollment files, Medicare Provider Analysis and Review files (MedPAR) files, Outpatient Statistical Analysis File (OutSAF) and Carrier Files. Medicare data contain information on medical services that are collected as part of the Medicare claims data system. This system collects information on all services provided to Medicare beneficiaries under its hospital (Part A) and supplemental (Part B) insurance plans. Diagnoses on the hospital inpatient, hospital outpatient and physician claims are coded in the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). Procedures in the physician claims are coded in the HCFA Common Procedure Coding System (HCPCS), which includes Common Procedure Terminology (CPT) codes and other codes assigned by HCFA and the local carriers. Procedures on the hospital records are coded in ICD-9-CM. Procedures on the hospital outpatient claims are coded in ICD-9-CM and HCPCS. In this study a screening PSA test is defined by CPT codes 84152, 84153 and 84154, and HCPCS code G0103.

Study Aims

The study aims are to:

Aim 1: Determine the prevalence of prostate specific antigen (PSA) screening in the Medicare population from 2000-2009.

Aim 2: Examine the effect of patient characteristics (age, race, ethnicity, zip code income and education, rural or urban residence and comorbidity) on likelihood of receipt of PSA testing for prostate cancer screening.

Study Cohort

Our analysis includes two study cohorts for each specific aim. The study cohort for aim one, consists of male Medicare beneficiaries aged 65-85 who had at least 12 months of enrollment in Medicare parts A and B and who are not enrolled in a health maintenance organization in a given year from 2000-2009. The cohort for aim two includes male Medicare beneficiaries aged 67-85 in 2009 who were enrolled in Medicare parts A and B without a diagnosis or history of prostate cancer identified in 2007-2009 and who were not enrolled in a health maintenance organization during that time (n=449,976). Claims with prostate cancer diagnosis and prostate cancer history were identified using ICD9 codes 185 and V10.46, respectively. The study includes subjects at least 67 years of age for aim two because two years of data are required to evaluate for history or diagnosis of prostate cancer. The analysis for aim two cohort required claims data one year prior to Jan 1, 2009 to assess for comorbidity and to examine its effect on screening. Table 1 provides descriptive statistics of the study sample for specific aim two.

Table 1. Number and percent of beneficiaries in 2009 cohort by beneficiary characteristics

Beneficiary characteristic	Number	%
Overall	449,976	100
Age group		
67-70	140,848	31.3
71-75	144,389	32.1
76-80	102,388	22.8
81-85	62,351	13.9
Race/ethnicity		
Non-Hispanic White	342,211	76.1
Black	25,942	5.8
Hispanic	71,847	16.0
Other	9,976	2.2
Median income at zip code level		
Q1 (≤ $37,917)	112,286	25.0
Q2 ($37,917-45,818)	112,290	25.0
Q3 ($45,818-61,181)	112,900	25.1
Q4 (> $61,181)	112,500	25.0
Rural/Urban		
Metropolitan	342,377	76.1
Urban	97,443	21.7
Rural	10,156	2.3
Comorbid conditions		
0	172,060	38.2
1	102,632	22.8
2	76,302	17.0
≥ 3	98,982	22.0

[‡]Aged 67-85 in 2009 without prostate cancer diagnosis or history identified in 2007-2009.

Measurements

A list of variables with their sources and definitions is provided in Table 2. The patient characteristics examined are age, race and ethnicity, zip code level income, rural or urban residence, and comorbidity. Patient age, gender and ethnicity were obtained

from Medicare enrollment files. Age was divided into four categories 67-70, 71-75, 76-80, and 81-85 to examine how PSA screening rates vary among different age groups. Median zip code level income was obtained from 2009 population estimates for Primary Care Service Areas (PCSA) developed by the Dartmouth Institute for Health Policy and Clinical Research. Income was divided into quartiles. The size of residential area (metropolitan, rural, or urban) was categorized using continuum codes developed by the US Department of Agriculture. Elixhauser comorbidity[22] measures were generated using inpatient, hospital outpatient, and physician claims from MEDPAR, OUTSAF, and Carrier Files in the year prior to 2009. Comorbidity was categorized as none, 1, 2 and 3 or more.

Table 2. Sources and Definition of Variables

Variable	**Data Source**	**Definition**
Age	Medicare	Age in years
Race/Ethnicity	Medicare	Non-Hispanic White, Non-Hispanic Black, Hispanic, Other
Zip Code level Income	Dartmouth Institute	Medium household income at zip code level (quartile range)
Residence	Continuum Codes	Metropolitan, Urban, Rural
Comorbidity	Medicare	Elixhauser Comorbidity (none, 1, 2, 3 or more)

Statistical Analysis

The prevalence rate of PSA testing was calculated as: frequency of test/ number of male Medicare beneficiaries aged 65-85 who had complete enrollment in a given year. The proportion of beneficiaries receiving a screening PSA each year from 2000-2009 was

plotted to yield a graphical description of change in PSA screening over time. The prevalence rates over time were further stratified according to age group.

