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Physical Activity and Prostate Cancer Mortality in Puerto Rican Men

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Studies on the association between physical activity and fatal prostate cancer have produced inconclusive results. The Puerto Rico Heart Health Program was a cohort study of a randomly selected sample of 9824 men age 35 to 79 years at baseline who were followed for mortality until 2002. Multiple examinations collected information on lifestyle, diet, body composition, exercise, urban-rural residence, and smoking habits. Physical activity status was measured using the Framingham Physical Activity Index, an assessment of occupational, leisure-time, and other physical activities measured as usual activity over the course of a 24-hour day. Physical activity was stratified into quartiles. Multivariate logistic regression analysis was used to assess the association of physical activity with prostate cancer mortality. Other covariates included age, education, urban-rural residence, smoking, and body mass index. Compared with the lowest level of physical activity (Q1), the risk of prostate cancer mortality was OR = 0.99 (95% CI = 0.64–1.55) for Q2, OR = 1.34 (95% CI = 0.88–2.05) for Q3, and OR = 1.19 (95% CI = 0.75–1.90) for Q4. Further analyses by age group, overweight status, or vigorous physical activity also did not show a significant association between physical activity and prostate cancer mortality. Physical activity did not predict prostate cancer mortality in this group of Puerto Rican men.

Keywords: cancer, epidemiology, physical activity, mortality, chronic disease

Second to lung cancer, prostate cancer kills more men than any other cancer in the United States. A large number of deaths from prostate cancer is also observed among other Western societies.[1,2] Although microscopic (latent) prostate tumors in most populations are similar, there are striking differences in the incidence rates among racial/ethnic groups.[2,3] The incidence and mortality from cancer

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among African American men is one of the highest in the world.[4,5] Between 1988 and 1992, the highest reported rates (age-adjusted world standard), exceeding 30,000 per 100,000 man years, were observed among US Blacks. Rates in Black Caribbean men, especially from Jamaica, are also among the highest in the world. Prostate cancer mortality among all Hispanics in the US is considered lower than among non-Hispanic Whites. Differences among Hispanic subgroups support an increased burden of prostate cancer mortality among Puerto Ricans and other Caribbean men of different skin color.[6–9]

Prostate cancer rates in the Commonwealth of Puerto Rico are similar to those observed in the United States. The age-adjusted prostate cancer mortality rates among men from Puerto Rico and the United States are 16.1/100,000 and 15.7/100,000, respectively. However, prostate cancer kills more Puerto Rican men in Puerto Rico than any other cancer, including lung cancer. Puerto Ricans in the United States have prostate cancer mortality rates lower than those observed in Puerto Rico but higher than those among other Hispanic subgroups such as Mexican Americans or Cuban Americans.[10–13] The fact that prostate cancer rates change in migrant populations and vary dramatically in ethnically similar populations residing in different geographic locations strongly suggests that environmental factors can greatly influence the risk of this cancer.[14] Despite the large number of deaths from prostate cancer among men and minority men, there is little knowledge about lifestyle changes that can modify the risk.[4,10–13,15–24]

One important lifestyle factor that has been studied in association with prostate cancer is physical activity. Results from these studies have not been consistent. Although some studies show a small benefit, there are several reports showing no relationship or an increased risk with physical activity. Moreover, the relationship between physical activity and prostate cancer among US Hispanic men has not been well characterized.[25–38] We report here on the association of physical activity and prostate cancer mortality in a cohort of Puerto Rican men who took part in the Puerto Rico Heart Health Program (PRHHP).

Methods

Study Population

The Puerto Rico Heart Health Program is a prospective cohort study designed to examine morbidity and mortality from coronary heart disease in urban and rural Puerto Rican men.[39–42] Briefly, the original sampling was designed to recruit men age 45 to 64 years who were free from coronary heart disease at the time of the first examination in 1965. These men were sampled from 3 urban areas and 4 rural areas in the northeast part of Puerto Rico by the personnel who participated in the United States decennial census.[40] All of these men were encouraged to attend the baseline examination, and an 80% response rate was achieved. The original cohort consisted of men who were 45 to 64 years of age. Other participants age 35 to 44 years (n = 348) and 65 to 79 years (n = 678), who were not part of the original sampling frame, were also included in the current study. Thus, the total number of examined participants used in this analysis was 9824 men between the ages of 35 and 79 years.

All men completed an extensive self-report of demographic characteristics, personal and family health history, and health habits, including education, occupation, income, a history of smoking, and place of residence.

