A Follow-up Study of Physical Activity and Incidence of Colorectal Polyps in African-American Women

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Abstract

Background: **Physical activity is associated with a reduced risk of colon cancer, but the effect of activity on colorectal adenomas, which are precursors to colon cancer, is uncertain. The influence of physical activity on colorectal adenomas among African-American women is of particular interest because African-American women have an increased risk of colon cancer relative to other U.S. women.**
Methods: **We prospectively assessed the relation of physical activity to the incidence of colorectal polyps among African-American women. We followed 45,400 women in the Black Women's Health Study from 1997 to 2003. Data were obtained by biennial mailed questionnaires. During 287,029 person-years of follow-up, 1,390 women reported having been diagnosed with colorectal polyps. A review of medical records of 58 women who reported colorectal polyps indicated that 59% had adenomas and 41% had hyperplastic** polyps. **We converted hours per week of vigorous exercise and hours per week of walking to metabolic equivalent (MET)-hours. We estimated incidence rate ratios with Cox proportional hazard models, controlling for age, body mass index, smoking, family history of colorectal cancer, and education.**
Results: **For total MET-hours/wk spent in walking and vigorous exercise, the incidence rate ratio decreased from 0.94 for <5 MET-hours/wk to 0.72 for ≥40 MET-hours/wk (P_{trend} = 0.01). The inverse association was apparent among most subgroups examined, including women who may be at higher risk of colorectal adenomas because of being obese.**
Conclusions: **Increased physical activity is associated with a reduced incidence of colorectal polyps among African-American women.** (Cancer Epidemiol Biomarkers Prev 2006; 15(8):1438−42)

Introduction

An appreciable body of evidence suggests that leisure-time physical activity reduces the incidence of colon cancer in men and women (1, 2). There is much less evidence on whether physical activity protects against colorectal adenomas, which are thought to be precursors to most colon cancers (3), and the evidence has been inconsistent (4-17). No findings have been reported on the relation of physical activity to the incidence of colorectal adenomas in African-American women. This is an issue of particular interest because incidence and mortality rates of colorectal cancer are greater among African-American women than among U.S. white women (18). We report here on the effect of leisure-time physical activity on the incidence of colorectal polyps in African-American women. It has been estimated that about three quarters of clinically recognized polyps are adenomas and one quarter are hyperplastic polyps (19). We used data from the Black Women's Health Study (BWHS), a large follow-up study of black women in the United States.

Materials and Methods

The BWHS began in 1995 when 59,000 African-American women ages 21 to 69 years enrolled in the study by completing mailed health questionnaires (20). Most respondents were subscribers to Essence magazine, a popular magazine targeted to black women; the remainder were members of the Black Nurses' Association or the National Education Association or were friends and relatives of early respondents. Twenty-seven percent of respondents lived in the Northeast, 29% in the South, 23% in the Midwest, and 21% in the West. Participants are followed through biennial mailed questionnaires. The present report is based on data collected through 2003. Each of the 1997, 1999, 2001, and 2003 follow-up questionnaires was completed by ≥80% of the original cohort; 2% of the cohort had died by 2003. The Institutional Review Boards of Boston University Medical Center (Boston, MA) and Howard University Cancer Center (Washington, DC) approved the BWHS.

Colorectal Polyps. The 1995 baseline questionnaire and the follow-up questionnaires through 2003 included questions about a list of illnesses that included colon and rectal cancer. In 1999, colorectal polyps were added to the list; on that questionnaire and all subsequent questionnaires, participants were asked if they had been diagnosed with "colon or rectal polyps" and the year of first diagnosis. Because colorectal polyps were not asked about specifically until 1999, we began follow-up for the present analyses in 1997.

In a sample of 63 BWHS participants who reported colorectal polyps on the 2001 questionnaire and for whom we obtained medical records, colorectal polyps were confirmed in 58 (92%). Among the 58 participants, 34 (59%) had adenomas and 24 (41%) had hyperplastic polyps.

Physical Activity. Physical activity data from the 1997, 1999, and 2001 questionnaires were used for the present analyses. All questionnaires through 2001 collected information on the average number of hours per week in the previous year that the participant had walked for exercise, had walked to and from work, stores, church, and school, and had exercised vigorously (e.g., running). We estimated total metabolic equivalent (MET)-hours/wk from walking

and vigorous exercise by summing the MET-hours/wk from walking (hours per week multiplied by 3.5) and the MET-hours/wk from vigorous exercise (hours per week multiplied by 7.0; ref. 21).

