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Physical Activity and the Incidence of Obesity in Young African-American Women

Lynn Rosenberg, ScD, **Kristen L. Kipping-Ruane**, **Deborah A. Boggs, ScD**, and **Julie R. Palmer, ScD**
Slone Epidemiology Center, Boston University, Boston, Massachusetts

Abstract

Background—Obesity occurs more commonly among African-American women than among other racial/ethnic groups, and most weight gain occurs before middle age.

Purpose—The study prospectively investigated the relationship of vigorous exercise and brisk walking to the incidence of obesity (BMI ≥30) among African-American women aged <40 years.

Methods—During 1995–2009 in the Black Women's Health Study, the current authors followed 20,259 African-American women who were aged <40 years and not obese at baseline. BMI, exercise, and walking were assessed at baseline and on biennial follow-up questionnaires. Data for BMI were collected through 2009. Data for exercise and walking were collected through 2007. Validation and reproducibility data indicated that reporting was more accurate for vigorous exercise than for brisk walking. Cox proportional hazards models estimated incidence rate ratios (IRRs) and 95% CIs of incident obesity for hours/week of vigorous exercise and walking relative to "little or no exercise" (<1 hour/week of vigorous exercise and <1 hour/week of brisk walking). The analyses were conducted in 2012.

Results—The incidence of obesity decreased with increasing vigorous exercise; the IRR was 0.77 (95% CI=0.69, 0.85) for ≥7 hours/week relative to little or no exercise; the IRRs were reduced both among women with a healthy weight (BMI <25) at baseline and among women who were overweight (BMI 25–<30) at baseline. The IRRs for brisk walking for exercise and walking for transport were <1.0 for most levels of walking, but without clear trends of decreasing risk with increasing time spent walking.

Conclusions—The results suggest that vigorous exercise may reduce the incidence of obesity among young African-American women. Results for brisk walking were inconclusive.

Introduction

Background

The prevalence of obesity (BMI ≥30) has increased greatly in recent decades in the U.S.[1,2] Of the two main strategies to reduce obesity—prevention of weight gain and maintenance of

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Address correspondence to: Lynn Rosenberg, ScD, Slone Epidemiology Center at Boston University, 1010 Commonwealth Avenue, Boston MA 02215. lrosenbe@bu.edu.

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weight loss—the second strategy has had limited success.[3] Thus, behavioral modifications that could successfully reduce the incidence of obesity are needed.[4]

Participants who exercise in weight reduction trials generally lose weight,[3,5] but even the longest trials last less than 1 year, and most lost weight is regained within a relatively short time.[6] At least 35 prospective observational studies have assessed physical activity in relation to longer-term weight gain or obesity, mostly in white adults who are middle-aged or older.[3,5,7] Various types of activity (e.g., total recreational activity, walking) have been assessed. The more-recent studies have tended to be larger than earlier ones and to have repeated measures of physical activity and weight; they suggest that higher levels of physical activity are associated with less weight gain or obesity, and that the size of the activity-related reduction is small relative to the overall increase in weight.[3,5,7]

Approximately half of African-American women are obese, and the prevalence is higher than in other ethnic groups at all ages.[1,2] In view of the fact that most adult weight gain occurs before middle age,[1,8–10] it is important to determine whether physical activity is associated with reduced incidence of obesity in younger African-American women.[11] The Coronary Artery Risk Development in Young Adults (CARDIA) study, a follow-up study of approximately 5000 black and white men and women aged 18–30 years at entry, of whom one fourth were black women, is the only study with an appreciable number of younger black women that has reported on exercise in relation to weight. The study found that race did not modify an association of higher levels of leisure-time walking with reduced weight gain during 15 years of follow-up[12]; race also did not modify an association of higher levels of physical activity from exercise, home maintenance, and the job with lower BMI gain during 20 years of follow-up.[13]

To test the hypothesis that vigorous exercise and brisk walking reduce the incidence of obesity in younger African-American women, an assessment was made of data collected in a large follow-up study of African-American women, the Black Women's Health Study (BWHS). The analyses were based on repeated measures of both activity and weight collected during 14 years of follow-up of women who were aged <40 years at the start of follow-up.

