ELSEVIER

Urologic Oncology 7 (2002) 105–109

UROLOGIC ONCOLOGY

Original article

Age, lifestyle, health risk indicators, and prostate-specific antigen scores in men participating in the world senior games

Ray M. Merrill, Ph.D.*, Ugo A. M. Perego, M.Sc., Stephen W. Heiner, Ph.D.

Department of Health Science, College of Health and Human Performance, Brigham Young University, Provo, UT 84602, USA

Received 22 June 2001; accepted 3 September 2001

Abstract

Background: A number of risk factors have been implicated for prostate cancer, with dietary fat intake the most commonly accepted modifiable risk. *Objective:* To assess the relationship between health risk indicators (e.g., cholesterol, blood pressure, blood sugar, and percent body fat), which are related to dietary fat intake, and prostate-specific antigen (PSA) scores. Relationships between demographics and select behaviors (e.g., cigarette smoking and physical activity) with PSA scores are also considered. The setting was the 1999 Huntsman World Senior Games in St. George, Utah. Subjects' analysis is based on 536 men aged 50 years and older completing a questionnaire and receiving free screening, including a PSA. *Methods:* Frequency distributions, multiple regression techniques, and the Spearman correlation coefficients. *Results:* A positive relationship was observed between increasing age groups and mean PSA scores (Cochran-Mantel-Haenszel Chi-Square: 53.8, $p<0.0001$). After adjusting for age, none of the personal risk factor indicators (i.e., cholesterol, blood pressure, blood sugar, and percent body fat) were related to PSA scores. Other factors not related to PSA scores after adjusting for age were race, marital status, education, history of chronic disease, cigarette smoking, alcohol use, and physical activity. *Conclusion:* Because risk indicators such as cholesterol, blood pressure, blood sugar, and percent body fat are associated with dietary fat intake, their failure to be related with PSA scores makes it further unclear how this commonly accepted modifiable risk factor for prostate cancer may influence the disease.

Keywords: Aged 50 and over; Alcohol; Physical activity; PSA; Tobacco smoking

1. Introduction

Prostate cancer is the most frequently diagnosed cancer and the second leading form of cancer death for men in the United States [1]. Prostate cancer is a disease of old age, with the frequency of occurrence near zero prior to age 45, then increasing exponentially to above 1100 per 100,000 for men in their 70s, before decreasing slightly in the oldest ages [2]. Probable risk factors for the disease include dietary fat intake, especially from red meat and dairy products; increasing age; and family history [3–6]. Other potential risk factors more recently implicated are physical inactivity, cigarette smoking, and alcohol consumption [7–11]. Causal processes by which these risk factors may influence prostate cancer are not fully understood. Perhaps they are related to other health risk indicators such as high cholesterol, blood pressure, blood sugar, or body fat that, in turn, influence prostate cancer.

The purpose of this study is to assess the relationship between demographics, behaviors (tobacco, alcohol, and physical activity), and health risk indicators (cholesterol, blood pressure, blood sugar, and percent body fat) with prostate-specific antigen (PSA) scores. PSA is a tumor marker currently used for early detection of prostate cancer. It has been used as a standard screening procedure for this form of cancer since the 1980s and has been associated with the sharp increase in incidence of prostate cancer measured between 1987 and 1992 [12].

2. Methods

Analysis is based on 536 male senior athletes, aged 50 years and older, who participated in one or more of the free screening tests at the 1999 Huntsman Senior World Games in St. George, Utah. Trained health science and nursing students from Brigham Young University administered the screening tests. Dixie Medical Center administered cholesterol and PSA screenings. Intermountain Health Care Homecare conducted blood sugar screenings. Professional phlebotomists and nursing students drew all blood samples. Trained students used blood pressure cuffs and stethoscopes for blood pressure screenings, and bioelectrical impedance was used for percent body fat screenings. All

* Corresponding author. Tel.: +1-801-378-9788; Fax: +1-801-378-4388.

E-mail address: Ray_Merrill@byu.edu. (R.M. Merrill)

1078-1439/02/$ – see front matter
PII: S1078-1439(01)00176-4

screenings were performed using calibrated instruments to enhance validity.