In a validation study conducted at Howard University Cancer Center, 101 BWHS participants wore actigraphs (activity monitors) for 7 days during their waking hours. They also completed physical activity diaries and the BWHS questions about physical activity. Hours per week of physical activity from walking and vigorous exercise reported on the BWHS questionnaire and in the diary were converted to MET-hours/wk by multiplying the hours per week of walking by 3.5 and the hours per week of vigorous exercise by 7.0; total physical activity was the sum of the MET-hours from walking and vigorous exercise. For total physical activity, the Spearman correlation coefficient was 0.28 ($P < 0.01$) for the correlation of the BWHS questionnaire data with the actigraph counts and 0.32 ($P < 0.01$) for the correlation of the questionnaire data with the diary data. For vigorous exercise, the corresponding correlation coefficients were 0.40 ($P < 0.01$) and 0.41 ($P < 0.01$).

Other Factors. The baseline and follow-up questionnaires collected information on a wide range of health-related factors, such as cigarette smoking and alcohol use. All questionnaires collected information on weight, and the 1995 questionnaire collected information on height, allowing for the computation of body mass index (BMI; kg/m^2). The 1995 questionnaire included a 68-item modification of the short version of the National Cancer Institute/Block food frequency questionnaire (22); nutrient estimates were derived using the DietSys software version 3.7 (National Cancer Institute, Bethesda, MD). The 1999 questionnaire asked about family history of colon cancer and rectal cancer and about whether the participant had undergone colonoscopy or sigmoidoscopy in the previous 2 years. The 2003 questionnaire asked about colonoscopy and sigmoidoscopy in the previous 2 years.

Analysis. We assessed colorectal polyps occurring in a particular follow-up cycle in relation to exposure data from the previous cycle (e.g., polyps reported on the 1999 questionnaire in relation to physical activity reported on the 1997 questionnaire). A total of 53,176 women completed the 1997 follow-up questionnaire, the start of follow-up for the present analyses. After exclusion of women who had cancer at baseline ($n = 1,467$), reported colorectal polyps occurring before 1997 ($n = 537$), did not complete a follow-up questionnaire after 1997 (3,112), did not complete the 1997 questions on physical activity (2,612), or whose status with respect to colorectal polyps was uncertain ($n = 48$), a total of 45,400 women remained. During 287,029 person-years of follow-up from 1997 to 2003, 1,390 of these women reported the occurrence of a colorectal polyp.

We used age- and time-stratified Cox regression models (Statistical Analysis System version 8.2, SAS Institute, Cary, NC) to derive incidence rate ratios (IRR) for colorectal polyps in relation to physical activity with control for potential confounding factors (23). Women contributed person-years from the start of follow-up in 1997 to the time of diagnosis of colorectal polyps, loss to follow-up, death, or the end of follow-up in 2003, whichever came first. In the analyses of total MET-hours from walking and vigorous activity, we controlled for known or suspected risk factors for colorectal polyps that were associated with risk of polyps in our data; in addition to age, these were BMI [weight (kg)/height^2 (m)], cigarette smoking, history of colorectal cancer in a parent or sibling, and years of education. In the analysis of hours per week of walking, we also controlled for vigorous activity; in the analysis of hours per week of vigorous activity, we also controlled for walking. Additional control for geographic region of residence, alcohol use, nonsteroidal anti-inflammatory drug use, red meat intake, fiber intake, and total energy intake did not alter the IRRs by

>10%. The Anderson-Gill data structure was used to handle time-varying covariates (24).

To test for trend among women who walked or exercised vigorously, a continuous term was included in the regression model and those reporting no activity were excluded; for hours per week of walking or vigorous exercise, the midpoint of each stratum of hours/week of activity reported was used. To assess whether the association between MET-hours of physical activity and colorectal polyps was modified by other factors (e.g., BMI), we conducted likelihood ratio tests that compared models with and without cross-product terms between MET-hours of physical activity (categorical) and these factors (25). Departure from the proportional hazards assumption was tested by the likelihood ratio test comparing models with and without cross-product terms between MET-hours of physical activity (categorical), time period, and age (<50 versus ≥50; ref. 26).

Results

Age, BMI, cigarette smoking, family history of colorectal cancer, and years of education were positively associated with the incidence of colorectal polyps in the BWHS (data not shown). As shown in Table 1, total MET-hours/wk expended in walking and vigorous exercise were positively associated with years of education and inversely associated with age, BMI, smoking, and family history of colorectal cancer.