Methods

The Study Population

The BWHS is an ongoing follow-up study begun in 1995 when 59,000 African-American women aged 21–69 years from the mainland U.S. enrolled through mailed health questionnaires. The questionnaire collected information on demographic characteristics, weight, height, recreational exercise, medical history, usual diet, and other factors. The cohort is followed every 2 years through health questionnaires that update exposure information and incident medical conditions. Follow-up over seven completed cycles has been 80%. The Boston University Medical Campus IRB approved the study.

Women who at baseline were aged <40 years and had a healthy weight (BMI ≥18.5–<25), or were overweight but not obese (BMI 25– <30) were eligible for inclusion (n=22,874). After exclusion of women who reported cancer or cardiovascular disease (myocardial infarction or stroke); who were pregnant at baseline; did not report weight on any follow-up questionnaire; reported gastric surgery; or had a missing value for vigorous exercise at baseline, 20,259 women remained for the analysis. The follow-up period was 1995 through 2009, and analyses were conducted in 2012.

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Obesity

Participants reported current weight and height at baseline and updated their weight on every follow-up questionnaire. BMI was calculated for each questionnaire cycle through 2009, with obesity defined as BMI ≥30. In a BWHS validation study, self-reported height and weight were highly correlated with measured values (r=0.93 and r=0.97, respectively).[14]

Physical Activity and Covariates

At baseline, participants reported average number of hours per week (none, <1, 1, 2, 3–4, 5–6, 7–9, ≥10) spent in vigorous exercise (e.g., basketball, swimming, running, aerobics); walking for exercise; and walking to and from work (hereafter called walking for transport) in the previous year. The questions on vigorous exercise and walking for exercise were included again in the 1997, 1999, 2001, and 2007 questionnaires. Walking for transport was asked about again in the 1997, 1999, and 2001 questionnaires, with the wording "walking to and from church, store, school, work." The 2003 questionnaire ascertained pace of walking: casual (<2 mph); average or normal (2–3 miles per hour [mph]); fairly brisk (3–4 mph); and brisk or striding (≥4 mph). Fairly brisk and brisk or striding were combined into a single category, brisk.

In a validation study in which BWHS participants wore actigraphs during their waking hours for 1 week,[14] actigraph counts were significantly correlated (p<0.05) with reported questionnaire data on vigorous activity (r =0.40) and walking for exercise (r =0.26). During the 1997 follow-up cycle, in response to multiple waves of mailings of the questionnaire to nonrepondents, duplicate questionnaires were completed by 1172 women. The weighted kappa for the agreement between the responses to the two questionnaires was 0.70 (p<0.01) for the question on vigorous exercise; 0.57 (p<0.01) for the question on walking for exercise; and 0.58 (p<0.01) for the question on walking for transport[14]; kappas for duplicates in subsequent cycles were similar. The question about pace of walking was asked in 2003; based on 644 duplicate questionnaires, the weighted kappa was 0.44 (p<0.01).

The number of hours per day spent watching TV (0, <1, 1–2, 3–4, ≥5) was ascertained in 1995, 1997, 1999, and 2001. Smoking status and amount smoked and alcohol drinking status and amount consumed were ascertained at baseline and updated in each follow-up questionnaire. Pregnancy status and parity were ascertained at baseline and updated on each follow-up questionnaire. Level of education was ascertained on the 1995 and 2003 questionnaires.