Participants were also asked to complete a questionnaire, which obtained information on age, gender, race, marital status, educational history, tobacco use, alcohol consumption, and physical activity. The tobacco question was categorized as regularly smoked cigarettes in the past year, regularly smoked cigarettes but not within the past year, and never regularly smoked cigarettes. The alcohol question was similarly categorized. A previously validated questionnaire was used to provide an indication of physical activity among the elderly participants [13–14]. The physical activity variable was continuously scaled and followed an approximately normal distribution.

Data were analyzed using the SAS system for personal computers, release 8.0. Frequency distributions, multiple regression techniques, and the Spearman correlation coefficients were used to summarize and describe the data. Tests of significance were based on the 0.05 level.

3. Results

The number and percentage of men participating in free screening at the 1999 World Senior Games are presented according to demographic and lifestyle variables in Table 1. Variable categories with the highest frequencies were among those aged 60–69, Caucasian, married/cohabitating, and having at least some college. A history of chronic conditions was seen in over one-fourth of the subjects. The majority did not have a history of tobacco or alcohol use and had maintained a high level of physical activity for five or more years.

Subjects were asked to identify the risk factors for prostate cancer from the following choices: increasing age, high-fat diet, low-fiber diet, smoking, family history, having multiple sexual partners, and other. Generally recognized or putative risk factors for prostate cancer are increasing age, high-fat diet, and family history. Participants identified these as risk factors 79.96% (427), 45.13% (241), and 50.37% (269) of the time, respectively.

Table 2 presents mean screening scores for PSA, cholesterol, systolic blood pressure, diastolic blood pressure, blood sugar, and percent body fat according to age. Each of the screening scores is influenced by age except blood sugar and percent body fat. With increasing age, screening scores increased for PSA and systolic blood pressure and decreased for cholesterol and diastolic blood pressure. Men with PSA scores greater than 4ng/mL are typically recommended to receive a biopsy of the prostate [15]. Approximately 14.5% of the men in our study had PSA scores above this level. Standard benchmarks for the other screening tests are: cholesterol >200 mmol/l; blood pressure, systolic >140 mm Hg, diastolic >90 mm Hg; blood sugar, low <70 mmol/l, high >120 mmol/l; percent body fat, men >25%, women >30% [16–17].

Table 1
Summary of demographic and lifestyle variables for 536 men aged 50 years and older participating in screening at the 1999 World Senior Games

Characteristics	Number	Percent
Age		
50–59	142	26.5%
60–69	264	49.25%
70–79	110	20.52%
80+	20	3.73%
Race		
Caucasian	505	95.64%
Other	23	4.36%
Marital Status		
Never Married	7	1.32%
Married/Cohabitating	460	86.96%
Divorced/Widowed	62	11.72%
Educational History		
Less than high school	18	3.45%
High school graduate	89	17.05%
Some college	136	26.05%
College graduate	124	23.75%
Post graduate schooling	155	29.69%
History of Chronic Disease*		
Yes	143	26.68%
No	393	73.32%
History of Tobacco Use†		
Current	13	2.48%
Previous	141	26.86%
Never	371	70.67%
History of Alcohol Use‡		
Current	85	16.25%
Previous	61	11.66%
Never	377	72.08%
How Long Physicaly Active (three or more times/week)		
Not active	10	1.88%
0–6 months	6	1.13%
6 months –1 year	3	0.56%
1–5 years	18	3.39%
More than 5 years	494	93.03%

*Refers to a history of cancer, heart disease, diabetes, glaucoma, arthritis, lung disease, or other.

†Smoked regularly within the past year (current); smoked regularly in the past (previous); and never smoked regularly (never).

‡Drank alcohol regularly within the past year (current); drank alcohol regularly in the past (previous); and never drank regularly (never).

Mean levels of PSA are presented by demographic and lifestyle variables in Table 3. Mean scores are adjusted for age. None of the variables considered significantly influenced PSA scores, although alcohol use was only marginally insignificant. For this variable, those who never consumed alcohol had slightly higher PSA levels. Also considered was the continuous scale measure of physical activity. This variable was not associated with PSA, based on the Spearman rank correlation (0.0475, $P=0.3957$ adjusted for age).

Table 4 presents Spearman rank correlation coefficients of PSA by each of the screening variables. Associations between PSA and cholesterol, systolic or diastolic blood pressure, blood sugar, or percent body fat were not significant.