Table 2 provides data on vigorous exercise and walking in relation to colorectal polyp incidence. For women who exercised vigorously relative to women who did no vigorous exercise, the IRRs were all <1.0 for categories of vigorous exercise ranging from <1 hour/wk to ≥7 hours/wk: the IRR was 0.81 [95% confidence interval (95% CI), 0.69-0.96] for <1 hour/wk and 0.85 (95% CI, 0.60-1.21) for ≥7 hours/wk (P_{trend} among vigorous exercisers = 0.54). For walking, the IRRs were 0.99 or 1.00 for the categories <1 hour/wk to 3 to 4 hours/wk and 0.82 and 0.85 for 4 to 6 hours/wk and ≥7 hours/wk, respectively (P_{trend} among walkers = 0.03); all 95% CI included 1.0. For total MET-hours/wk expended in walking and vigorous exercise, the IRR decreased monotonically from 0.94 (95% CI, 0.76-1.15) for <5 MET-hours/wk to 0.83 (95% CI, 0.67-1.03) for 20 to 39 MET-hours/wk and 0.72 (95% CI, 0.57-0.91) for ≥40 MET-hours/wk (P_{trend} among the walkers and exercisers = 0.01).

We repeated the analysis of total MET-hours/wk from walking and vigorous exercise in relation to colorectal polyps confined to women who reported on the 1999 or 2003 questionnaire that they had undergone sigmoidoscopy or colonoscopy. Based on 63,302 person-years of follow-up involving 10,079 women, the IRRs for the categories of total MET-hours/wk of <5, 5 to 9, 10 to 19, 20 to 39, and ≥40, relative to none, were 0.88 (95% CI, 0.72-1.09), 0.86 (95% CI, 0.70-1.06), 0.85 (95% CI, 0.69-1.04), 0.76 (95% CI, 0.61-0.95), and 0.64 (95% CI, 0.50-0.81), respectively.

Table 1. Baseline characteristics of 45,381 women according to MET-hours/wk of vigorous exercise and walking in the BWHS

Characteristic	MET-h/wk				
	<5	5-9	10-19	20-39	≥40
No. studied	10,984	8,188	10,117	8,782	7,329
Age, y (mean)	42.2	40.9	40.7	39.4	38.7
BMI, kg/m^2 (mean)	29.8	28.9	28.4	27.5	27.0
Education, y (mean)	14.6	14.9	15.0	15.1	15.0
Family history of colorectal cancer (%)	5.8	6.2	5.9	5.4	5.4
Current smoker (%)	18.2	14.6	14.3	13.1	14.8

As shown in Table 3, the IRR for ≥40 MET-hours/wk of physical activity spent in walking and vigorous exercise was <1.0 in all categories of age, BMI, family history of colorectal cancer, cigarette smoking, and years of educational attainment, except among the subgroups of women with BMI 25 to 29 and ≤12 years of education. None of the tests for interaction was statistically significant (age, $P = 0.22$; BMI, $P = 0.41$; family history of colorectal cancer, $P = 0.56$; cigarette smoking, $P = 0.62$; education, $P = 0.38$).

Discussion

The results from studies of physical activity and colorectal adenomas have been mixed and inconclusive. Among the case-control studies (4, 7-17), most were small with ≤300 adenoma cases (4, 7-9, 11, 13-17), and statistically significant inverse associations were found in only 2 (16, 17). In a follow-up of nurses who had undergone endoscopy, during which 439 adenomas of the distal colorectum were reported, the IRR was 0.58 (95% CI 0.40-0.86) for the highest quintile of weekly energy expenditure from walking and exercise relative to the lowest ($P_{trend} = 0.0009$; ref. 5). In a similar follow-up study of men, in which 586 adenomas were reported, there were also inverse associations, although weaker: the relative risk for the top quintile of energy expenditure relative to the lowest was 0.79 ($P_{trend} = 0.12$) for colon adenomas and 0.92 ($P_{trend} = 0.55$) for rectal adenomas (6).

The present study provides the first data on physical activity in relation to colorectal polyps specifically reported for a black population. The incidence of polyps among black women in the BWHS declined as total MET-hours expended in walking and vigorous exercise increased. A reduction in incidence of ~20% was associated with 20 to 39 MET-hours/wk of physical activity and of 30% with ≥40 MET-hours/wk. Age, BMI, cigarette smoking, family history of colorectal cancer, and higher level of education were associated with increased risk of colorectal polyps in our data. Physical activity was inversely associated with the incidence of colorectal polyps in almost all strata of these factors, which suggests that these factors did not

explain or modify the association of physical activity with colorectal polyps. The inverse association of physical activity with polyps among obese women is noteworthy because the risk of developing adenomatous polyps may be greater among people who are obese (4-6, 9, 11, 15, 16, 27).

