Physical Activity and Physical Fitness in African-American Girls With and Without Obesity

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Abstract

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Lack of physical activity and low levels of physical fitness are thought to be contributing factors to the high prevalence of obesity in African-American girls. To examine this hypothesis, we compared habitual physical activity and physical fitness in 54 African-American girls with obesity and 96 African-American girls without obesity residing in rural South Carolina. Participation in vigorous (≥6 METs) (VPA) or moderate and vigorous physical activity (≥4 METs) (MVPA) was assessed on three consecutive days using the Previous Day Physical Activity Recall. Cardiorespiratory fitness was assessed using the PWC 170 cycle ergometer test. Upper body strength was determined at two sites via isometric cable tensiometer tests. Relative to their counterparts without obesity, girls with obesity reported significantly fewer 30-minute blocks of VPA (0.90 ± 0.14 vs. 1.3 ± 0.14) and MVPA (1.2 ± 0.18 vs. 1.7 ± 0.16) ($p<0.01$). Within the entire sample, VPA and MVPA were inversely associated with body mass index ($r=-0.17$ and $r=-0.19$) and triceps skinfold thickness ($r=-0.19$ and $r=-0.22$) ($p<0.05$). In the PWC 170 test and isometric strength tests, girls with obesity demonstrated absolute scores that were similar to, or greater than, those of girls without obesity; however, when scores were expressed relative to bodyweight, girls with obesity demonstrated significantly lower values ($p<0.05$). The results support the hypothesis that lack of physical activity and low physical fitness are important contributing factors in the development and/or maintenance of obesity in African-American girls.

Key words: exercise, overweight, children, females

Introduction

Obesity is a serious public health concern for Americans. Results from the Third National Health and Nutrition Examination Survey (NHANES III) indicate that approximately one out of every three adults in the United States is overweight, an increase of 8% from previous national estimates (13). Women at most ages suffer more from this problem than do men, and the problem is even more significant for African-American women, of whom nearly 50% are considered overweight (13). Recent evidence linking obesity to increased mortality and other adverse health outcomes in women underscores the urgency to better understand this serious health problem in African-American women (14,19).

The disproportionate levels of obesity observed in adult African-American women may have their origins in childhood and adolescence. As part of the NHBLI Growth and Health Survey, Campaigne et al. (5) assessed the prevalence of obesity in a biracial sample of 2379 girls aged 9 and 10. Using the 85th percentile level of either body mass index (BMI) or triceps skinfold thickness from NHANES I and II, the prevalence of obesity was found to be significantly higher in African-Americans than in whites. More recently, Troiano et al. (23), using data from NHANES III, reported the prevalence of overweight among girls aged 6 to 11 and

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12 to 17 to be higher among African-Americans than either whites or Mexican-Americans. Moreover, between NHANES II (1976 to 1980) and NHANES III (1988 to 1991), African-American girls demonstrated the largest increase in the prevalence of overweight, increasing from 18.4% to 30.7% in 6 year olds to 11 year olds and 18.2% to 29.9% in 12 year olds to 17 year olds.

Presently, the factors that contribute to the increased prevalence of overweight and obesity in African-American girls are not well understood. One area of concern is lack of physical activity. In the 1990 Youth Risk Behavior Survey, African-American girls exhibited the largest age-related decline in the percentage of girls reporting three or more vigorous exercise sessions per week, dropping from 21.6% in 9th grade to 9.1% by 12th grade (11). Despite such findings, few investigators have examined the relationship between physical activity and adiposity in African-American girls. Wolf and coworkers (26) studied physical activity behavior and obesity in a multiethnic sample of girls in grades 5 through 12. Relative to whites, Asians, and Hispanics, African-American girls were significantly more likely to be classified as obese. African-Americans reported more physical activity than Asians and Hispanics but were significantly less active than whites. Importantly, when body composition and physical activity behavior were examined across all ethnic/race groups, age-adjusted BMI was inversely associated with participation in physical activity.

Also of interest is the relationship between excess adiposity and the various components of physical fitness. As an outcome of obesity, excess bodyweight (BW) may impair functional capacity, particularly in activities that require locomotion or lifting of BW. Alternatively, low physical fitness may contribute to a state of positive energy balance, because impaired functional capacity may reduce the willingness of children to participate in regular physical activity. Presently, few data are available regarding the relationship between obesity and physical fitness in African-American girls. Although several studies have reported that African-American girls have lower levels of aerobic fitness than do youngsters from other population groups (2,12,20), it remains uncertain whether this difference is related to the higher prevalence of obesity in this population. In studies involving other population groups, youngsters with obesity consistently demonstrate lower levels of weight-relative aerobic fitness than do children without obesity (24). However, to date, no study has compared the physical fitness of African-American girls with and without obesity.