Table 2
Mean level of prostate-specific antigen (PSA), cholesterol, systolic blood pressure, diastolic blood pressure, blood sugar, and percent body fat according to age

	Age categories					
Screening variables	50–59	60–69	70–79	80+	50+	*P* value*
PSA						
95% Confidence interval	1.32 ± 0.23	2.05 ± 0.21	3.32 ± 0.58	3.58 ± 1.52	2.17 ± 0.19	<0.0001
Cholesterol						
95% Confidence interval	203.89 ± 5.81	202.18 ± 4.12	194.47 ± 6.66	179.17 ± 15.27	201.22 ± 2.97	0.0041
Systolic blood pressure						
95% Confidence interval	131.01 ± 2.82	134.77 ± 2.07	139.48 ± 4.33	136.33 ± 9.64	134.76 ± 1.60	0.0063
Diastolic blood pressure						
95% Confidence interval	84.02 ± 1.88	82.84 ± 1.16	80.63 ± 2.46	72.89 ± 4.78	82.38 ± 0.94	0.0019
Blood sugar						
95% Confidence interval	90.70 ± 3.42	96.59 ± 5.09	96.42 ± 4.99	103.42 ± 12.09	94.61 ± 2.88	0.4211
Percent body fat	16.69 ± 1.35	17.06 ± 0.85	17.18 ± 1.44	15.10 ± 5.83	16.79 ± 0.64	0.7075

*Based on Cochran-Mantel-Haenszel statistic testing whether the mean scores differ across the four age categories (50–59, 60–69, 70–79, 80+).

4. Discussion

This study investigated possible relationships between demographics, lifestyle, screening scores, and PSA for a select group of elderly men. The aim of this study was to provide further insight into processes by which prostate cancer occurs, based on PSA as a surrogate marker for prostate cancer. The only relationship identified was between increasing age and PSA. A positive relationship between age and PSA is consistent with other studies in this area [18]. Race, marital status, education, and history of chronic disease were not related to PSA scores.

The only modifiable risk factor that has been consistently linked to prostate cancer has been dietary fat intake, especially from red meat and dairy products [19]. Although the current study did not collect information on diet, personal screening scores reflecting diet (blood pressure, cholesterol, blood sugar, and percent body fat) were not associated with PSA after adjusting for age. Other studies have looked at these variables in relation to prostate cancer. While no evidence was found for a positive correlation with blood pressure [20], obesity and high levels of cholesterol have been positively associated with prostate cancer [21–23]. We are not aware of any studies that have considered the relationship between blood glucose and prostate cancer.

Studies focusing on the relationship between vigorous physical activity and prostate cancer have shown a protective effect from physical activity [24–25]. However, we found no relationship between physical activity and PSA, based on either of the physical activity variables used, nor did we find a relationship between percent body fat and

Table 3
Mean level of prostate-specific antigen (PSA) by demographic and lifestyle variables

Variables	Adjusted mean*	*P* value†
Race		
Caucasian	2.19	
Other	2.02	0.4949
Marital status		
Never married	2.22	
Married/cohabitating	2.19	
Divorced/widowed	2.11	0.8071
Education		
Less than high school	3.16	
High school graduate	1.96	
Some college	1.94	
College graduate	2.33	
Graduate degree or schooling	2.30	0.1517
History of chronic disease		
Yes	1.99	
No	2.25	0.1320
History of tobacco use		
Current	2.13	
Previous	2.11	
Never	2.19	0.4583
History of alcohol use‡		
Current	2.02	
Previous	1.88	
Never	2.26	0.0580
How long physically active (three or more times/week)		
Not active	3.13	
0–1 year	1.83	
At least 1year	2.17	0.2959

*Means adjusted for age.

†Cochran-Mantel-Haenszel statistic testing whether the mean scores differ while adjusting for age.

Table 4
Spearman correlation coefficients of prostate-specific antigen (PSA) by the screening variables and exercise

	Correlation	P value*	Adjusted *P* value†
Cholesterol	−0.0109	0.6364	0.5579
Systolic blood pressure	0.1673	0.0051	0.0933
Diastolic blood pressure	0.0471	0.4260	0.0913
Blood sugar	0.0099	0.7065	0.9907
Percent body fat	0.0119	0.7680	0.6176

*Cochran-Mantel-Haenszel statistic testing for nonzero correlation.

†Cochran-Mantel-Haenszel statistic testing for nonzero correlation adjusted for age.

PSA. This may be partly explained by the subject population, in which there were not a large number of individuals who were either physically inactive or obese.