Dietary intake in the previous year was assessed in 1995 with a 68-item modified version of the Block-National Cancer Institute food frequency questionnaire[16] and in 2001 with an 85-item version that added items frequently written in on the 1995 questionnaire. In a validation study of the 1995 food frequency questionnaire, correlation coefficients for agreement of the questionnaire data with responses from 3-day food diaries and 24-hour recalls supplied by BWHS participants ranged from 0.4 to 0.8 for fat, protein, carbohydrate, fiber, calcium, vitamin C, folate, and β-carotene.[17] The individual food items were aggregated into 35 groups; factor analysis (principal components analysis) identified two dietary patterns,[8] one characterized by fruits and vegetables and the other by meat and fried foods; a factor score was calculated for each of the two patterns for each participant.[8,18]

Data Analysis

Participants contributed to the analysis from baseline in 1995 until the first occurrence of obesity, loss to follow-up, death, or the end of follow-up in 2009, whichever occurred first. Women who reported developing cancer or cardiovascular disease (myocardial infarction or stroke) during follow-up were censored at the date of diagnosis; women who became

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pregnant were censored in that follow-up cycle. Cox proportional hazards models were used to estimate incidence rate ratios (IRRs) and 95% CIs for the association between exercise and incidence of obesity. The reference category for all analyses was "little or no exercise," defined as <1 hour per week reported for vigorous exercise, walking for exercise, and walking for transport. Physical activity and covariates that changed over time (e.g., smoking status) were treated as time-varying variables in the analysis.

The multivariable models for vigorous exercise were adjusted for age (single year); time period (questionnaire cycle); education (≤12, 13–15, ≥16 years); geographic region (Northeast, South, Midwest, West); smoking status (never; past; currently smoke <15 cigarettes/day; currently smoke ≥15 cigarettes/day); alcohol intake (currently drink <1, 1–3, 4–6, ≥7 drinks/week); parity (0, 1, 2, ≥3 births); fruit/vegetable dietary pattern score (quintiles); and meat/fried foods dietary pattern score (quintiles). Walking for exercise and walking for transport were assessed in separate models in which vigorous exercise and all the covariates listed above were controlled. Tests for trend were conducted with use of an ordinal value for each level of activity. All statistical analyses were performed using SAS version 9.1.

Results

The cohort of 20,259 women was followed for 14 years, with a mean follow-up of 12.6 years. Mean weight at baseline was 66.2 kg (146 pounds) in the cohort of 20,259 women, and mean BMI was 24.1. At the end of follow-up, mean weight was 77.5 kg (171 pounds), and mean BMI was 28.3.

Vigorous exercise at baseline was positively associated with higher educational level, nulliparity, living in the western U.S., and a high score on the fruit/vegetable dietary pattern; it was inversely associated with age, BMI, smoking, and TV watching (Table 1). Associations with brisk walking for exercise were similar to those with vigorous exercise, with the exception that age and BMI were not associated with brisk walking. Brisk walking for transport was positively associated with younger age, nulliparity, and fruit/vegetable dietary pattern; it was inversely associated with TV watching (data not shown).

The IRR for obesity decreased as hours/week of vigorous exercise increased (Table 2): the multivariable IRR for ≥7 hours/week of vigorous exercise relative to little or no exercise was 0.77 (95% CI=0.69, 0.85). An inverse association was present among both women with a healthy weight at baseline and women who were overweight at baseline: the IRR for ≥7 hours/week of vigorous exercise was 0.77 (95% CI=0.63, 0.95) among the former (p trend <0.0001), and 0.79 (95% CI=0.70, 0.89) among the latter (p trend <0.0001). The inverse association of vigorous exercise with obesity was present across strata of education: the IRR for ≥7 hours/week of strenuous exercise relative to little or no exercise was 0.71 (95% CI=0.52, 0.96) among women with ≤12 years of education; 0.75 (95% CI=0.63, 0.89) among women with 13–15 years of education; and 0.78 (95% CI=0.67, 0.91) among women with ≥16 years of education.

The IRRs for incidence of obesity in almost all the categories of brisk walking for exercise relative to little or no exercise were <1.0, but there were no clear trends of decreasing risk with increasing hours of walking (Table 3). Among women with baseline BMI <25, the IRRs were significantly less than 1.0 for 1–2 hours/week and 3–4 hours/week, but the IRR for the highest category, ≥7 hours/week, was above 1.0 (IRR=1.25 (95% CI=0.93, 1.67). Among women who were overweight at baseline, the IRRs were significantly below 1.0 for 1–2 and ≥7 hours/week. The IRRs did not vary appreciably across categories of education.

