ORIGINAL INVESTIGATION

Physical Activity and Benign Prostatic Hyperplasia

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Background: Benign prostatic hyperplasia (BPH) leading to prostatic enlargement and lower urinary tract symptoms is highly prevalent among older men. Sympathetic nervous system activity, which is decreased by physical activity, is associated with increased prostatic smooth-muscle tone and prostatic symptoms. Therefore, we assessed whether physical activity leads to fewer lower urinary tract symptoms in the Health Professionals Follow-up Study.

Methods: We observed men who were aged 40 to 75 years at baseline in 1986 for subsequent incidence of surgery for BPH. The men were free of diagnosed cancer, including prostate cancer at baseline and during follow-up, had not had a radical prostatectomy, and provided data on physical activity. Cases were men who underwent BPH surgery between 1986 and 1994 (n = 1890) or, among those who did not have surgery, who scored 15 or more points of 35 (n = 1853) on 7 questions about lower urinary tract symptoms modified from the American Urological Association Symptom Index. Noncases were men who scored 7 points or less (n = 21 745). Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated from multiple logistic regression models.

Results: After controlling for age, race or ethnicity, alcohol consumption, and smoking, physical activity was inversely related with total BPH (extreme quintiles: OR, 0.75; 95% CI, 0.67-0.85; *P* for trend, <.001), surgery for BPH (OR, 0.76; 95% CI, 0.64-0.90; *P* for trend, <.001), and symptomatic BPH (OR, 0.75; 95% CI, 0.64-0.87; *P* for trend, <.001). Walking, the most prevalent activity, was inversely related to BPH risk; men who walked 2 to 3 h/wk had a 25% lower risk of total BPH.

Conclusion: Our results indicate that more physically active men have a lower frequency of lower urinary tract symptoms.

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BENIGN PROSTATIC hyperplasia (BPH), a condition characterized by hyperplastic nodules in the periurethral region and transition zone of the prostate, overall prostatic enlargement, and lower urinary tract symptoms, is highly prevalent among middle-aged and elderly men.[1] More than 40% of older men may experience bothersome lower urinary tract symptoms,[2] and in the United States more than 200 000 transurethral resections of the prostate are performed annually for symptom relief.[3] The lower urinary tract symptoms associated with BPH may reflect multiple underlying abnormalities, including greater prostatic mass impinging on the urethra (mechanical or static component), which is influenced by androgens, and heightened tone of prostatic smooth muscle (dynamic component), which is controlled by sympathetic adrenergic neurons of the autonomic nervous system.[4] Widely used pharmacological treatments for lower urinary tract symptoms include α_1-adrenergic receptor blockers, which relax prostatic smooth muscle, while a reduction in prostatic mass is achieved by 5α-reductase inhibitors, which block the conversion of testosterone to the more potent dihydrotestosterone.[5,6]

Increasing physical activity to moderate levels over the long term reduces sympathetic nervous system activity at rest in general.[7] Thus, we hypothesized that physical activity will have a beneficial effect on BPH, which is in part mediated by diminished systemic sympathetic nervous system activity.

In a previous report of obesity and BPH in the Health Professionals Follow-up Study (HPFS) (1986-1992), Giovannucci et al[8] found that physical activity contributed to a lower risk of BPH in part by aiding in weight control, but possibly by an additional independent mechanism. In the only other report we found

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SUBJECTS AND METHODS

STUDY POPULATION

The HPFS is an ongoing prospective study of heart disease and cancer among 51 529 male dentists, veterinarians, pharmacists, optometrists, osteopathic physicians, and podiatrists. At enrollment in 1986, the men were 40 to 75 years old; they completed a semiquantitative food frequency questionnaire and provided information on age, weight, height, physical activity, use of cigarettes and alcohol, and medical history. We collected waist circumference in a subset of these men on a supplementary questionnaire in 1987.[10] We collect updated exposure and disease information biennially by mailed follow-up questionnaires.

On the 1988, 1990, 1992, and 1994 questionnaires, we asked participants whether they had undergone surgery for prostatic enlargement (ie, transurethral resection). In 1988, we mailed a confirmatory follow-up letter to a sample of respondents who reported such surgery. Of 99 randomly selected participants who confirmed having had a prostatectomy, 77 granted permission to review medical records. For 74 of the 77 cases, we were able to obtain medical records, all of which confirmed the surgery. We subsequently considered the participant's self-report of surgery as sufficient.