Assessment of Physical Activity and Other Characteristics

During the first examination, each participant provided sociodemographic information. A complete medical history was conducted with a physical examination that included laboratory determination and a resting 12-lead electrocardiogram. At this first examination, physical activity status was assessed using the Framingham Physical Activity Index.[41,43] This questionnaire assessed occupational, leisure-time, and other physical activities measured as usual activity over the course of a 24-hour day and was interviewer administered. The interviewer asked the individual about the average hours of participation in sleep, rest, occupational, and extracurricular activities over a typical 24-hour period. The intensity of the activity was also inquired about according to the following categories: sedentary, slight activity, moderate activity, and heavy activity. Usual physical activity was determined by a review of the number of hours spent at various activities. The Framingham Physical Activity Index has Spearman correlation values of .36 for Paffenbarger's Harvard Alumni and .72 for Penn Alumni Questionnaires, .57 for the Baecke Questionnaire of Habitual Physical Activity, and .48 for the Lipid Research Clinics Questionnaire. For analysis, the number of hours at each activity was converted to an index of usual daily energy expenditure. This was accomplished by grading activities into different categories using estimated oxygen consumption per hour for each activity or metabolic equivalents (METs). One MET is equivalent to energy expenditure at rest, approximately 3.5 ml of O_2 per kilogram of body weight per minute. The usual activities were classified using the original scheme used in the Framingham Study as sedentary (MET = 1.0), light (MET = 1.1), lightly moderate to moderate (MET = 2.4), and strenuous (MET = 5.0). The product of this grade and duration in hours gave a score of a physical activity index. A score of 24 meant the individual slept or reclined for 24 hours in a day. Higher scores indicated either strenuous activity for shorter periods and/or moderate activity for a longer time. The questionnaire was used in subsequent follow-up examinations. Estimates of consistency of administration between the first test using the Framingham Physical Activity Index and 2- to 3-year posttest in this group of Puerto Rican men provided Pearson correlation coefficients of .30 to .59.[41,44]

We categorized our analytic sample by quartiles of physical activity. The physical activity index ranged from 24 to 71. We further examined patterns of physical activity within quartiles by hours spent doing no activity such as sleeping or resting; sedentary or very light activities such as sitting; light activities such as walking at level; moderate physical activity such as brisk walking, climbing stairs, or walking uphill; and vigorous physical activity such as cutting sugar cane or other strenuous activities. The cutoff point for quartile 1 was a physical activity index of 27 or less, which represents the group that is most inactive. To assure quartile 1 reflects only those who are sedentary, we reclassified 18 participants (out of 2401) from quartile 1 into quartile 2 (N = 2277). These participants had a physical activity index of less than 27 but reported participating in some type of moderate physical activity. Thus, quartile 1 of physical activity includes participants who only engaged in no physical activities, sedentary activities, or very light physical activities. The physical activity index range for quartile 2 was greater than 27 but less than 30, for quartile 3 the range was greater than or equal to 30 but less than 37 (N = 2171), and for quartile 4, scores were greater than or equal to 37 (N = 2287).

Obesity Classification

We used the guidelines released by the National Heart, Lung, and Blood Institute, National Obesity Education Initiative to classify our participants based on body mass index (BMI).[45] Briefly, underweight individuals are those whose BMI is less than 18.5, normal or healthy-weight persons have a BMI between 18.5 and 24.9, overweight individuals are those with a BMI between 25 and 29.9, and the obese are persons with a BMI of 30 and above.

Other Covariates

Education level was determined from the interview by ascertaining the highest grade completed in school. For our analysis, participants were grouped into 5 categories: no formal schooling, and those who attended or completed grades 1 to 4, grades 5 to 8, high school, or college. The detailed smoking history provided the basis to classify participants into nonsmokers, previous smokers, and smokers. Rural-urban residence was determined based on place of residence at baseline. Characterization of rural areas was composed primarily of small farms located on very hilly terrain, and urban areas consisted of a denser cluster of houses, many of which housed residents who worked in the business and industry around San Juan.

Ascertainment of Fatal Prostate Cancer

Prostate cancer mortality was assessed throughout the active phase of the study, and 35 men had died of prostate cancer by 1980. An additional 88 prostate cancer deaths between 1981 and 2002 were ascertained using passive follow-up by matching participants in the PRHHP with the Puerto Rico Cancer Registry and Puerto Rico Vital Statistics Registry. Cases were matched on the basis of a full match with first name, maternal and paternal last names, date of birth, place of birth, and gender. Validity of matched cases was assessed by obtaining copies of the death certificate. A recent update (2003–2005) from the Puerto Rico Cancer Registry identified an additional 44 prostate cancer deaths. In total, there were 167 prostate cancer deaths in the study population.