Descriptive analysis was used to summarize the patient characteristics and rates of PSA testing utilization. We compared PSA testing rates among the categories for each independent variable: age categories, race and ethnicity categories, zip code level income quartiles, rural or urban residence categories, and comorbidity scores. The dependent variable is receipt of PSA test (yes/no in 2009). Chi-square tests were performed to test whether there are differences in PSA testing rates in each of the independent variable categories. To further examine the association between patient characteristics and receipt of PSA test, logistic regression was done and the adjusted odds ratio and 95% confidence intervals were reported. Analyses were conducted using SAS version 9.2 (SAS Inc., Cary, NC).

RESULTS

Figure 2 shows that prostate specific antigen testing rates increased steadily among Texas Medicare beneficiaries aged 65-85, from 2001 to 2007, followed by no change in 2008, and a slight reduction in screening rates in 2009. Figure 3 shows PSA testing rates in the Texas Medicare population stratified by age. PSA testing rates steadily increased in all age categories from 2001-2007, and remained the same in 2008 and 2009 for 65-70 and 71-75 age groups, but declined in the 76-80 and 81-85 age groups.

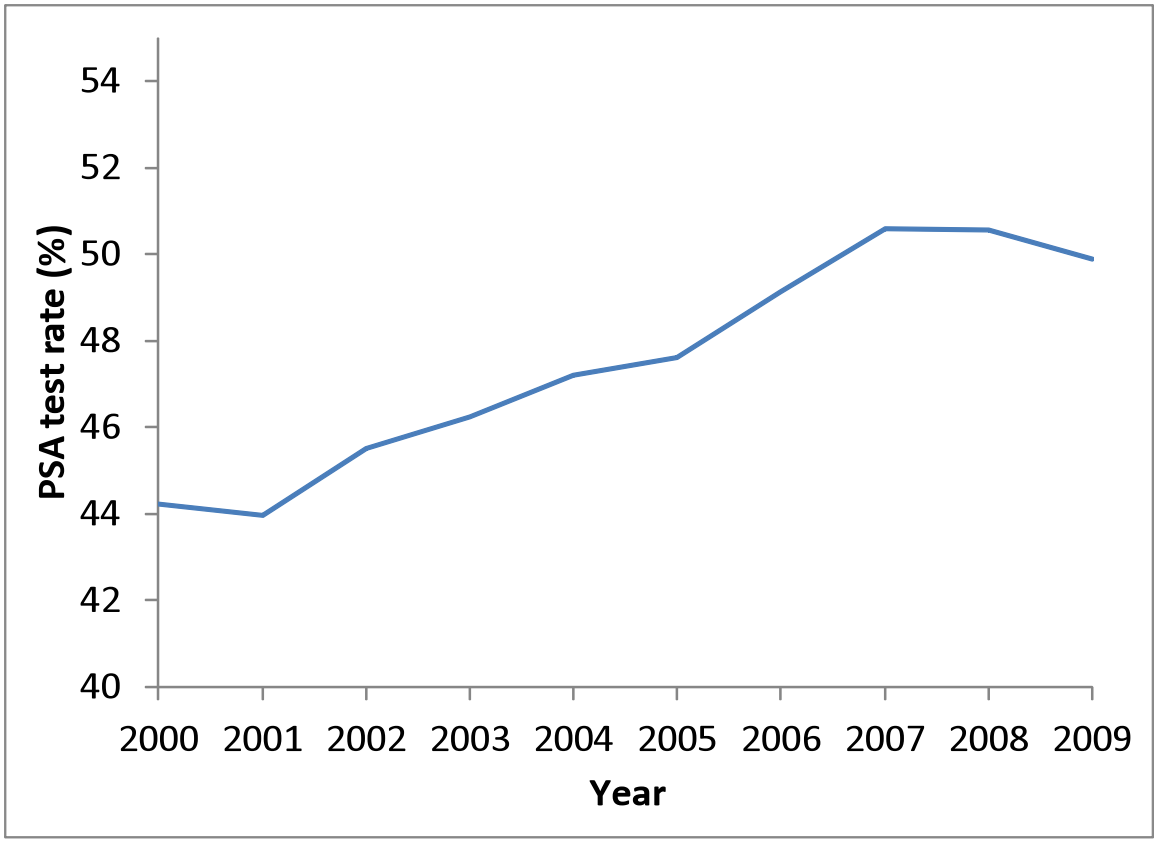

Figure 2. PSA test rates of male Medicare beneficiaries aged 65-85 from the year 2000 through 2009.