On the 1992 and 1994 questionnaires we asked participants how frequently, by percentage (0%, 10%, 25%, 50%, 75%, or almost 100% of the time) they experienced the following lower urinary tract symptoms (slightly modified from the American Urological Association[11] to fit the constraints of our mailed questionnaire) during the past month: sensation of incomplete bladder emptying, having to urinate again after less than 2 hours, stopping and starting several times during urination, difficulty postponing urinating, weak urinary stream, and having to push or strain to begin urination. We also asked how many times per night the participants had to get up to urinate (0, 1, 2, 3, 4, 5, or ≥6). For each symptom, we assigned a score of 0 to 5, corresponding to the category of percentage of the time that a symptom was reported to be experienced. To obtain a total symptom score, we summed the points for each of the 6 lower urinary tract symptoms and the number of times per night the participant got up to urinate (we assigned 5 for ≥5 times per night). The minimum possible score was 0 and the maximum was 35. On the 1992 questionnaire, we asked men whether they had had an enlarged prostate detected by digital rectal examination after 1986, and whether in the past 2 years they had had a rectal examination.

We excluded men who did not provide information on physical activity in 1986, had a history of cancer before 1986 (except nonmelanoma skin cancer), had a history of prostate cancer during follow-up, had had surgery for BPH before 1986, or died before the 1988 questionnaire was mailed (no opportunity to report BPH surgery). In addition, we excluded men with an invalid dietary questionnaire in 1986 (about 3%) so that we could control for dietary factors. This left 44 209 men in the baseline population. For those without BPH surgery, we excluded men who did not respond to the questions about lower urinary tract symptoms in 1992, leaving a total of 30 634 men in the analysis.

CLASSIFICATION OF BPH CASES

Four primary BPH case definitions were used: (1) surgery for prostatic enlargement between the date of return of the baseline questionnaire in 1986 and December 31, 1993; (2) symptomatic BPH reported on the 1992 or 1994 questionnaire among those who did not undergo surgery for BPH; (3) *total BPH*, consisting of surgery-defined cases and symptom-defined cases; and (4) prostatic enlargement detected by digital rectal examination between 1986 and 1992. Symptomatic BPH cases were further classified as having (1) high-moderate to severe lower urinary tract symptoms (15-35 points), (2) severe symptoms only (20-35 points), (3) severe obstructive symptoms (12-20 points total for sensation of incomplete bladder emptying, stopping and starting several times during urination, weak urinary stream, and having to push or strain to begin urination), or (4) severe irritative symptoms (9-15 points for having to urinate again after less than 2 hours, finding it difficult to postpone urinating, number of times per night having to get up to urinate). The distinction between obstructive

on physical activity and BPH, among men who reported surgery for BPH in the Physicians' Health Study, exercise appeared protective; however, among those who exercised, risk appeared to increase with increasing frequency of activity.[9]

In this report we extend our preliminary findings by examining in detail the relationship of total physical activity, type and intensity of activity, and inactivity with incident surgery for BPH and prevalent symptomatic BPH among men in the HPFS.

RESULTS

Among the 30 634 men with complete data, 3743 were BPH cases; 1890 reported having had surgery for BPH between 1986 and 1994 and 1853 reported having had high-moderate to severe lower urinary tract symptoms in 1992 or 1994, of whom 673 experienced severe symptoms. In addition, 5146 men reported lower urinary tract symptoms that were classified as low-moderate. The remainder (n = 21 745) were considered to be asymptomatic. Among the 17 224 men who had had a digital rectal examination, 2775 reported prostatic enlargement.

Among the 30 634 men, mean physical activity was 19.9 ± 24.7 MET-h/wk (median, 12.1 MET-h/wk); walking was the greatest contributor, followed by running, biking, tennis, and rowing or calisthenics. After age standardization, men who were more physically active were less likely to have BPH, were less likely to smoke, were leaner, had a higher total energy intake, drank more alcohol, were more likely to have had a vasectomy, and were less likely to have diabetes (**Table 1**).

The OR of BPH decreased with increasing MET-h/wk of physical activity for each case definition except enlarged prostate (**Table 2**); because age-adjusted and multivariate OR estimates were similar, only multivari-

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and irritative symptom complexes in this cohort is supported by a recent analysis.[12] Men whose total symptom scores were between 8 and 14 points (low-moderate) were not considered to be symptomatic cases or noncases.

Noncases were defined as men without BPH surgery whose total urinary symptom scores in both 1992 and 1994 were 0 to 7 points, or 0 to 7 points on only the 1992 questionnaire if the 1994 symptom questions were not completed. In the analysis of prostatic enlargement, *noncases* were men who reported having had normal results of a digital rectal examination in the past 2 years, irrespective of symptom score.