Statistical Analysis

The outcome variable of interest was mortality from prostate cancer. The multivariate logistic function model was used to analyze relationships between known risk factors and prostate cancer mortality. We examined the potential contribution of the following variables in the model: age (years), education (no formal schooling, grades 1 to 4, grades 5 to 8, attended or completed high school, attended or completed college), body weight classification (underweight, healthy weight, overweight, obesity), baseline smoking status (nonsmokers, former smokers, current smokers), and urban-rural residence (urban, rural).[43,46–48]

Results

The analytic sample consisted of 9780 participants with complete data (44 of the 9824 men who participated in the PRHHP study had missing or incomplete data on physical activity). Prostate cancer deaths are referred to as cases and the remainder of the cohort is referred to as noncases. Selected baseline characteristics of the study population are shown in Table 1. Cases were older and somewhat more educated than noncases. Smoking, body mass index, and physical activity were similar between cases and noncases. The percent distribution in different quartiles of physical activity ranged from 22.8% to 27.5%, showing little variability among both cases and noncases.

After adjustment for age and BMI, we found that physical activity was not associated with prostate cancer mortality in this group of Puerto Rican men (Table 2). Adjustments for other confounders outlined in Table 1 did not modify the relationship; these other confounders were not significantly related to prostate cancer either.

To better understand if the relationship of physical activity differed by categories of body mass index and age, we stratified our cohort among those who were overweight or obese (BMI ≥ 25) and those who were not overweight (BMI < 25). Physical activity was not associated with prostate cancer within these strata. Similarly, in strata defined by those who were younger than 55 years of age at baseline and among those who were 55 years of age or older, there was no association of physical activity and prostate cancer mortality.

We further examined participation in vigorous physical activity and risk of prostate cancer mortality. Participants in the cohort were grouped based on their baseline participation in vigorous physical activity (MET ≥ 5) for 1 hour or more a day. The age-adjusted odd ratios among those reporting participating in vigorous physical activity for 1 or more hours a day was 0.96 (95% CI = 0.68–1.34). Adjustment for education, body mass index, and smoking did not alter the results. Stratifying the analysis among those younger than 55 years of age (OR = 0.70, 95% CI = 0.456–1.21) or 55 years or older (OR = 1.17, 95% CI = 0.76–1.80) did not yield a significant relationship between vigorous physical activity and fatal prostate cancer.

Discussion

Results of studies on the relationship between physical activity and prostate cancer risk across studies have not been consistent. Although some longitudinal studies have shown a protective association of physical activity with prostate cancer risk,[28,34,38,49–56] others have found no association or positive association.[31,35,37,57–62] Several comprehensive reviews of the literature have concluded that the data regarding physical activity and prostate cancer is inconsistent.[32,63] Our results are in accordance with those previous studies showing no association between

Table 1 Baseline Characteristics of the Puerto Rico Heart Health Program Participants According to Prostate Cancer Mortality

	Prostate cancer deaths (n = 167)		Noncases (n = 9613)		
	n	%	n	%	Chi-square *P*
Age, y					.04
35–44	3	1.8	345	3.6	
45–54	69	41.3	4840	50.4	
55–64	82	49.1	3763	39.2	
65+	13	7.8	665	6.9	
Education					.09
no formal schooling	16	9.6	975	10.1	
grades 1–4	51	30.5	3392	35.3	
grades 5–8	58	34.7	2754	28.7	
attended/completed high school	22	13.2	1700	17.7	
more than high school	20	12.0	786	8.2	
Living					.52
urban	47	28.1	2928	30.5	
rural	120	71.9	6685	69.5	
Smoking					.53
none	51	30.5	3237	33.7	
past	73	43.7	4208	43.8	
current	43	25.8	2159	22.5	
BMI (weight (kg)/height (m)^2)					.89

(continued)

Table 1 *(continued)*

	Prostate cancer deaths (n = 167)		Noncases (n = 9613)		Chi-square
	n	**%**	**n**	**%**	***P***
underweight (<18.5)	4	2.4	310	3.2	
normal weight (18.5–24.9)	76	45.5	4530	47.1	
overweight (25–29.9)	66	39.5	3609	37.5	
obese (30+)	21	12.6	1164	12.1	
Physical activity					.64
quartile 1 (low)	43	25.8	2621	27.3	
quartile 2	38	22.8	2381	24.8	
quartile 3	46	27.5	2240	23.3	
quartile 4 (high)	40	24.0	2371	24.7	

Abbreviation: BMI, body mass index.