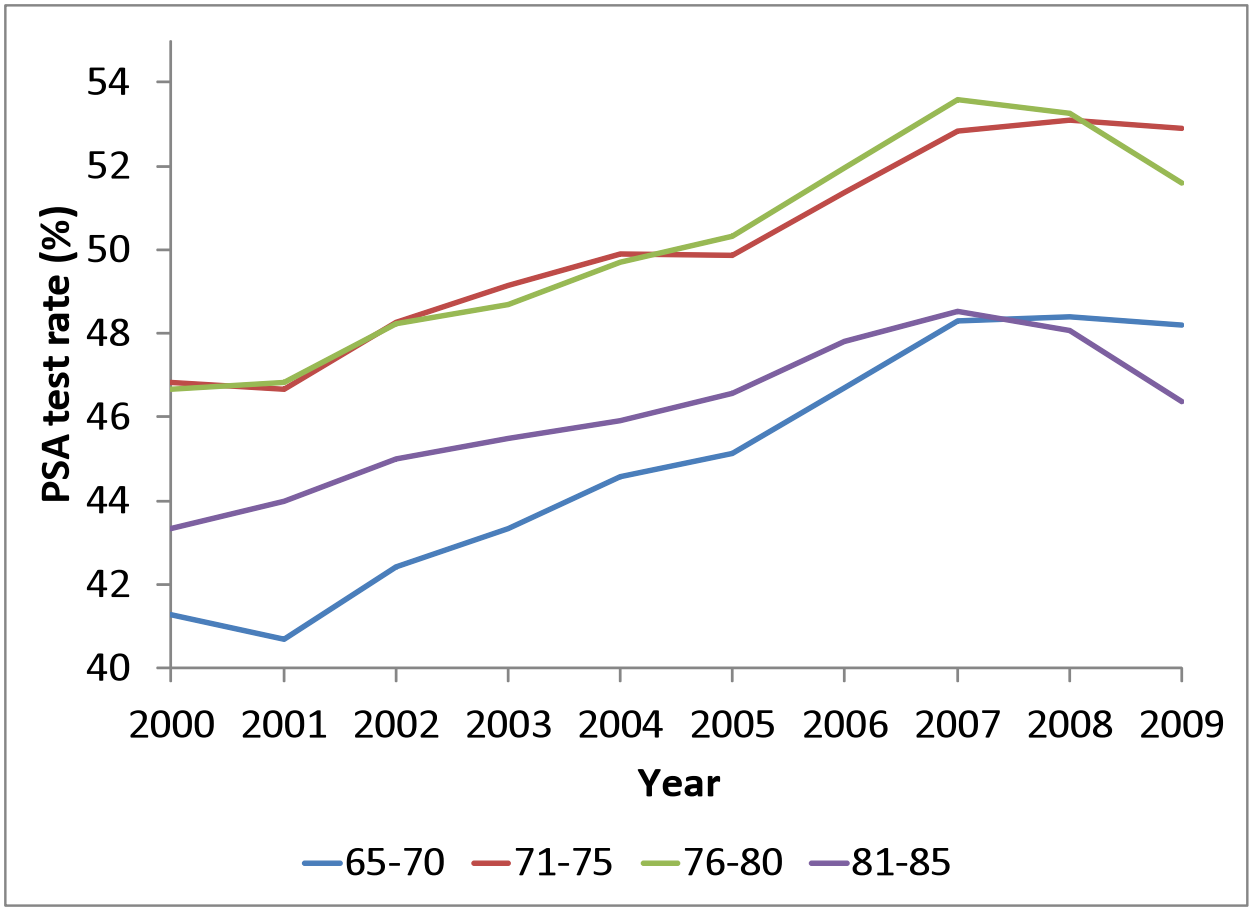

Figure 3. PSA test rates of male Medicare beneficiaries from the year 2000 through 2009, stratified by age.

Table 3 provides PSA testing rates of Medicare beneficiaries by patient characteristics in the 2009 cohort. The PSA testing rates for age, race/ethnicity, income, and comorbidity categories are displayed graphically in Figures 4-7. Age, race, income, and comorbidity were significantly associated with PSA testing. Screening rates were higher among Non-Hispanic Whites (49.1%) compared to Non-Hispanic Blacks (37.3%) and Hispanics (39.4%). PSA testing rates were highest in the 71-75 age group (48.9%), followed by 67-70 (47.9%), 76-80 (46.4%), and 81-85 (40%) age groups. PSA testing rates increased as zip code median income level increased among beneficiaries (51.5% for highest income level quartile Q4 vs 42.5%, 45.5% and 47.7% for Q1-Q3). PSA testing rates varied substantially by comorbidity score. The testing rates were highest for those with one comorbidity (57.3%) compared to other categories in this group. There were no differences in screening rates in rural vs urban regions.

Table 3. PSA test rate by beneficiary characteristic.

Beneficiary characteristic	PSA test rate (%)	p value[‡]
Overall	46.8	
Age group		
67-70	47.9	< 0.001
71-75	48.9	
76-80	46.4	
81-85	40.0	
Race/ethnicity		
Non-Hispanic White	49.1	< 0.001
Non-Hispanic Black	37.3	
Hispanic	39.4	
Other	47.4	
Median income at zip code level		
Q1 (≤ $37917)	42.5	< 0.001
Q2 ($37917-45818)	45.5	
Q3 ($45818-61181)	47.7	
Q4 (> $61181)	51.5	
Rural/Urban		
Metropolitan	46.9	0.118
Urban	46.6	
Rural	46.0	
Comorbid conditions		
0	36.0	< 0.001
1	57.3	
2	55.7	
≥ 3	47.8	

[‡]Chi-square test.