ASSESSMENT OF PHYSICAL ACTIVITY

In 1986 and 1988 we asked participants to report how much time per week they engaged in the following activities *during the past year*: walking or hiking outdoors (including walking at golf), jogging (slower than 10 minutes per mile), running (10 minutes per mile or faster), bicycling (including stationary machine), lap swimming, tennis, squash or racquetball, calisthenics, and rowing. We also asked the number of flights climbed and walking pace (easy [<2 mph], average [2-2.9 mph], brisk [3-3.9 mph], or striding [≥4 mph]). To generate the total physical activity score, we summed activity-specific MET hours per week (MET-h/wk) in 1986. (A MET hour is the metabolic equivalent of sitting at rest for 1 hour.[13]) The weekly MET hours were calculated as the product of hours per week and the following multipliers: jogging, 7.0; running, 10.0; biking, 7.0; swimming, 7.0; tennis, 7.0; racquetball or squash, 12.0; and rowing or calisthenics, 6.0.[14] The MET value assigned to walking was dependent on pace (walking pace: easy, 2.5; average, 3.0; brisk, 4.0; and striding, 4.5). For stairs, number of flights climbed per day was multiplied by 0.11, which includes a conversion to weekly number climbed. To obtain a stable estimate of MET-h/wk for specific activities, we averaged the time spent participating in a particular activity in 1986 and 1988. We also generated quintiles of total MET-h/wk for high-intensity activities (running, jogging, biking, swimming, tennis, and racquetball, or squash) and low- to moderate-intensity activities (flights of stairs climbed, walking, and rowing or calisthenics) averaged over 1986 and 1988. The validity and reproducibility of the physical activity questions on the HPFS questionnaire have been assessed previously.[13] As a marker of inactivity, on the 1988 questionnaire we asked participants how many hours of television or videotapes they watched weekly.

STATISTICAL ANALYSIS

We computed age-standardized means and proportions for demographic and lifestyle factors by quintile of physical activity. We calculated odds ratios (ORs) and corresponding 95% confidence intervals (CIs) for each BPH definition and their associations with physical activity from age-adjusted and multiple logistic regression models controlling for age, race or ethnicity, smoking status, and alcohol intake. Other factors whose distributions varied both by disease status and by level of physical activity or that are hypothesized risk factors were evaluated for confounding by inclusion in the multiple logistic regression models. To evaluate trend, the midpoint of each category of physical activity was entered as a single continuous variable in the logistic regression models. To determine whether any effect of physical activity was independent of obesity, we entered quintiles of body mass index (BMI) or waist circumference (adjusted for height by means of linear regression) in multiple logistic regression models. To determine whether the effect of physical activity varied by waist circumference, BMI, or age, we entered joint categories of MET-h/wk (quintiles) and waist circumference (quintiles) or BMI (quintiles) into the multiple logistic regression models, and ran multiple logistic regression models stratified by age (≤55 years or >55 years, the median age in the cohort in 1986). Multiplicative interaction was assessed by means of models with and without a cross-product term for physical activity and waist circumference, BMI, or age, the statistical significance of which was evaluated by the Wald test. To further distinguish between active and sedentary lifestyles, we generated cross-categories of MET-h/wk of physical activity and inactivity assessed as hours per week of watching television or videotapes, which were entered in the multiple logistic regression model. All analyses were conducted with the use of SAS release 6.12 (SAS Institute, Cary, NC).

ate ORs are presented throughout. Comparing extreme quintiles of physical activity and controlling for age, race or ethnicity, smoking, and alcohol intake, the OR for total BPH was 0.75 (95% CI, 0.67-0.85) and the relationship was generally linearly decreasing (*P* for trend, <.001). The magnitude of the inverse association between physical activity and BPH was similar whether defined by surgery, symptoms, severity of symptoms, or type of symptom. An even stronger decline in risk of total BPH was seen when extreme deciles of physical activity were compared; the OR for the upper (≥47.3 MET-h/wk) compared with the lower (<1.2 MET-h/wk) decile of physical activity was 0.62 (95% CI, 0.52-0.74).