The large number of cases of colorectal polyps in the present study provided high statistical power and allowed for informative assessment of subgroups. The high rate of follow-up mitigates concerns about bias from selective losses. Multivariable analyses controlled for important risk factors for colorectal polyps. Physical activity reported on the BWHS questionnaire was statistically significantly associated with two commonly used, albeit imperfect, measures that have been used in physical activity validation studies—diary record data and movement as measured with an actigraph (28, 29). Because the BWHS questionnaire data on physical activity were collected prospectively, systematic bias in the reporting of physical activity will have been absent. Random misclassification of reported physical activity on the BWHS questionnaire would have tended to attenuate a true inverse association between physical activity and the incidence of colorectal polyps.

Our validation study suggested that women in the BWHS reported colorectal polyps with high specificity. However, participants were not systematically screened for colorectal polyps. The presence of undetected cases of colorectal polyps would have attenuated an association, but we expect the degree of attenuation to have been small because colorectal polyps occur relatively rarely. An analysis confined to women who had undergone colonoscopy or sigmoidoscopy yielded an inverse association with total MET-hours of activity from walking and vigorous exercise that was a little stronger than that observed in the total sample.

We were unable to stratify the analyses according to whether the colorectal polyp was an adenoma or a hyperplastic polyp because we had that information on only a small subset of cases. Hyperplastic polyps are not thought to be risk factors for colon cancer. Although colon adenomas and hyperplastic polyps share many risk factors (30, 31), there is almost no information on the relation of hyperplastic polyps to

Table 2. Risk of colorectal polyps in relation to hours per week of vigorous exercise, hours per week of walking, and MET-hours/wk of vigorous exercise and walking in the BWHS

	Hours/wk of vigorous exercise					
	None	<1	1-2	3-4	5-6	≥7
Cases	875	181	173	88	39	34
Person-years	139,733	51,070	44,437	28,163	12,355	11,271
Age-adjusted IRR (95% CI)	1.00 (Reference)	0.80 (0.68-0.94)	0.92 (0.78-1.08)	0.74 (0.60-0.93)	0.81 (0.59-1.11)	0.77 (0.55-1.09)
Multivariate IRR* (95% CI)	1.00 (Reference)	0.81 (0.69-0.96)	0.95 (0.80-1.12)	0.77 (0.62-0.97)	0.87 (0.63-1.20)	0.85 (0.60-1.21)
	Hours/wk of walking					
	None	<1	1-2	3-4	5-6	≥7
Cases	153	230	496	235	108	168
Person-years	27,837	44,170	101,484	47,450	25,594	40,494
Age-adjusted IRR (95% CI)	1.00 (Reference)	0.99 (0.81-1.22)	0.96 (0.80-1.15)	0.94 (0.77-1.15)	0.78 (0.61-1.00)	0.79 (0.63-0.98)
Multivariate IRR † (95% CI)	1.00 (Reference)	1.00 (0.82-1.23)	1.00 (0.83-1.20)	0.99 (0.81-1.22)	0.82 (0.63-1.05)	0.85 (0.68-1.06)
	MET-h/wk of vigorous exercise and walking					
	None	<5	5-9	10-19	20-39	≥40
Cases	132	288	273	325	229	143
Person-years	20,793	49,475	53,541	64,706	55,242	43,272
Age-adjusted IRR (95% CI)	1.00 (Reference)	0.93 (0.76-1.15)	0.89 (0.72-1.10)	0.90 (0.74-1.10)	0.82 (0.66-1.01)	0.70 (0.55-0.88)
Multivariate IRR ‡ (95% CI)	1.00 (Reference)	0.94 (0.76-1.15)	0.91 (0.74-1.12)	0.91 (0.74-1.12)	0.83 (0.67-1.03)	0.72 (0.57-0.91)

*Adjusted for age, BMI, smoking, family history of colorectal cancer, education, and total hours of walking.
†Adjusted for age, BMI, smoking, family history of colorectal cancer, education, and hours of vigorous exercise.
‡Adjusted for age, BMI, smoking, family history of colorectal cancer, and education.