Table 2 Odds Ratios for Prostate Cancer Mortality in Relation to Baseline Physical Activity (167 Cases Among 9613 Men)

	Quartiles of physical activity			
	Q1	Q2	Q3	Q4
Overall, Range				
OR (95% CI)[a]	1.0	1.01 (0.65–1.58)	1.32 (0.87–2.02)	1.10 (0.71–1.71)
OR (95% CI)[b]	1.0	0.99 (0.64–1.55)	1.34 (0.88–2.05)	1.19 (0.75–1.90)
BMI: underweight or normal weight				
OR (95% CI)[c]	1.0	1.22 (0.62–2.41)	1.64 (0.87–3.09)	1.07 (0.55–2.11)
BMI: overweight or obese				
OR (95% CI)[c]	1.0	0.87 (0.49–1.56)	1.22 (0.68–2.18)	1.53 (0.81–2.91)
Age: <55 years				
OR (95% CI)[d]	1.0	1.35 (0.67–2.73)	1.63 (0.82–3.24)	1.03 (0.47–2.25)
Age: 55+ years				
OR (95% CI)[d]	1.0	0.78 (0.43–1.41)	1.20 (0.69–2.09)	1.34 (0.75–2.38)

Abbreviation: BMI, body mass index.

[a] Adjusted for age (35–44, 45–54, 55–64, 65+ years) and BMI (underweight, normal weight, overweight, obese).

[b] Adjusted for age, education (no formal schooling, grades 1–4, grades 5–8, attended/completed high school, more than high school), BMI, living (urban, rural), and smoking (never smoker, current smoker, past smoker).

[c] Adjusted for age (continuous years), education, living, and smoking.

[d] Adjusted for age (continuous years), education, BMI, living, and smoking.

physical activity and prostate cancer. We did not observe a dose-response trend either, and adjustment for age, BMI, smoking, or education did not change the association.

Most of the studies to date have been of men of European ancestry. One study was from Shanghai, another from Hawaii, and another had data on African Americans.[49,50,64] Severson et al[55] used the same physical activity index from the Framingham study and heart rate (as a marker of physical fitness) in a cohort of 7925 Japanese men in Hawaii age 46 to 65 years to examine their associations with prostate cancer incidence. After adjustment for age and BMI, they found no association when comparing the most active relative to the least active men, no protective effect of occupational physical activity, and heart rate was not related to prostate cancer incidence either. Our findings are the first longitudinal study of physical activity and prostate cancer in a large group of Hispanic men.

In our study we had data on prostate cancer mortality and not incidence. Prostate cancer mortality might be a reflection of the most aggressive prostate cancer cases and, therefore, is of great public health significance. By using fatal prostate cancer we also avoided the possibility of increased prostate cancer incidence owing to secular trends in incidence due to screening. Active men might be more likely to undergo screening and might have higher rates of incidence of prostate cancer, especially at the early stage. By concentrating our efforts on prostate cancer mortality, we reduced this bias. Prostate cancer ascertainment was conducted in conjunction between the Puerto Rico Cancer Registry and the Puerto Rico Office of Vital Statistics. The Puerto Rico Cancer Registry is a full member of the North American Association of Central Cancer Registry and adheres to Data Standards for Cancer Registry established by this organization. Our reliance on prostate cancer mortality allowed us to also validate our mortality cases by obtaining death certificates on a subset of 88 cases. Of these 88 requests for death certificates, we received 87 death certificates with prostate cancer mortality as the underlying cause of death. Thus, we believe our ascertainment of fatal prostate cancer using the two registries is valid.

Our exposure variable, physical activity, has been used in other studies; however, one potential limitation of our study is that it might not be specific enough to differentiate lifetime or usual levels of physical activity. This is not a unique problem of this study because objective measures of physical activity for use in large epidemiological studies are not yet feasible. We further studied participation in vigorous physical activity to examine if the intensity of participation in physical activity is important for prostate cancer. One hypothesis was that changes in testosterone levels associated with participation in aerobic compared with anaerobic physical activity might have a differential effect on prostate cancer. Our findings failed to observe an association between vigorous physical activity and prostate cancer in contrast to results from Giovannucci et al (2005).[36,38]

In summary, physical inactivity was not a risk factor for fatal prostate cancer in this group of Puerto Rican men. Most studies of prostate cancer and physical activity have been among European Whites; ours is the first to examine this relationship longitudinally in a well-characterized subgroup of Hispanics. Further studies should examine the role of lifetime physical activity and incorporation of more valid objective measures of physical activity to examine the role of physical activity in the prevention of prostate cancer.

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