Recent studies have suggested that tobacco smoking increases the risk of prostate cancer [26–27]. This may be because of the stimulating effect of nicotine on the level of testosterone [28]. Failure to find a relationship between tobacco smoking and PSA in the current study may be at least partially due to the small number of current smokers among the participants.

Studies assessing the link between alcohol consumption and prostate cancer had mixed results. In one study, researchers concluded that alcohol intake reduces the level of circulating testosterone and that men with alcoholic cirrhosis have diminished testosterone levels and thus lower risk of prostate cancer [29]. Another study indicated that a positive correlation existed between the level of alcohol intake and risk of prostate cancer, suggesting that alcohol contains chemicals that may be carcinogenic [30]. Although marginally insignificant, the most probable correlate with PSA appears to be alcohol, as suggested by the former of these two studies.

Several factors indicate the health conscious orientation of many of the senior participants at the games. First, mean screening scores are relatively very good. Second, current tobacco and alcohol use are comparatively low, factors likely influenced by the location of the games in Utah, where about 70% of the adult population is affiliated with the Church of Jesus Christ of Latter-day Saints [31]. This is a proscriptive religion that strongly discourages its members from tobacco smoking or alcohol consumption [32]. Based on telephone area codes recorded on the questionnaires, 165 of 536 (30.78%) subjects were from Utah. This suggests that, although affiliation with the LDS Church may have contributed to the low levels of tobacco smoking and alcohol use, the primary reason appears to be the health orientation of the participants in general.

In the questionnaire, participants identified their knowledge of prostate cancer risk factors. The percentage of participants identifying increased age, high-fat diet, and family history, as risk factors for prostate cancer were higher than in a previous study of elderly men in the United States. For example, increasing age was identified as a risk factor for prostate cancer by about 80% of the participants in this study, compared to about 55% in the former study [33]. There were no significant relationships between awareness of these risk factors and the participants' demographics, lifestyle, or personal screening scores, including PSA. A similar study with a more diverse group of participants might identify relationships between prostate cancer awareness and some of these other variables.

About 25% of the participants at the Senior Games chose to receive one or more free screening tests and comprise the subjects in this study. Although the results are based on a restricted population with certain limitations already mentioned, the controlled administration of the questionnaire and screening tests helped ensure validity and allowed us to evaluate several possible relationships not previously considered in a single group of elderly men.

5. Conclusion

Increasing age was the only factor significantly associated with PSA scores. After adjusting for age, no relationship was found between levels of PSA and demographics (race, marital status, education, history of chronic disease) or lifestyle behaviors (cigarette smoking, alcohol use, physical activity). Further, none of the personal risk indicators (cholesterol, blood pressure, blood sugar, and percent body fat) were related with the age-adjusted PSA scores. Because these risk indicators are often influenced by diet, it is further unclear how diet, a commonly accepted modifiable risk factor for prostate cancer, influences this disease.

References

[1] Greenlee RT, Murray T, Bolden S, Wingo PA. Cancer statistics, 2000. CA Cancer J Clin 2000;50:7–33.
[2] Ries LAG, Eisner MP, Kosary CL, et al., editors. SEER Cancer Statistics Review, 1973–1997. Bethesda, MD: National Cancer Institute, 2000.
[3] Can prostate cancer be prevented? [American Cancer Society Web site]. Available at: http://www3.cancer.org/eprise/main/docroot/CRI/content/CRI_2_4_2X_Can_prostate_cancer_be_prevented_36. Accessed November 12, 2001.
[4] Kolonel LN, Yoshizawa CN, Hankin JH. Diet and prostatic cancer: a case-control study in Hawaii. Am J Epidemiol 1988;127:999–1012.
[5] Ross RK, Shimizu H, Paganini-Hill A, Honda G, Henderson BE. Case-control studies of prostate cancer in blacks and whites in Southern California. J Natl Cancer Inst 1987;78:869–74.
[6] Graham S, Haughey B, Marshall J, et al. Diet in the epidemiology of carcinoma of the prostate gland. J Natl Cancer Inst 1983;70:687–92.
[7] Oliveria SA, Kohl HW, Trchopoulos D, Blair SN. The association between cardiorespiratory fitness and prostate cancer. Med Sci Sports Exerc 1996;28:97–104.
[8] Oliveira SA, Lee IM. Is exercise beneficial in the prevention of prostate cancer? Sports Med 1997;23:271–8.
[9] Tymchuk CN, Tessler SB, Aronson WJ, Barnard RJ. Effects of diet and exercise on insulin, sex hormone-binding globulin, and prostate-specific antigen. Nutr Cancer 1998;31:127–31.
[10] Platz EA, Kawachi I, Rimm EB, et al. Physical activity and benign prostatic hyperplasia. Arch Intern Med 1998;158:2349–56.
[11] Giovannucci E, Leitzmann M, Soiegelman D, et al. A prospective study of physical activity and prostate cancer in male health professionals. Cancer Res 1998;58:5117–22.
[12] Potoski AL, Miller BA, Albertsen PC, Kramer BS. The role of increasing detection in the rising incidence of prostate cancer. JAMA 1995;273:548–52.
[13] Voorrips LA, Ravelli ACJ, Dongelmans PCA, Deurenberg P, Van Staveren WA. A physical activity questionnaire for the elderly. Med Sci Sports Exerc 1991;23:974–9.
[14] Bonnefoy M, Kostka T, Berthouze SE, Lacour JR. Validation of a physical activity questionnaire in the elderly. Eur J Appl Physiol 1996;74:528–33.
[15] Catalona WJ, Smith DS, Ratliff TL, Basler JW. Detection of organ-confined prostate cancer is increased through prostate-specific antigen-based screening. JAMA 1993;270:948–54.
[16] Blood glucose levels [American Diabetes Association Web site]. Available at: www.diabetes.org. Accessed November 2000.