Table 3. Risk of colorectal polyps in relation to MET-hours/wk of vigorous exercise and walking according to age, BMI, family history of colorectal cancer, cigarette smoking, and years of educational attainment in the BWHS

MET-h/wk	Age			
	<50		≥50	
	Cases	IRR (95% CI)	Cases	IRR (95% CI)
None	57	1.00	75	1.00
<5	100	0.75 (0.54- 1.05)	188	1.07 (0.82- 1.40)
5-9	109	0.78 (0.56- 1.07)	164	1.00 (0.76- 1.31)
10-19	133	0.80 (0.59- 1.10)	192	0.99 (0.76- 1.30)
20-39	95	0.68 (0.49- 0.95)	134	0.95 (0.71- 1.27)
≥40	60	0.57 (0.40- 0.83)	83	0.84 (0.62- 1.16)

MET-h/wk	BMI					
	<25		25-29		≥30	
	Cases	IRR (95% CI)	Cases	IRR (95% CI)	Cases	IRR (95% CI)
None	24	1.00	30	1.00	77	1.00
<5	49	0.97 (0.59-1.58)	94	1.22 (0.81-1.85)	140	0.78 (0.59-1.04)
5-9	58	1.02 (0.63-1.66)	107	1.28 (0.85-1.92)	106	0.68 (0.51-0.92)
10-19	69	0.96 (0.60-1.54)	125	1.16 (0.78-1.73)	128	0.77 (0.58-1.03)
20-39	71	1.04 (0.65-1.67)	91	1.07 (0.70-1.62)	66	0.60 (0.43-0.83)
≥40	34	0.59 (0.35-1.01)	62	1.02 (0.66-1.59)	42	0.63 (0.43-0.92)

MET-h/wk	Family history of colorectal cancer			
	Yes		No	
	Cases	IRR (95% CI)	Cases	IRR (95% CI)
None	21	1.00	105	1.00
<5	39	0.67 (0.39-1.14)	241	0.98 (0.78-1.24)
5-9	45	0.76 (0.45-1.29)	219	0.92 (0.73-1.16)
10-19	57	0.78 (0.46-1.30)	246	0.88 (0.70-1.11)
20-39	30	0.52 (0.29-0.92)	186	0.87 (0.68-1.11)
≥40	24	0.59 (0.33-1.09)	113	0.73 (0.56-0.95)

METs/wk	Smoking status			
	Current smoker		Past/never smoker	
	Cases	IRR (95% CI)	Cases	IRR (95% CI)
None	38	1.00	94	1.00
<5	52	0.78 (0.51-1.20)	236	1.00 (0.78-1.27)
5-9	51	0.83 (0.54-1.27)	222	0.93 (0.73-1.18)
10-19	56	0.82 (0.54-1.25)	269	0.95 (0.75-1.20)
20-39	33	0.65 (0.40-1.04)	196	0.89 (0.69-1.14)
≥40	30	0.80 (0.49-1.30)	113	0.72 (0.54-0.95)

MET-h/wk	Education (y)					
	≤12		13-15		≥16	
	Cases	IRR (95% CI)	Cases	IRR (95% CI)	Cases	IRR (95% CI)
None	24	1.00	54	1.00	54	1.00
<5	45	1.04 (0.63-1.71)	115	0.92 (0.66-1.27)	128	0.91 (0.66-1.25)
5-9	45	1.21 (0.74-2.00)	92	0.77 (0.55-1.09)	134	0.90 (0.66-1.24)
10-19	56	1.41 (0.87-2.29)	108	0.79 (0.57-1.10)	158	0.87 (0.64-1.19)
20-39	25	0.94 (0.53-1.65)	73	0.73 (0.51-1.04)	131	0.87 (0.63-1.20)
≥40	25	1.25 (0.71-2.20)	51	0.66 (0.45-0.97)	64	0.64 (0.44-0.92)

NOTE: In the analysis of each factor, adjustment is made for the other factors in this table.

physical activity. A study that assessed subsequent polyp occurrence among subjects who had had a recent colon adenoma found that physical activity was unrelated to hyperplastic polyps, but the number of cases was small (14). If hyperplastic polyps are unrelated to physical activity, their inclusion in the case series in the present study would have diluted the association of colorectal polyps with physical activity.

In summary, the present data suggest a protective effect of physical activity against the occurrence of colorectal polyps in black women. Colorectal cancer is a much rarer outcome than colorectal polyps (3, 5, 18). The assessment of whether physical activity protects against colon or rectal cancer in black women in the BWHS awaits accrual of sufficient cases of colon and rectal cancer for informative analysis.

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