This study compared the physical activity behavior of African-American girls with and without obesity residing in rural South Carolina. In addition, in order to examine the relationship between obesity and physical fitness, cardiorespiratory fitness and upper body strength were measured and compared.

Methods

Subjects

All 558 fifth-grade students in two rural school districts were invited to participate in the study. The student population in both counties was approximately 70% African-American and 50% female. Sixty-five percent were eligible for the districts' free or reduced-price lunch programs. From the 195 African-American girls eligible for the study, 150 (76.9%) volunteered to participate. Before participation, written informed consent was obtained from each participant and the primary guardian. The study was approved by the University of South Carolina institutional review board for use of human subjects.

Anthropometric Measures

Anthropometric measurements included height, BW, and triceps and calf skinfold measurements. Height was measured to the nearest 1.0 cm with a portable stadiometer. BW was measured to the nearest 0.2 kg with a standard beam scale (Detecto). For calf and triceps skinfold measurements, the right midcalf and mid-upper arm were measured and marked, and three separate measures were obtained with calibrated Lange skinfold calipers. The average of the three measurements were used in the analysis. BMI was calculated as BW in kilograms divided by height in meters squared (kg/m^2). Percent body fat (%BF) was estimated using the skinfold equation of Slaughter et al. (21). Fat free mass (FFM) was calculated from the formula: $FFM = BW-(BW\times(\%BF/100))$.

Measurement of Physical Activity

Physical activity during the after-school hours was assessed by use of the Previous Day Physical Activity Recall (PDPAR). This self-report instrument makes use of a standardized form organized into 17 30-minute blocks beginning at 3:00 PM and continuing through 11:30 PM. Thirty-five common activities were listed on the form, and each student entered the main activity in which he or she participated during each of the 30-minute time periods on the previous day. The main activity was defined as the activity that occupied the majority of the 30-minute time period. For each 30-minute block, the student rated the intensity of the designated activity as either very light, light, medium, or hard. Very light activities are described as those requiring slow breathing with little or no movement. Light activities were described as those requiring normal breathing and regular movement. Medium activities were described as those requiring increased breathing and moderate movement. Hard activities were described as those requiring hard breathing and moving quickly. For each level of intensity, students were provided with cartoon illustrations depicting activities typical of each intensity level. The PDPAR has established validity based on concurrent observation with both motion sensors ($r=0.77$) and heart rate monitors

($r=0.63$) and established test-retest reliability ($r=0.98$) (25).

Students completed the PDPAR instrument on three consecutive days in the classroom under the supervision of two trained research assistants. All assessments were completed over a 10-week period during the spring months (March to May). Data from each day were reduced to the average daily number of 30-minute blocks in which the main activity was rated at 6 METs or greater (vigorous physical activity [VPA]) and 4 METs or greater (moderate and vigorous physical activity [MVPA]).

Physical Fitness Measures

Cardiorespiratory fitness was assessed via the Physical Work Capacity 170 test (PWC 170) with a Monark cycle ergometer (22). Subjects performed three 3-minute stages at a cadence of 60 rpm. Power outputs for each stage were selected to elicit heart rates of approximately 120, 150, and 180 beats/minute. Heart rate during the last minute of each exercise stage was recorded via a Polar Vantage XL heart rate monitor. Individual simple linear regression analyses were then used to predict the power output required to elicit a heart rate of 170 beats/min. Because previous studies have shown power output during the PWC 170 to be positively influenced by BW, PWC 170 scores were expressed relative to total BW and estimated FFM (1,4,7).

Maximal shoulder extension and elbow flexion were measured via isometric cable tensiometer strength tests as described by Clarke et al. (6). For each measure, three trials were performed with the highest score taken as the actual measure. To control for differences in body size, both measures were expressed relative to body mass.

Classification of Subjects

Subjects were classified as obese if either their BMI or triceps skinfold thickness was equal to or greater than the race- and age-specific 85th percentile of the first National Health and Nutrition Survey (NHANES 1) (15). Using these criteria, the number of students classified as obese and nonobese were 54 and 96, respectively.

Statistical Analysis

Differences between girls with and without obesity on physical activity and physical fitness measures were tested using Student *t*-tests. Associations between physical activity variables and body composition measures were assessed using Spearman rank order correlation coefficients. Significance was set at an α level of 0.05.

Results

The physical characteristics of the African-American girls with and without obesity are shown in Table 1. Compared with their counterparts without obesity, girls with obesity exhibited significantly greater BW, BMI, skinfold thickness, %BF, and FFM. No significant differences were observed for height or age.