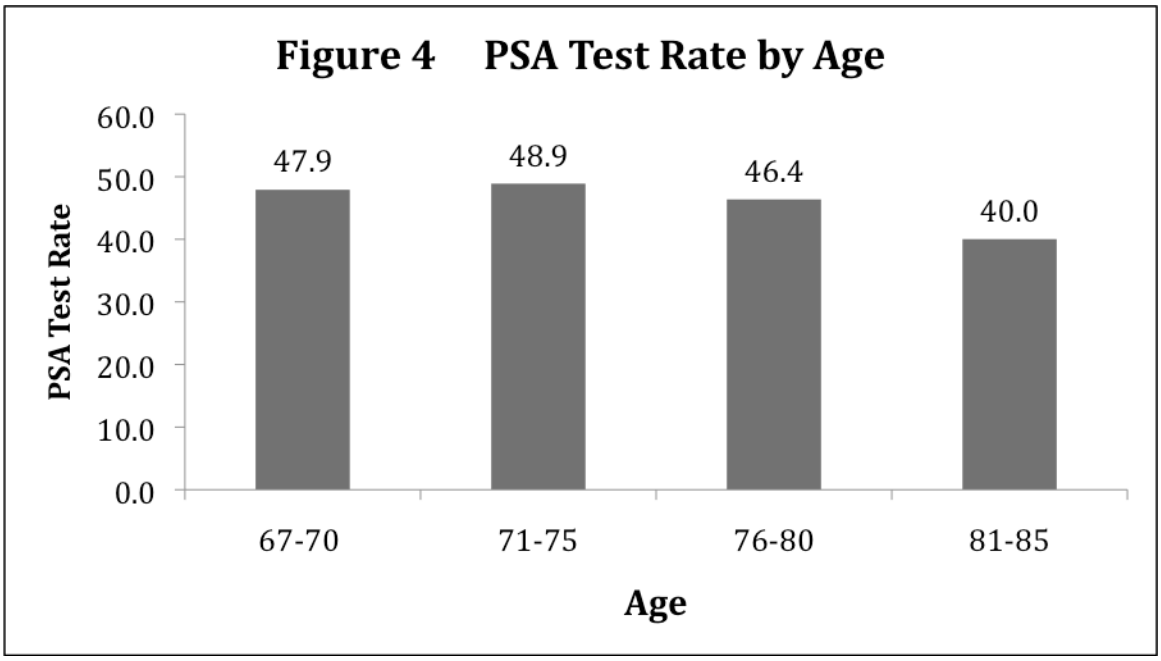
Figure 4 PSA Test Rate by Age
PSA Test Rate
60.0
50.0
40.0
30.0
20.0
10.0
0.0
47.9
48.9
46.4
40.0
67-70
71-75
76-80
81-85
Age

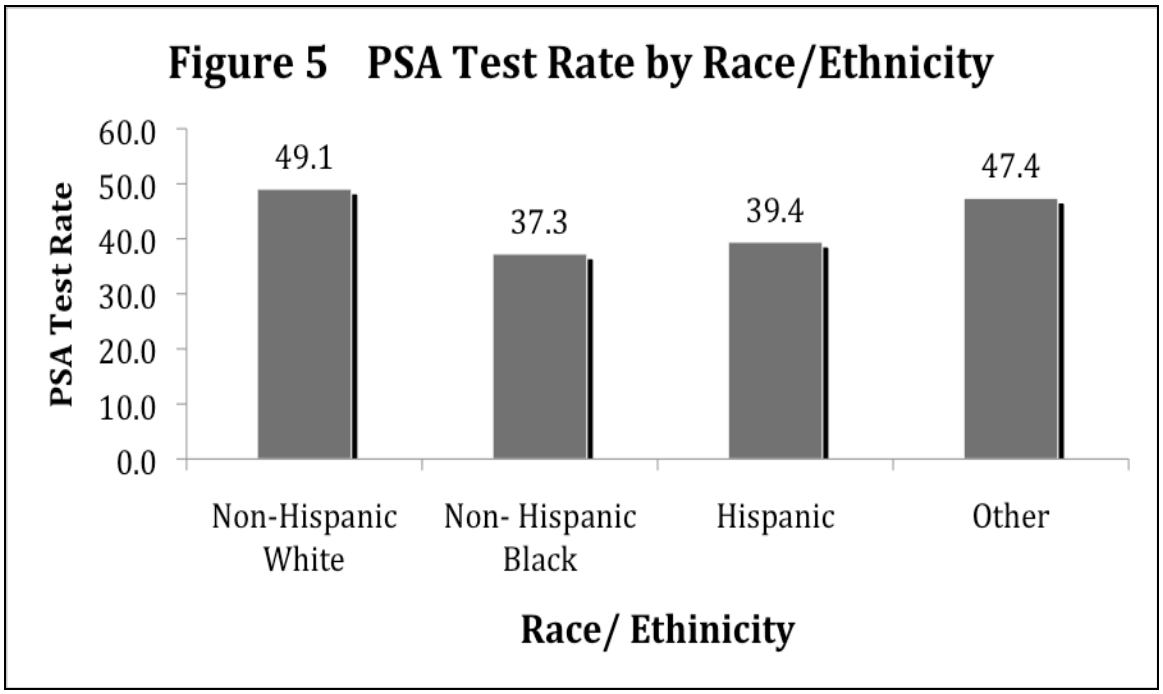
Figure 5 PSA Test Rate by Race/Ethnicity
PSA Test Rate
60.0
50.0
40.0
30.0
20.0
10.0
0.0
49.1
37.3
39.4
47.4
Non-Hispanic White
Non- Hispanic Black
Hispanic
Other
Race/ Ethinicity