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The IRRs for walking for transport at a brisk pace relative to little or no exercise were all <1.0 (Table 4). Among women who had a healthy weight at baseline, the IRR was significantly less than 1.0 for 1–2, 3–4, and ≥7 hours/week; the estimate among women who were overweight at baseline was significantly less than 1.0 for 1–2 hours/week; the *p*-values for trend were 0.055 in the former group and 0.40 in the latter. The association of walking for transport with obesity did not vary appreciably across strata of education.

Discussion

In this large prospective study of African-American women, 1995–2009, the incidence of obesity decreased with increasing level of vigorous exercise. There was a reduction in obesity among women with a healthy weight at baseline and those who were initially overweight. Results on brisk walking were suggestive of reductions in obesity in most categories, but there were some anomalous results and no clear trends.

Previous results most relevant to the current findings are those from follow-up studies of women. The Nurses' Health Study found that 1 hour per day of brisk walking during 6 years of follow-up among middle-aged nurses, most of whom were white, was associated with a 24% reduction in the incidence of obesity.[19] In the present study, there was a 23% reduction associated with ≥7 hours/week of vigorous exercise, but results for brisk walking were inconclusive. The reduction associated with vigorous exercise was present among both women with a healthy weight at baseline and those who were overweight.

Other studies have focused on weight gain rather than obesity. The CARDIA study followed 5000 men and women aged 18–30 years, of whom about one quarter were African-American women. After 15 years of follow-up,[12] greater leisure-time walking was associated with less weight gain, especially among the heavier women; after 20 years of follow-up, higher levels of a measure of activity from exercise, home maintenance, and the job were associated with less weight gain, with no modification of the effect by initial weight.[13]

The Nurses' Health Study II followed 46,754 female nurses aged 25–43 years, almost all of whom were white, for 8 years.[20] Increased levels of jogging and running were inversely associated with weight gain, and there was a weaker inverse association of brisk walking with weight gain, as in the present study. The benefits of exercise in Nurses' Health Study II appeared greater among women who were overweight at baseline.

In a later report from the Nurses' Health Study II, based on 16 years of follow-up of 18,414 nurses, increases in brisk walking were inversely associated with weight gain, again among the heavier women, whereas slower walking was not associated with reduced weight gain.[21] Another report from the same study found that increases in MET hours of recreational physical activity were associated with less weight gain.[22] Taken together, these results suggest that the more vigorous the exercise, the greater the reduction in weight gain or obesity. Since reductions have been observed both for women who had a healthy weight and those who were overweight at the start of follow-up, it appears that the trajectory toward obesity can be interrupted, even in overweight women.

Strengths and Limitations

Strengths of the present study include repeated reports of weight over time and the high correlation between self-reported and measured weight and height.[14] However, because weight tends to be under-reported, particularly by heavier women,[23] the observed IRRs may have underestimated the true associations. Other strengths are the large sample size and the

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long length of follow-up. Important potential confounding factors were controlled for; updates were made throughout follow-up.

Physical activity, which varies considerably over time, was updated during follow-up but not as often as weight. BWHS validation[14] and reproducibility data indicate that vigorous exercise was reported with greater accuracy than brisk walking; the latter variable was based on reports of hours/week and pace, and each of these was reported less reliably than vigorous exercise. Less misclassification of vigorous exercise will have contributed, in part, to the stronger associations observed of vigorous exercise with obesity incidence. Random misclassification of the physical activity variables would have tended to dilute associations of incident obesity with the extreme categories.

On the other hand, "reverse causation" (i.e., changes in exercise in response to weight gain) could have increased or increased the magnitude of associations. For example, some women may have increased their exercise after learning that they had gained weight. Misclassification of this type could have contributed, for example, to the stronger inverse association of 1–2 hours/week of walking with obesity incidence than with higher levels of walking, distorting a true trend of decreasing obesity risk with increasing level of walking. Reporting of walking for transport may have been less affected by misclassification than walking for exercise because routines of walking to work, church, school, and stores may be relatively stable.