Table 1. Physical characteristics of fifth-grade African-American girls with (n = 54) and without (n = 96) obesity

Characteristic	With Obesity	Without Obesity
Age (years)	10.7 ± 0.7	10.8 ± 0.6
Height (m)	1.50 ± 0.06	1.49 ± 0.08
BW (kg)	56.5 ± 10.9	40.9 ± 6.7
BMI (kg/m^2)	25.1 ± 4.0*	18.5 ± 1.9
Tricep skinfold (mm)	20.6 ± 4.9*	10.5 ± 3.1
Calf skinfold (mm)	21.9 ± 6.7*	11.6 ± 3.6
% BF	31 ± 8*	19 ± 4
FFM	38.6 ± 4.7*	33.2 ± 5.0

*Significantly different from without obesity ($p<0.001$).

Mean levels of participation in VPA and MVPA are shown in Figure 1. Girls with obesity reported significantly lower participation in VPA, with the mean number of 30-minute blocks with activity rated at 6 METs or greater being 0.90 ± 0.14 and 1.3 ± 0.14 for girls with and without obesity, respectively. Approximately 30% of the girls with obe-

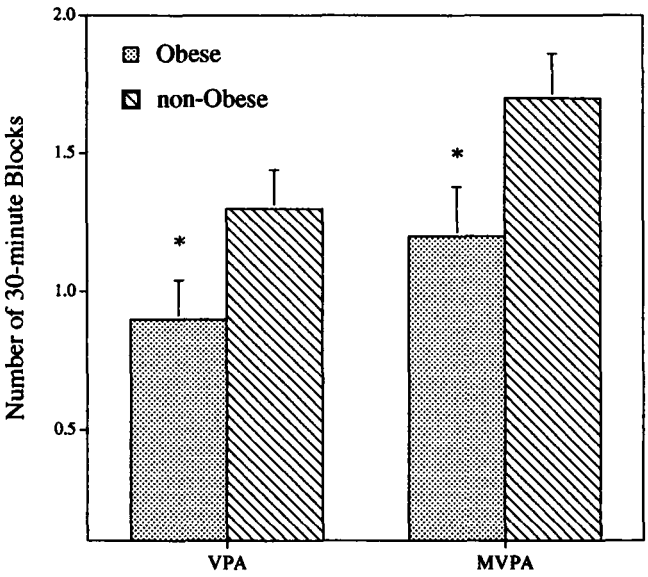

Figure 1: Participation in vigorous physical activity (VPA) (≥6 METs) and moderate and vigorous physical activity (MVPA) (≥4 METs) for fifth-grade African-American girls with (n = 54) and without (n = 94) obesity. Data are means ± standard error. *Significantly different from nonobese $p<0.01$.

Table 2. Means and standard deviations for the PWC 170 cycle ergometer test and cable tensiometer strength tests in fifth-grade African-American girls with (n = 54) and without (n = 96) obesity

Fitness variable	With obesity	Without obesity
PWC 170		
Absolute (kg/m)	445.5 ± 108.6	438.4 ± 119.8
Relative to BM* (kg/m per kg)	8.1 ± 2.3†	10.8 ± 2.8
Relative to FFM (kg/m per kg FFM)	11.6 ± 2.8‡	13.3 ± 3.4
Shoulder extension		
Absolute (kg)	20.8 ± 4.2§	18.6 ± 4.1
Relative to BM (kg/kg)	0.82 ± 0.18‡	1.01 ± 0.21
Relative to FFM (kg/kg FFM)	0.54 ± 0.12	0.56 ± 0.12
Elbow flexion		
Absolute (kg)	22.7 ± 3.9§	21.2 ± 4.5
Relative to BM (kg/kg)	0.90 ± 0.19†	1.15 ± 0.23
Relative to FFM (kg/kg FFM)	0.59 ± 0.11§	0.64 ± 0.12

*BM, body mass.
†Significantly different from without obesity ($p<0.001$).
‡Significantly different from without obesity ($p<0.01$).
§Significantly different from without obesity ($p<0.05$).

sity, compared with 25% of the girls without obesity, reported no participation in VPA over the 3-day measurement period. Girls with obesity reported significantly lower participation in MVPA, with the mean number of 30-minute blocks with activity rated at 4 METs or greater being 1.2 ± 0.18 and 1.7 ± 0.16 for girls with and without obesity, respectively. Active outdoor games, running, and dancing were the most prevalent forms of physical activity among girls without obesity, whereas while walking and aerobic dance were the most prevalent activities among girls with obesity.

Means and standard deviations for the physical fitness measures are shown in Table 2. In the PWC 170 cycle ergometer test, girls with obesity produced absolute power outputs that were similar to those without obesity. However, when expressed relative to BW, girls with obesity exhibited significantly lower relative power outputs. Notably, this difference remained statistically significant when power output was expressed relative to FFM.