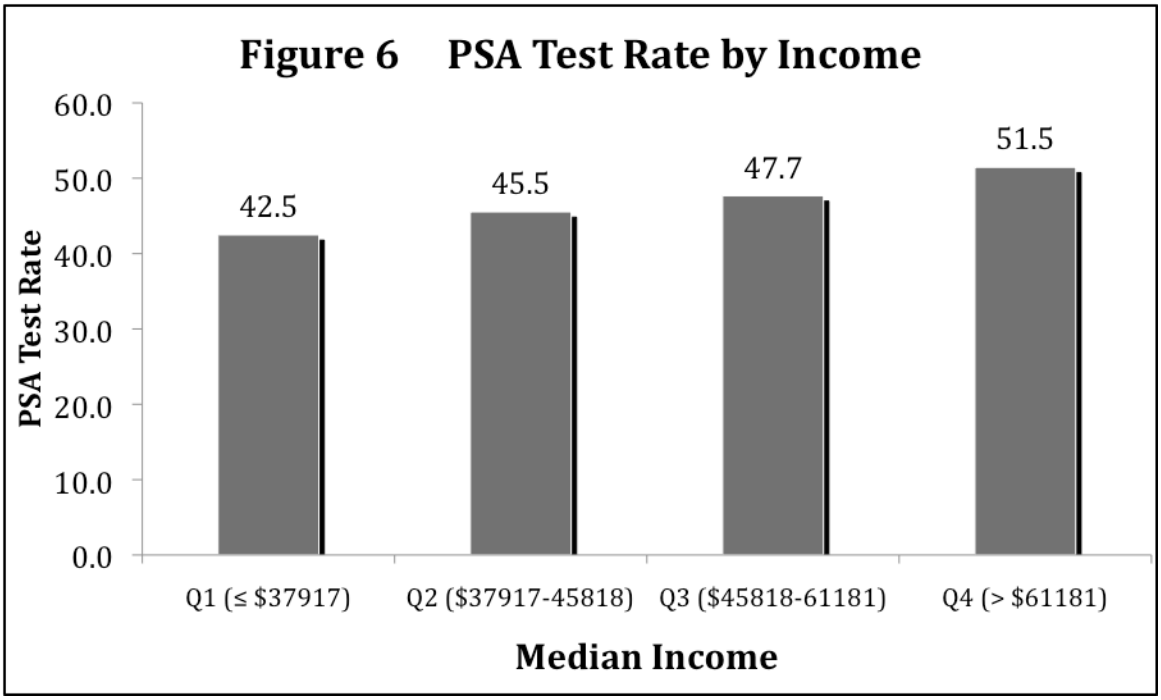
Figure 6 PSA Test Rate by Income
60.0
50.0
40.0
30.0
20.0
10.0
0.0
PSA Test Rate
42.5
45.5
47.7
51.5
Q1 (≤ $37917)
Q2 ($37917-45818)
Q3 ($45818-61181)
Q4 (> $61181)
Median Income