[17] Hearth and stroke A–Z guide [American Heart Association Web site]. Available at: www.americanheart.org. Accessed February 2001.
[18] Lopez LA, Del Villar V, Ulla M, et al. Prevalence of abnormal levels of serum tumor markers in elderly people. Age Ageing 1996;25:45–50.
[19] Whittemore AS, Kolonel LN, Wu AH, et al. Prostate cancer in relation to diet, physical activity, and body size in blacks, whites, and Asians in the United States and Canada. J Natl Cancer Inst 1995;97:652–61.
[20] Friedman GD. Blood pressure and heart rate: no evidence for a positive association with prostate cancer. Ann Epidemiol 1997;7:486–9.
[21] Giovannucci E, Rimm EB, Stampfer MJ, Colditz GA, Willett WC. Height, body weight, and risk of prostate cancer. Cancer Epidemiol Biomarkers Prev 1997;6:557–63.
[22] Swinnen JV, Verhoeven G. Androgens and the control of lipid metabolism in human prostate cancer cells. J Steroid Biochem Mol Biol 1998;65:191–8.
[23] Putnam SD, Cerhan JR, Parker AS, et al. Lifestyle and anthropometric risk factors for prostate cancer in a cohort of Iowa men. Ann Epidemiol 2000;10:361–9.
[24] Oliveria SA, Kohl HW, Trchopoulos D, Blair SN. The association between cardiorespiratory fitness and prostate cancer. Med Science Sports Ex 1996;28:97–104.
[25] Oliveira SA, Lee IM. Is exercise beneficial in the prevention of prostate cancer? Sports Med 1997;23:271–8.
[26] Hsing AW, McLaughlin JK, Hrubec Z, Blot WJ, Fraumeni JF. Tobacco use and prostate cancer: 26-year follow-up of US veterans. Am J Epidem 1991;133:437–41.
[27] Coughlin SS, Neaton JD, Sengupta A. Cigarette smoking as a predictor of death from prostate cancer in 348,874 men screened for the Multiple Risk Factor Intervention Trial. Am J Epidem 1996;143:1002–6.
[28] Dai WS, Gutai JP, Kuller LH, Cauley JA. Cigarette smoking and serum sex hormones in men. Am J Epidem 1988;128:796–805.
[29] Platz AE, Rimm EB, Kawachi I, et al. Alcohol consumption, cigarette smoking, and risk of benign prostatic hyperplasia. Am J Epidem 1999;149:106–15.
[30] Hayes RB, Brown LM, Schoenberg JB, et al. Alcohol use and prostate cancer risk in US blacks and whites. Am J Epidem 1996;143:692–7.
[31] Kosmin BA, Lachman SP. One nation under God: religion in contemporary American society. New York: Harmony, 1993.
[32] Church of Jesus Christ of Latter-day Saints. The doctrine and covenants, 1986; section 89.
[33] Breslow RA, Sorkin JD, Frey CM, Kessler LG. Americans' knowledge of cancer risk and survival. Prev Med 1997;26:170–7.