Relative to their counterparts without obesity, girls with obesity produced significantly greater absolute scores on both isometric strength tests. However, when elbow flexion and shoulder extension measures were expressed relative to BW, girls with obesity were found to exhibit significantly lower levels of upper body strength. When strength measures were expressed relative to FFM, elbow flexion but not shoulder extension was significantly lower in girls with obesity.

Spearman rank order correlations between physical activity scores and body composition measures are shown in Table 3. Participation in VPA and MVPA was inversely associated with BMI and triceps skinfold measurements ($p<0.05$). Correlations between the physical activity variables and calf skinfold measurements were in the expected direction, but were of marginal statistical significance ($p<0.10$).

Discussion

No previous investigation has examined physical activity, physical fitness, and adiposity in rural fifth grade African-American girls. Our results indicate that African-American girls classified as obese participate in significantly less physical activity and are less physically fit than

Table 3. Spearman rank order correlations between the physical activity measures and markers of adiposity in fifth-grade African-American girls

Parameter	VPA	MVPA
BMI	−0.17*	−0.19*
Tricep skinfold	−0.19*	−0.22*
Calf skinfold	−0.07†	−0.10†

*$p<0.05$.
†$p<0.10$.

their counterparts without obesity. Furthermore, when examined across the entire sample, physical activity behavior was inversely associated with several measures of adiposity. Together, these findings support the hypothesis that physical inactivity may be an important contributing factor in the development and/or maintenance of obesity in young African-American girls.

Lack of physical activity has long been hypothesized to be an important factor in the cause of childhood obesity. However, the scientific research literature remains equivocal on this point. Although most studies have demonstrated lower activity levels in youth with obesity, or an inverse relationship between physical activity and adiposity, some have failed to report such a relationship (3,18,24). In this study, girls with obesity reported significantly fewer 30-minute blocks of VPA (≥6 METs) and MVPA (≥4 METs) than did girls without obesity. Thus, not only were girls with obesity less likely to participate in vigorous activities such as jogging, aerobic dance, and competitive sports, but they were also less likely to participate in moderate-intensity activities such as walking, bicycling to school, and household chores.

Previous studies, using either weightbearing or nonweightbearing testing protocols, have shown children with and without obesity to exhibit similar absolute values of maximal oxygen consumption (liters/minute). However, when maximal oxygen consumption is expressed relative to BW or FFM (mL/minute per kg) children with obesity consistently demonstrate lower levels of aerobic power than do children without obesity (24). In this study, girls with obesity exhibited similar absolute power outputs during the PWC 170 cycle ergometer test. However, when power output was expressed relative to BW or FFM, girls with obesity had significantly lower power outputs at a heart rate of 170. Similarly, in the isometric strength tests, girls with obesity demonstrated significantly greater absolute upper body strength compared with girls without obesity, but significantly lower strength scores when values were expressed relative to BW. Therefore, it appears that excess adiposity may have little effect on performance during nonweightbearing activities but may have detrimental effects on functional capacity during weightbearing activities such as walking, running, and climbing. This raises the possibility that African-American girls with obesity may be less inclined to engage in activities such as walking, running, and climbing because these weightbearing activities are relatively more demanding for them than for their counterparts without obesity.

Of concern, 36% of the girls participating in this study were classified as obese. This suggests that, as early as the fifth grade, a substantial percentage of African-American girls are in need of interventions to produce negative energy balance. Although such interventions would include modifications to diet, the results of this study indicate that interventions targeted at African-American girls with obesity should also include strategies to increase habitual physical activity. In support of this concept, exercise training has been shown to be an effective treatment of obesity in African-American youth (10), as well as in children from other race/ethnicity groups (8). Furthermore, in view of the fact that African-American girls may be more accepting of a larger body shape than other population groups (16) and tend to underestimate their BW and degree of body fatness (9,17), intervention programs should also consider cultural influences on perception of body shape and their effects on health behaviors such as physical activity and diet.

Some limitations of this study warrant consideration. First, because of the cross-sectional nature of this study, we were unable to infer causal relationships between physical activity, physical fitness, and obesity. Second, because we did not measure dietary behavior, we were unable to assess possible differences in caloric consumption between the two groups. Nevertheless, within the limitations of our study design, our results provide important evidence that a substantial number of African-American girls are at increased risk for future cardiovascular disease due to excess adiposity, low physical fitness, and low physical activity.

In summary, African-American girls with obesity participated in less physical activity and were less physically fit than did their counterparts without obesity. These findings support the hypothesis that lack of physical activity and low physical fitness may be important contributing factors in the development and/or maintenance of excessive adiposity in African-American girls. Clearly, long-term prospective studies are needed to fully elucidate the role of physical inactivity in the development of obesity in African-American girls.

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