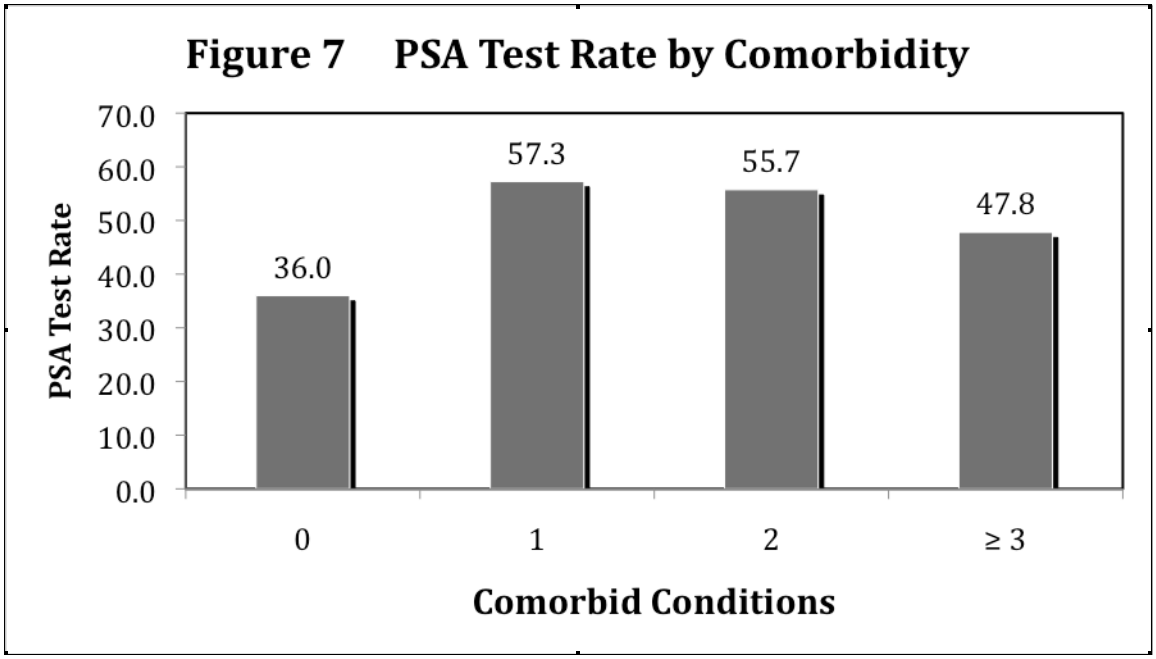
Figure 7 PSA Test Rate by Comorbidity
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
PSA Test Rate
36.0
57.3
55.7
47.8
0
1
2
≥ 3
Comorbid Conditions

Table 4 presents the results of a logistic regression analysis for patient factors associated with PSA testing. Among beneficiaries, Non-Hispanic Blacks (OR 0.64, 95% CI 0.63,0.66) and Hispanics (OR 0.73, 95% CI 0.71,0.74) were less likely to receive PSA screening tests compared to Non-Hispanic Whites. Men with higher median income were more likely to receive a PSA test compared to those in lower income categories. Men of older age (76-85) were less likely to undergo PSA testing compared to those in younger age groups. Those with comorbid conditions were more likely to have PSA testing compared to men with no comorbidities.

Table 4. Effect of beneficiary characteristics on PSA testing.

Beneficiary characteristic	Odds Ratio (95% CI)
Age group	
67-70	Ref
71-75	1.01 (0.99, 1.02)
76-80	0.88 (0.86, 0.89)
81-85	0.66 (0.64, 0.67)
Race/ethnicity	
Non-Hispanic White	Ref
Black	0.64 (0.63, 0.66)
Hispanic	0.73 (0.71, 0.74)
Other	0.88 (0.84, 0.92)
Median income at zip code level	
Q1 (≤ $37917)	Ref
Q2 ($37917-45818)	1.03 (1.01, 1.05)
Q3 ($45818-61181)	1.10 (1.08, 1.12)
Q4 (> $61181)	1.28 (1.26, 1.31)
Rural/Urban	
Metropolitan	Ref
Urban	1.06 (1.04, 1.07)
Rural	1.03 (0.99, 1.07)

Comorbid conditions	
0	Ref
1	2.38 (2.34, 2.42)
2	2.30 (2.26, 2.34)
≥ 3	1.75 (1.72, 1.78)

DISCUSSION

Despite compelling arguments for and against the use of prostate specific antigen to screen for prostate cancer, there is still no consensus on whether PSA testing provides a mortality benefit. On an individual level, PSA testing has undoubtedly saved the lives of men, however, it may also be exposing many more men to harms associated with its diagnosis and treatment. It is important to note that in order for screening to be efficacious, it must improve the outcome and reduce the cause specific mortality from cancer at the population level, not the individual.

Two landmark randomized clinical trials, the European Randomized Study of Screening for Prostate Cancer (ERSPC) and the US Prostate, Lung, Colorectal, and Ovarian (PLCO), published data that had the potential of resolving the debate on whether PSA testing reduces mortality from prostate cancer. However, the two trials reported contradictory results on the mortality benefit of prostate screening, offering no resolution to the dilemma primary care practitioners face when deciding whether to order the test for screening.

Another reason for the uncertainty faced by providers may also be attributed to the disagreement among authorities and professional organizations on use of PSA testing to screen for prostate cancer. The American Cancer Society recommends the use of PSA

testing to screen for prostate cancer in men with a life expectancy of at least 10 years and in a setting where patients are informed by their physician of the potential risks and benefits.[4] The US Preventive Services Task Force, however, recommends against the routine use of PSA testing to screen for prostate cancer. The task force further states, "many men are harmed as a result of prostate cancer screening and few, if any, benefit".[5]

In the absence of clear evidence based guidelines for prostate cancer screening, the findings of this study will help direct efforts at designing interventions to promote optimal prostate cancer screening for Texas men. Medicare claims data were used to describe the patient characteristics of Texas men who undergo PSA testing and to examine if these characteristics predict whether or not a man receives a PSA test. The analyses found that Non-Hispanic Black and Hispanic men are significantly less likely to receive PSA screening compared to non-Hispanic Whites. This finding is consistent with a previous study using SEER Medicare data, which found that African American men undergo PSA screening less frequently than Whites.[23] There are many possible explanations for why African American men are screened less frequently than Whites, such as a cultural distrust of the medical care system, lack of access to care, or lack of knowledge about prostate cancer. African American men have higher incidence and death rates from prostate cancer compared to all other racial groups, and more emphasis on preventive measures such as PSA screening may be warranted in this high-risk group.