The OR for total BPH between high and low quintiles of MET-h/wk was essentially unaltered when quintiles of BMI were included in the multivariate models (OR, 0.76; 95% CI, 0.68-0.86). Among the subset of men in this analysis for whom waist circumference was available (n = 22 021), the OR for total BPH was 0.71 (95% CI, 0.62-0.82) for high compared with low quintile of activity; this OR was only slightly attenuated when quintiles of waist were included in the multivariate model (OR, 0.75; 95% CI, 0.65-0.87). Adjusting for baseline total energy, fat, or dietary fiber intake, for diabetes, or for vasectomy status, which are suspected BPH risk factors, separately in the logistic models did not alter the relationship between physical activity and BPH.

The benefit of physical activity on total BPH risk was somewhat greater for low- to moderate-intensity (for each increment of 10 MET-h/wk: OR, 0.90; 95% CI, 0.86-0.93) than for high-intensity (OR, 0.97; 95% CI, 0.95-1.00) activities (**Table 3**). After simultaneously controlling for the other 7 activities, walking was inversely related to total BPH (**Table 4**), with benefit generally greater with more rapid walking pace (additionally controlling for total MET-h/wk; OR compared with average

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Table 1. Age-Standardized Baseline Characteristics by Quintile of Physical Activity in 1986, Health Professionals Follow-up Study, 1986-1994*

	Physical Activity, MET-h/wk				
	0.1-3.0	3.1-8.2	8.3-17.5	17.6-33.7	≥33.8
Age, y	53.2	53.8	53.2	52.8	52.5
Benign prostatic hyperlasia, %†	13.5	12.5	12.0	12.0	11.0
Major race or ethnicity, %					
Southern European	24.0	23.2	22.7	23.0	23.8
Scandinavian	9.9	10.9	10.6	10.8	10.1
Other white	58.1	58.1	58.2	58.4	57.0
African American	0.9	0.7	0.6	0.7	0.5
Asian	1.8	1.3	1.4	1.3	1.6
Other	5.4	5.8	6.5	5.8	6.9
Mean body mass index, kg/m^2	26.1	25.8	25.3	25.1	24.8
Mean waist circumference, cm‡	96.5	95.8	94.5	93.5	92.5
Mean energy intake, kJ/d	8240	8387	8354	8396	8631
Mean energy intake from fat, %	33.3	32.7	32.1	31.4	30.6
Mean total dietary fiber intake, g/d	19.1	20.1	21.1	21.8	22.5
Mean alcohol intake, g/d	11.5	11.8	11.9	12.0	12.6
Current cigarette smoker, %	13.3	10.6	8.0	6.7	6.0
Vasectomy, %	22.5	22.7	24.3	26.0	25.7
Diabetes mellitus, %	3.2	2.8	2.7	2.4	1.9

*All factors except age were directly standardized to the age distribution of the 30 634 participants. MET indicates metabolic equivalent.
†Total, either surgery for benign prostatic hyperplasia or high-moderate or severe lower urinary tract symptoms in 1992 or 1994.
‡Waist circumferences adjusted for height by means of the residuals method among men who provided waist circumference and height measurements in 1987.

Table 2. Relation Between Quintile of Physical Activity in 1986 and BPH, Health Professionals Follow-up Study, 1986-1994*

	Physical Activity, MET-h/wk					
BPH	0.1-3.0	3.1-8.2	8.3-17.5	17.6-33.7	≥33.8	*P* for Trend†
Total						
No. of cases	881	785	739	702	636	
OR	1.00	0.90	0.88	0.84	0.75	<.001
95% CI	. . .	0.81-1.01	0.79-0.99	0.75-0.95	0.67-0.85	
Surgery						
No. of cases	425	420	370	363	312	
OR	1.00	0.98	0.89	0.89	0.76	<.001
95% CI	. . .	0.84-1.14	0.76-1.05	0.76-1.04	0.64-0.90	
High-moderate or severe symptoms						
No. of cases	456	365	369	339	324	
OR	1.00	0.84	0.86	0.80	0.75	<.001
95% CI	. . .	0.73-0.98	0.74-1.00	0.68-0.93	0.64-0.87	
Severe symptoms						
No. of cases	167	142	134	107	123	
OR	1.00	0.90	0.86	0.69	0.79	.03
95% CI	. . .	0.71-1.13	0.68-1.09	0.54-0.89	0.62-1.00	
Severe obstructive symptoms						
No. of cases	193	143	157	128	130	
OR	1.00	0.80	0.89	0.73	0.73	.01
95% CI	. . .	0.64-1.00	0.72-1.11	0.58-0.92	0.58-0.92	
Severe irritative symptoms						
No. of cases	318	269	252	223	236	
OR	1.00	0.88	0.85	0.75	0.78	.01
95% CI	. . .	0.74-1.05	0.71-1.01	0.63-0.90	0.66-0.94	
Enlarged prostate						
No. of cases	563	547	580	551	534	
OR	1.00	0.99	1.01	0.98	0.93	.25
95% CI	. . .	0.86-1.13	0.89-1.15	0.86-1.12	0.82-1.07	