Evidence that the measures in the present study of brisk walking and vigorous exercise are useful indicators of actual activity comes from a study of type 2 diabetes in the BWHS[24]; there were clear inverse associations of brisk walking and vigorous exercise walking with the incidence of type 2 diabetes, with a stronger inverse association with vigorous exercise, as observed in previous studies.[24] In another BWHS study, an inverse association of vigorous exercise with symptoms of depression was observed, in agreement with results from previous studies of this association.[24]

Conclusion

The present study suggests that vigorous exercise is effective in the prevention of obesity in younger African-American women. The results for brisk walking were suggestive of a reduction in some subgroups but with less evidence of a dose–response relationship. The findings were consistent across level of education. Since participants in the BWHS represent the educational levels of the 83% of African-American women nationally who have completed high school or a higher level of education, [26] the results may be applicable to most African-American women of the same ages.

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Am J Prev Med. Author manuscript; available in PMC 2014 September 01.

Table 1

Vigorous exercise and brisk walking for exercise in 1995 by baseline characteristics of 20,259 BWHS participants

Characteristic[a]	Little or no exercise[b]	Strenuous exercise		*p*-value[c]	Brisk walking for exercise		*p*-value[d]
		1–4 hours/week	≥5 hours/week		1–4 hours/week	≥5 hours/week	
Number	5268	8941	3802		3007	1072	
Age, mean (SD)	31.2 (5.2)	30.6 (5.2)	30.4 (5.0)	<0.01	31.0 (5.1)	31.5 (5.0)	0.48
BMI, mean (SD)	24.2 (3.1)	24.2 (2.9)	23.9 (2.8)	<0.01	24.0 (2.8)	24.1 (2.7)	0.07
Education ≥16 years	45	54	51	<0.01	53	46	<0.01
Current smoker	16	11	11	<0.01	10	11	<0.01
Current drinker	22	25	25	<0.01	23	24	<0.23
TV ≥3 hours/week	52	44	44	<0.01	40	46	<0.01
Nulliparous	45	56	59	<0.01	54	51	<0.01
Western U.S.	15	19	21	<0.01	21	21	<0.01
Top quintile fruit/vegetable dietary pattern	10	21	29	<0.01	25	32	<0.01

Note: Values are %, unless otherwise indicated.

[a] Age-standardized

[b] <1 hour/week of vigorous activity and walking

[c] *p*-value derived using trend tests across ordinal categories: no exercise, 1–4 hours/week vigorous exercise, ≥5 hours/week vigorous exercise

[d] *p*-value derived using trend tests across ordinal categories: no exercise, 1–4 hours/week brisk walking, ≥ hours/week brisk walking

BWHS, Black Women's Health Study

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Table 2

Vigorous exercise in relation to incident obesity overall and by baseline BMI

Category	Hours/week	Cases	Person-years	IRR[a]	95% CI
All women	Little or no exercise	2557	62,963	1.00 (ref)	—
	1–2	1339	38,919	0.87	0.81, 0.93
	3–4	900	28,504	0.82	0.75, 0.88
	5–6	426	13,920	0.79	0.71, 0.87
	≥7	416	13,770	0.77	0.69, 0.85
BMI <25	Little or no exercise	725	45,415	1.00 (ref)	—
	1–2	316	27,966	0.81	0.71, 0.93
	3–4	216	20,998	0.72	0.61, 0.84
	5–6	93	10,425	0.63	0.51, 0.79
	≥7	107	10,143	0.77	0.63, 0.95
BMI ≥25	Little or no exercise	1832	17,548	1.00 (ref)	—
	1–2	1023	10,952	0.88	0.81, 0.95
	3–4	684	7,506	0.85	0.78, 0.93
	5–6	333	3,495	0.90	0.80, 1.02
	≥7	309	3,627	0.79	0.70, 0.89

Note: p for trend <0.0001 for each of the three categories.