In addition to ethnic disparities, we found that PSA screening rates increase as medium income increases. Men with higher income may have better access to preventive care services. Furthermore, men with comorbid conditions are more likely to receive a

PSA test compared to men with none. Although we observed a decrease in PSA testing in men older than 75 years of age, there were still a large number of elderly men (n=168,739) in the cohort receiving a PSA test. Given the lack of evidence of PSA screening having a benefit in this group, the higher than expected rates of PSA testing may increase the risk of overdiagnosis and overtreatment in this population. We found no association between PSA test rate and rural/urban residence.

There are several limitations to the study. The study examined patient characteristics associated with PSA testing, however, we have no information on patient preferences, clinical intent, or physician practice patterns that may influence the use of PSA testing. Secondly, the temporal trends of PSA testing rates from 2000-2009, did not exclude men with a history of prostate cancer or disease. Therefore, the PSA testing rates observed are probably an overestimate of the screening PSA rate. In our data, we could not differentiate a screening PSA from those used to monitor response to treatment or other prostatic diseases. Thirdly, this is an observational study using claims data for Texas only and does not represent the US population. Therefore, implications of the results cannot be extended beyond the Texas population. Furthermore, our patient cohort was limited to those with fee-for-service Medicare coverage. Thus, our results do not include Medicare patients in HMOs or younger patients under 65 who may have undergone PSA testing.

In conclusion, patient age, race/ethnicity, income, and comorbidity were found to be associated with PSA testing. Knowledge of how patient characteristics influence PSA testing may provide Texas clinicians with more insight on how to optimize PSA

screening in the Texas Medicare population. Further research is needed to determine what role provider factors have on PSA test utilization rates. In addition, as more information is becoming available on the benefits and harms of PSA testing, it will be important to focus on overscreening and overdiagnosis of prostate cancer in the elderly population.

REFERENCES

1. *American Cancer Society: Cancer Facts and Figures 2012*.; Atlanta, GA: American Cancer Society 2012.

2. Schröder, F. H.; Hugosson, J.; Roobol, M. J.; Tammela, T. L.; Ciatto, S.; Nelen, V.; Kwiatkowski, M.; Lujan, M.; Lilja, H.; Zappa, M.; Denis, L. J.; Recker, F.; Berenguer, A.; Määttänen, L.; Bangma, C. H.; Aus, G.; Villers, A.; Rebillard, X.; van der Kwast, T.; Blijenberg, B. G.; Moss, S. M.; de Koning, H. J.; Auvinen, A.; Investigators, E., Screening and prostate-cancer mortality in a randomized European study. *N Engl J Med* 2009, *360* (13), 1320-1328.

3. Andriole, G. L.; Crawford, E. D.; Grubb, R. L.; Buys, S. S.; Chia, D.; Church, T. R.; Fouad, M. N.; Gelmann, E. P.; Kvale, P. A.; Reding, D. J.; Weissfeld, J. L.; Yokochi, L. A.; O'Brien, B.; Clapp, J. D.; Rathmell, J. M.; Riley, T. L.; Hayes, R. B.; Kramer, B. S.; Izmirlian, G.; Miller, A. B.; Pinsky, P. F.; Prorok, P. C.; Gohagan, J. K.; Berg, C. D.; Team, P. P., Mortality results from a randomized prostate-cancer screening trial. *N Engl J Med* 2009, *360* (13), 1310-1319.

4. Wolf, A. M.; Wender, R. C.; Etzioni, R. B.; Thompson, I. M.; D'Amico, A. V.; Volk, R. J.; Brooks, D. D.; Dash, C.; Guessous, I.; Andrews, K.; DeSantis, C.; Smith, R. A.; Committee, A. C. S. P. C. A., American Cancer Society guideline for the early detection of prostate cancer: update 2010. *CA Cancer J Clin* 2010, *60* (2), 70-98.

5. United States Preventive Services Task Force. Draft recommendation statement. http://www.uspreventiveservicestaskforce.org/draftrec3.htm; Oct 2011

6. US Census Bureau. The 2012 Statistical Abstract. Table 146. Medicare Enrollees: 1990 to 2010. U.S. Centers for Medicare and Medicaid Services, Office of the Actuary, CMS Statistics Medicare Enrollment. September 27, 2011.

7. Gilligan, T.; Wang, P. S.; Levin, R.; Kantoff, P. W.; Avorn, J., Racial differences in screening for prostate cancer in the elderly. *Arch Intern Med* 2004, *164* (17), 1858-1864.

8. Mandelblatt, J. S.; Gold, K.; O'Malley, A. S.; Taylor, K.; Cagney, K.; Hopkins, J. S.; Kerner, J., Breast and cervix cancer screening among multiethnic women: role of age, health, and source of care. *Prev Med* 1999, *28* (4), 418-425.