*Odds ratios are adjusted for age (3-year intervals), race or ethnicity (Southern European, Scandinavian, African American, Asian, other, other white), smoking (former; current 1-14, 15-34, ≥35 cigarettes per day; current unknown amount; never smoker), and alcohol consumption (quintiles) by multiple logistic regression. BPH indicates benign prostatic hyperplasia; MET, metabolic equivalent; OR, odds ratio; CI, confidence interval, and ellipses, not applicable.
†Estimated by entering the midpoint of each category as a continuous variable in the logistic regression model.

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Table 3. Relationship Between High- or Low- to Moderate-Intensity Physical Activity and Total BPH, Health Professionals Follow-up Study, 1986-1994*

	Physical Activity, MET-h/wk						
	<5	5.0-14.9	15.0-24.9	25.0-34.9	≥35.0	*P* for Trend†	Per 10 MET-h/wk
Total physical activity in 1986							
No. of cases	1192	1003	611	390	547		. . .
OR	1.00	0.96	0.86	0.88	0.76	<.001	0.96
95% CI	. . .	0.87-1.06	0.77-0.97	0.77-1.01	0.68-0.86		0.94-0.97
Low to moderate intensity‡							
No. of cases	1766	1142	506	204	125		. . .
OR	1.00	0.84	0.77	0.73	0.68	<.001	0.90
95% CI	. . .	0.77-0.92	0.68-0.86	0.61-0.86	0.55-0.84		0.86-0.93
High intensity§							
No. of cases	2432	708	246	149	208		. . .
OR	1.00	1.03	0.89	1.00	0.81	.02	0.97
95% CI	. . .	0.94-1.14	0.77-1.04	0.83-1.21	0.69-0.95		0.95-1.00

*Odds ratios are mutually adjusted for other intensity activities and for age (3-year intervals), race or ethnicity (Southern European, Scandinavian, African American, Asian, other, other white), smoking (former; current 1-14, 15-34, ≥35 cigarettes per day; current unknown amount; never smoker), and alcohol (quintiles) by multiple logistic regression. BPH indicates benign prostatic hyperplasia; MET, metabolic equivalent; OR, odds ratio; CI, confidence interval; and ellipses, not applicable.

†Estimated by entering the midpoint of each category as a continuous variable in the logistic regression model.

‡Flights of stairs climbed, walking, and rowing or calisthenics averaged over 1986 and 1988.

§Running, jogging, biking, swimming, tennis, and racquetball or squash averaged over 1986 and 1988.

pace: easy, 1.26 [95% CI, 1.06-1.50]; brisk, 0.86 [95% CI, 0.78-0.94]; striding, 0.80 [95% CI, 0.62-1.02]; *P* for trend, <.001). Running (but not jogging) and a high level of racquetball or squash were also associated with a significantly reduced risk of total BPH.

The inverse association between physical activity and total BPH, surgery for BPH, and high-moderate or severe symptomatic BPH was observed for both younger (≤55 years) and older men, and these relationships did not appear to vary by age. A stronger relationship between BPH and low- to moderate-intensity activity (comparing extreme quintiles: OR, 0.63) than high (OR, 0.84) was apparent among older men, while among younger men, high-intensity activity (OR, 0.75) was slightly more protective than low (OR, 0.82). No clear pattern of variation in the inverse relationship between BPH and physical activity by levels of waist circumference (total BPH: $P = .11$) or BMI (total BPH: $P = .17$) was observed. Nonetheless, when men in the highest quintile of physical activity and lowest quintile of waist circumference were compared with those in the lowest quintile of physical activity and highest waist circumference, the OR for total BPH was 0.47 (95% CI, 0.34-0.65). Similarly, for the same extremes of physical activity and BMI, the OR for total BPH was 0.61 (95% CI, 0.48-0.78).

Inactivity, measured as number of hours of television or videotape watching per week, was positively associated with symptomatic BPH (**Table 5**). For severe obstructive symptoms, the OR was 2.02 (95% CI, 0.91-4.50; *P* for trend, <.001) for 41 h/wk or more compared with 5 h/wk or less. Combining categories of physical activity and inactivity showed that in the lowest levels of physical activity, symptomatic BPH increased with number of hours of television or videotape viewing (**Figure**). When both hours of television or videotape viewing and MET-h/wk of physical activity were included in the same model, the positive relationship between symptomatic BPH and inactivity appeared to be independent of the inverse relationship between BPH and physical activity (extremes: television or videotape OR, 1.60; 95% CI, 0.90-2.84; *P* for trend, <.001; physical activity OR, 0.76; 95% CI, 0.65-0.88; *P* for trend, <.001).