[a]adjusted for age (single year); time period (questionnaire cycle); education (≤12, 13–15, ≥16 years); geographic region (Northeast, South, Midwest, West); smoking status (never, past, currently smoke <15 cigarettes/day, currently smoke ≥15 cigarettes/day); alcohol intake (currently drink <1, 1–3, 4–6, ≥7 drinks/week); parity (0, 1, 2, ≥3 births); fruit/vegetable dietary pattern score (quintiles); and meat/fried foods dietary pattern score (quintiles).

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Table 3

Brisk walking for exercise in relation to incident obesity overall and by baseline BMI

Category	Hours/week	Cases	Person-years	IRR[a]	95% CI
All women	Little or no exercise	2557	62,963	1.00 (ref)	—
	1–2	553	18,889	0.80	0.72, 0.89
	3–4	388	11,826	0.91	0.80, 1.03
	5–6	203	6,489	0.88	0.75, 1.03
	≥7	199	5,563	1.00	0.85, 1.18
BMI ≥25	Little or no exercise	725	45,415	1.00 (ref)	—
	1–2	147	13,759	0.79	0.64, 0.97
	3–4	93	8,655	0.74	0.58, 0.95
	5–6	54	4,630	0.85	0.62, 1.16
	≥7	71	3,941	1.25	0.93, 1.67
BMI ≥25	Little or no exercise	1832	17,548	1.00 (ref)	—
	1–2	406	5,130	0.79	0.70, 0.90
	3–4	295	3,171	0.95	0.82, 1.10
	5–6	149	1,859	0.84	0.69, 1.01
	≥7	128	1,622	0.81	0.66, 1.00

Note: p for trend: 0.48 for all women; 0.27 for BMI <25; 0.17 for BMI ≥ 25

[a]Adjusted for age (single year); time period (questionnaire cycle); education (≤12, 13–15, ≥16 years); geographic region (Northeast, South, Midwest, West); smoking status (never, past, currently smoke <15 cigarettes/day, currently smoke ≥15 cigarettes/day); alcohol intake (currently drink <1, 1–3, 4–6, ≥7 drinks/week); parity (0, 1, 2, ≥3 births); fruit/vegetable dietary pattern score (quintiles); meat/fried foods dietary pattern score (quintiles); and vigorous exercise (1–2, 3–4, 5–6, ≥7 hours/week).

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Table 4

Brisk walking for transport in relation to incident obesity overall and by baseline BMI

Category	Hours/week	Cases	Person-years	IRR[a]	95% CI
All women	Little or no exercise	2557	62,963	1.00 (ref)	—
	1–2	308	10,880	0.76	0.67, 0.87
	3–4	132	4,724	0.76	0.63, 0.91
	5–6	74	2,164	0.92	0.72, 1.16
	≥7	96	3,114	0.83	0.67, 1.03
BMI <25	Little or no exercise	725	45,415	1.00 (ref)	—
	1–2	88	8,294	0.70	0.55, 0.89
	3–4	39	3,651	0.67	0.47, 0.94
	5–6	24	1,620	0.94	0.62, 1.43
	≥7	23	2,395	0.61	0.39, 0.94
BMI ≥25	Little or no exercise	1832	17,548	1.00 (ref)	—
	1–2	220	2,586	0.81	0.69, 0.94
	3–4	93	1,073	0.82	0.66, 1.02
	5–6	50	544	0.89	0.67, 1.19
	≥7	73	719	0.99	0.77, 1.23

Note: p for trend: 0.070 for all women; 0.055 for BMI <25; 0.40 for BMI ≥25

[a]Adjusted for age (single year); time period (questionnaire cycle); education (≤12, 13–15, ≥16 years); geographic region (Northeast, South, Midwest, West); smoking status (never, past, currently smoke <15 cigarettes/day, currently smoke ≥15 cigarettes/day); alcohol intake (currently drink <1, 1–3, 4–6, ≥7 drinks/week); parity (0, 1, 2, ≥3 births); fruit/vegetable dietary pattern score (quintiles); meat/fried foods dietary pattern score (quintiles); and vigorous exercise (1–2, 3–4, 5–6, ≥7 hours/week.