9. Fowke, J. H.; Schlundt, D.; Signorello, L. B.; Ukoli, F. A.; Blot, W. J., Prostate cancer screening between low-income African-American and Caucasian men. *Urol Oncol* 2005, *23* (5), 333-340.

10. Brown, K. C.; Fitzhugh, E. C.; Neutens, J. J.; Klein, D. A., Screening mammography utilization in Tennessee women: the association with residence. *J Rural Health* 2009, *25* (2), 167-173.

11. N, H.; Noone AM; Krapcho M; Neyman N; Aminou R; Waldron W.; Altekruse SF; Kosary CL; Ruhl J; Tatalovich Z; Cho H; Mariotto A.; Eisner MP; Lewins DR; Chen HS; Feuer EJ; Cronin KA; BK, E., SEER Cancer Statistics Review, 1975-2008, National Cancer Institute. Bethsada, MD,.

12. Center for Disease Control: Prostate Cancer Risk by Age. Division of Cancer Prevention and Control. Atlanta, GA, 2011. Page last updated August 2010. http://www.cdc.gov/cancer/prostate/statistics/age.htm.

13. Franks, L. M., Latent carcinoma. *Ann R Coll Surg Engl* 1954, *15* (4), 236-249.

14. Makarov, D. V.; Carter, H. B., The discovery of prostate specific antigen as a biomarker for the early detection of adenocarcinoma of the prostate. *J Urol* 2006, *176* (6 Pt 1), 2383-2385.

15. Gann, P. H.; Hennekens, C. H.; Stampfer, M. J., A prospective evaluation of plasma prostate-specific antigen for detection of prostatic cancer. *JAMA* 1995, *273* (4), 289-294.

16. Lu-Yao, G.; Albertsen, P. C.; Stanford, J. L.; Stukel, T. A.; Walker-Corkery, E. S.; Barry, M. J., Natural experiment examining impact of aggressive screening and treatment on prostate cancer mortality in two fixed cohorts from Seattle area and Connecticut. *BMJ* 2002, *325* (7367), 740; Lu-Yao, G.; Albertsen, P. C.; Stanford, J. L.; Stukel, T. A.; Walker-Corkery, E.; Barry, M. J., Screening, treatment, and prostate cancer mortality in the Seattle area and Connecticut: fifteen-year follow-up. *J Gen Intern Med* 2008, *23* (11), 1809-1814.

17. Coldman, A. J.; Phillips, N.; Pickles, T. A., Trends in prostate cancer incidence and mortality: an analysis of mortality change by screening intensity. *CMAJ* 2003, *168* (1), 31-35.

18. Shaw, P. A.; Etzioni, R.; Zeliadt, S. B.; Mariotto, A.; Karnofski, K.; Penson, D. F.; Weiss, N. S.; Feuer, E. J., An ecologic study of prostate-specific antigen screening and prostate cancer mortality in nine geographic areas of the United States. *Am J Epidemiol* 2004, *160* (11), 1059-1069.

19. Concato, J.; Wells, C. K.; Horwitz, R. I.; Penson, D.; Fincke, G.; Berlowitz, D. R.; Froehlich, G.; Blake, D.; Vickers, M. A.; Gehr, G. A.; Raheb, N. H.; Sullivan, G.;

Peduzzi, P., The effectiveness of screening for prostate cancer: a nested case-control study. *Arch Intern Med* 2006, *166* (1), 38-43.

20. Weinmann, S.; Richert-Boe, K.; Glass, A. G.; Weiss, N. S., Prostate cancer screening and mortality: a case-control study (United States). *Cancer Causes Control* 2004, *15* (2), 133-138.

21. Schröder, F. H.; Hugosson, J.; Roobol, M. J.; Tammela, T. L.; Ciatto, S.; Nelen, V.; Kwiatkowski, M.; Lujan, M.; Lilja, H.; Zappa, M.; Denis, L. J.; Recker, F.; Páez, A.; Määttänen, L.; Bangma, C. H.; Aus, G.; Carlsson, S.; Villers, A.; Rebillard, X.; van der Kwast, T.; Kujala, P. M.; Blijenberg, B. G.; Stenman, U. H.; Huber, A.; Taari, K.; Hakama, M.; Moss, S. M.; de Koning, H. J.; Auvinen, A.; Investigators, E., Prostate-cancer mortality at 11 years of follow-up. *N Engl J Med* 2012, *366* (11), 981-990.

22. Elixhauser, A.; Steiner, C.; Harris, D. R.; Coffey, R. M., Comorbidity measures for use with administrative data. *Med Care* 1998, *36* (1), 8-27.

23. Carpenter, W. R.; Howard, D. L.; Taylor, Y. J.; Ross, L. E.; Wobker, S. E.; Godley, P. A., Racial differences in PSA screening interval and stage at diagnosis. *Cancer Causes Control* 2010, *21* (7), 1071-1080.

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