COMMENT

Among 30 634 members of the HPFS, we observed an inverse relationship between physical activity and total BPH; the reduction in risk was approximately equal for incident surgery and prevalent symptomatic cases, and the relationship did not vary substantially by severity of symptoms, or by obstructive vs irritative lower urinary tract symptoms. Low- to moderate-intensity physical activity, including walking at a moderate pace, appeared to be beneficial, particularly among older men. For example, increasing walking by 3 h/wk decreases risk by almost 10%. Inactivity, gauged as the number of hours per week spent watching television or videotapes, was positively associated with risk of symptomatic BPH, independent of physical activity.

Because BPH is multifactorial, we used several classifications of BPH. Surgery for BPH reflects severity of lower urinary tract symptoms experienced as well as propensity to seek surgical intervention. Surgery for BPH and symptomatic BPH combined may be more likely to capture the full range of high-moderate to the most severe symptomatic BPH. Prostatic enlargement, which does not strongly correlate with symptom severity,[15,16] more likely represents greater prostatic mass, either increased cell size or number. Among men reporting prostatic enlargement, the magnitude of the inverse association with physical activity was notably weaker than for the other definitions, suggesting that physical activity has little effect on the anatomic component of the disease.

The physical activity questionnaire has been shown to be valid in a subset of 238 of these men.[13] Also, the correlation between vigorous activity and resting pulse

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Table 4. Relationship Between Time Spent Participating in Specific Physical Activities and Total BPH, Health Professionals Follow-up Study, 1986-1994*

Activity	Time Spent Participating in Physical Activity, h/wk						*P* for Trend†
	0	0.08-0.32	0.33-0.66	0.67-1.34	1.35-1.99	≥2.00	
Walking‡							
No. of cases§	317	347	439	651	421	1477	
OR	1.00	0.95	0.86	0.80	0.87	0.73	<.001
95% CI	. . .	0.80-1.14	0.73-1.02	0.68-0.93	0.73-1.03	0.63-0.84	
Jogging							
No. of cases	2839	164	105	112	49	75	
OR	1.00	0.95	0.99	1.09	1.28	0.96	.68
95% CI	. . .	0.79-1.14	0.78-1.24	0.87-1.36	0.91-1.79	0.73-1.27	
Running							
No. of cases	2993	70	49	77	36	112	
OR	1.00	0.87	0.87	0.91	0.88	0.86	.04
95% CI	. . .	0.66-1.14	0.64-1.20	0.70-1.18	0.61-1.27	0.69-1.08	
Biking							
No. of cases	2101	426	300	299	119	170	
OR	1.00	1.13	1.14	1.03	1.09	0.90	.71
95% CI	. . .	1.00-1.28	0.99-1.32	0.89-1.19	0.87-1.36	0.75-1.09	
Swimming							
No. of cases	2860	171	99	98	50	59	
OR	1.00	0.95	1.08	1.08	1.54	0.99	.16
95% CI	. . .	0.79-1.14	0.85-1.37	0.85-1.38	1.07-2.21	0.72-1.36	
Tennis							
No. of cases	2867	60	57	80	59	213	
OR	1.00	1.00	1.19	0.92	1.08	0.92	.50
95% CI	. . .	0.75-1.33	0.88-1.61	0.72-1.19	0.80-1.46	0.77-1.09	
Racquetball or squash							
No. of cases	3160	19	21	37	12	42	
OR	1.00	0.83	1.02	0.81	0.89	0.69	.02
95% CI	. . .	0.51-1.35	0.64-1.65	0.57-1.17	0.48-1.67	0.49-0.98	
Rowing or calisthenics							
No. of cases	2232	350	288	296	94	118	
OR	1.00	0.94	1.02	1.00	0.95	0.83	.30
95% CI	. . .	0.82-1.07	0.88-1.18	0.86-1.16	0.74-1.21	0.67-1.04	

**BPH indicates benign prostatic hyperplasia; OR, odds ratio; CI, confidence interval; and ellipses, not applicable. Odds ratios are mutually adjusted for other activities and for age (3-year intervals), race or ethnicity (Southern European, Scandinavian, African American, Asian, other, other white), smoking (former; current 1-14, 15-34, ≥35 cigarettes per day; current unknown amount; never smoker), and alcohol (quintiles) by multiple logistic regression.*

†Estimated by entering the midpoint of each category as a continuous variable in the logistic regression model.

‡The ORs (and 95% CIs) for walking are 0.75 (0.64-0.87) for 2 to 3 h/wk, 0.75 (0.63-0.89) for 4 to 6 h/wk, and 0.67 (0.55-0.81) for 7 h/wk or more; P for trend <.001.

§Cases do not sum to total because of missing information on specific activities.

was –0.45. Although we collected information only on leisure-time and not work-related physical activity, the professions of these men generally do not involve high exertion. Because we assessed only 8 activities, we likely underestimated total MET-h/wk expended through planned exercise. The median level of total activity measure was equivalent to jogging 1½ to 2 hours weekly or walking at an average pace for 4 to 5 hours weekly.

We assessed prevalent lower urinary tract symptoms in 1992 and 1994 and thus, at the time of report of physical activity in 1986, it is unknown whether these men were already experiencing lower urinary tract symptoms. Incident surgery for BPH from 1986 to 1994 likely encompasses symptomatic BPH in the preceding years; again, it is unknown at what point they became symptomatic relative to reporting of physical activity at the start of follow-up. However, a British study conducted before the common use of medications for BPH showed that among 115 men with urinary symptoms, but not acute retention, one third had surgery within 1 year of seeking treatment, altogether 42% of the men elected to have surgery by the end of follow-up, and there was no change in the proportion undergoing surgery between 3½ and 7 years after the onset of symptoms.[17] In a US study published in 1937, men sought medical care an average of 3 years after the onset of symptoms.[18] These observations suggest that men who underwent surgery in 1990 or later were unlikely to have been substantially symptomatic at the time the physical activity was assessed. Indeed, among the 61% of men whose surgery was in 1990 or later, the relationship between physical activity and BPH surgery persisted (extreme quintiles: OR, 0.68; 95% CI, 0.56-0.84; *P* for trend, <.001).

Excluding men who underwent surgery for BPH, more than 30% of the base population did not report on lower urinary tract symptoms. The 13 576 nonrespondents did not differ from respondents on MET-h/wk of physical activity (19.3 ± 25.5), however. We required men to complete the symptom questionnaire to obtain a group of noncases with few or no symptoms.

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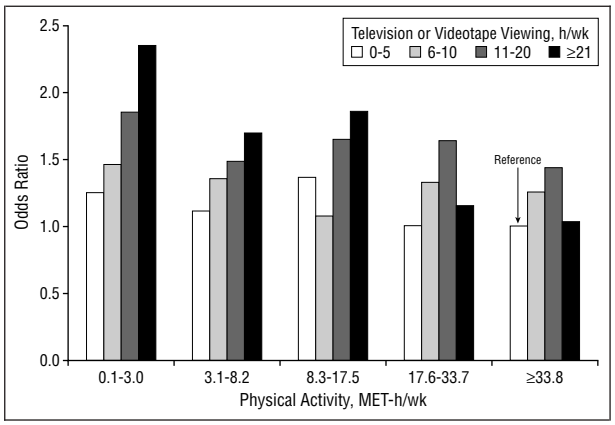
Table 5. Relationship Between Time Spent Watching Television or Videotapes and BPH, Health Professionals Follow-up Study, 1986-1994*

BPH	Time Spent Watching Television/Videotapes, h/wk: 0-5	6-10	11-20	21-40	≥41	*P* for Trend†
Total						
No. of cases‡	748	868	1022	468	30	
OR	1.00	1.11	1.23	1.31	1.42	<.001
95% CI	. . .	0.99-1.24	1.10-1.37	1.14-1.50	0.90-2.24	
Surgery						
No. of cases	378	439	463	239	15	
OR	1.00	1.11	1.07	1.19	1.21	.08
95% CI	. . .	0.95-1.29	0.91-1.24	0.99-1.43	0.66-2.21	
High-moderate or severe symptoms						
No. of cases	370	429	559	229	15	
OR	1.00	1.12	1.41	1.44	1.65	<.001
95% CI	. . .	0.97-1.30	1.22-1.62	1.21-1.73	0.93-2.93	

*Odds ratios are adjusted for age (3-year intervals), race or ethnicity (Southern European, Scandinavian, African American, Asian, other, other white), smoking (former; current 1-14, 15-34, ≥35 cigarettes per day; current unknown amount, never smoker), and alcohol consumption (quintiles) by multiple logistic regression. BPH indicates benign prostatic hyperplasia; OR, odds ratio; CI, confidence interval; and ellipses, not applicable.

†Estimated by entering the midpoint of each category as a continuous variable in the logistic regression model.

‡Cases do not sum to total because of missing information on television and videotape viewing.



Relation of symptomatic benign prostatic hyperplasia and physical activity by hours spent watching television or videotapes. MET indicates metabolic equivalent.

Because we did not begin asking participants about use of medications for BPH until 1996, we could not assess the relationship between physical activity and BPH among those not under medical management, and we could not examine whether further symptomatic relief could be expected with physical activity among those who were taking BPH medications. Report of symptoms may have been influenced by use of medications and their efficacy.

Only 1 other study, to our knowledge, has described the relationship between BPH and physical activity.[9] Among 320 men who underwent surgery for BPH and matched controls nested in the Physicians' Health Study, those who exercised had a lower risk of BPH surgery than sedentary men did. However, among men who exercised, risk increased with increasing frequency of exercise. This may reflect small numbers or perhaps a greater propensity for men in their cohort who frequently exercise to undergo surgery for BPH compared with men who less frequently exercise.

The mode of action of physical activity on modifying BPH onset and progression is unknown. However, we hypothesize that the reduction in systemic sympathetic nervous system activity at rest resulting from sustained physical fitness[7] would also reduce prostatic smooth muscle tone and thus mitigate the severity of lower urinary tract symptoms. Several lines of evidence support the role of sympathetic nervous system activity in symptomatic BPH. α_{1c}-Adrenoceptors have been identified as the major mediator of prostate contractility,[19,20] and contractility is dependent on dose of norepinephrine.[21] α_1-Adrenergic receptors are preferentially expressed in the prostate stroma, likely in smooth muscle cells,[22] and the ratio of prostatic stroma to epithelium is higher in men with symptomatic BPH.[23] Moreover, the amount of tissue norepinephrine correlates with the proportion of smooth muscle in prostatic tissue removed at transurethral resection in patients with symptomatic BPH,[24] hyperplastic prostatic smooth muscle appears to be more responsive than normal tissue to α_1-agonists,[25] and the proportion of smooth muscle is greater among men who respond to α-blockade.[26] Whether the systemic reduction in sympathetic nervous system activity with regular physical activity is also experienced locally in the prostate and, if so, whether the extent of the reduction in sympathetic nervous system activity that can be achieved with physical fitness is adequate to reduce prostatic tone remain to be explored.

Other potential mechanisms underlying the relationship between physical activity and BPH can be postulated. The static component of lower urinary tract symptoms likely results from overgrowth of the prostatic epithelium, which compresses the urethra. Prostatic epithelial cell proliferation is influenced by androgens, as evidenced by androgen receptor expression in prostatic epithelium,[27,28] reduction in hyperplastic prostate mass (primarily of the epithelium) with androgen deprivation,[29] the absence of BPH in men who are castrated before puberty,[30] and the small or absent prostate in men who are deficient in 5α-reductase 2.[31,32] However, there is little evidence of a reduction in plasma testosterone concentrations with physical activity, except with extreme physical training.[33,34] Thus,

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androgen modulation by physical activity is unlikely to be the mechanism for the effect of physical activity on BPH, as the majority of the men in this cohort did not engage in this level of activity. Moreover, in our data an inverse association with physical activity existed primarily with symptomatic BPH rather than with enlarged prostate. Another alternative explanation for our findings is that being physically active may diminish urinary output directly through increased perspiration or indirectly through other correlates of activity.

In this study, inactivity, as measured by number of hours of watching television or videotapes, was positively related to symptomatic BPH and independent of physical activity. In this analysis, inactivity was not simply a marker of obesity; simultaneously modeling activity (comparing extreme quintiles: OR, 0.77; 95% CI, 0.66-0.90), inactivity (≥41 h/wk vs ≤5 h/wk: OR, 1.57; 95% CI, 0.89-2.80), and BMI (comparing extreme quintiles: OR, 1.13; 95% CI, 0.97-1.32) showed each factor to have an independent effect on symptomatic BPH risk.

The findings of this study support that increased physical activity has a beneficial effect on limiting symptomatic BPH at any age. Even low- to moderate-intensity exercise, including walking, appears to confer protection against this common chronic condition. Whether the protective effect of physical activity is mediated by sympathetic nervous system activity or other mechanisms remains to be evaluated.

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