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Research Article

A 10-Month Physical Activity Intervention Improves Body Composition in Young Black Boys

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Objective. To determine if a 10-month after-school physical activity (PA) intervention could prevent deleterious changes in body composition and cardiovascular (CV) fitness in young black boys. *Methods*. Following baseline measures, 106 boys (8–12 yrs) were randomized to either a control group or an intervention group, further divided into attenders (ATT) and nonattenders (NATT), participating in ≥60% or <60% of the intervention, respectively. The daily intervention consisted of skills development (25 min), vigorous PA (VPA, 35 min), and strengthening/stretching (20 min) components. Body composition was measured by dual-energy X-ray absorptiometry. *Results*. Following the intervention, the ATT exhibited an increase in moderate-to-vigorous PA and a significant reduction in BMI, fat mass, and %BF compared to the control group. A significant association among the intervention energy expenditure and changes in body composition and CV fitness was observed only in the ATT group. *Conclusion*. An after-school PA program of sufficient length and intensity can promote healthy changes in body composition and fitness levels in black boys who attend at least 3 days/week.

1. Introduction

The prevalence of childhood obesity has more than tripled over the past three decades. The latest NHANES data (2003–2006) revealed that approximately 35% of 6–11-year-old children are classified as "*overweight*" or "*obese*" [1, 2]. This level of obesity in children begets risk factors for cardiovascular disease (CVD) and metabolic diseases. Approximately 25% of obese children have ≥2 CVD risk factors [3, 4] and more than 45% of newly diagnosed pediatric diabetes cases are classified as "adult-onset" type 2 diabetes [4–7]. This alarming evidence has pushed the prevention of childhood obesity to the forefront of today's scientific research. This study also reveals that although childhood obesity knows no gender or racial boundary, the rates of obesity are more prevalent in some minority populations. In the 69,000 children (5–17 years) measured across the United States, a significantly higher prevalence of overweight or obesity was reported in black children compared to White, Hispanic- or other minority children- and boys were reported to have a higher prevalence of obesity compared to girls.

Studies have shown that childhood obesity equates over time to as little as a +2% imbalance between daily energy intake and energy expenditure (EE) [8]. This small positive imbalance can be abated with an increase in regular physical activity (PA). Population-based objective measures of children's PA levels revealed that only 42% of 6–11-year-old children acquire the recommended 60 min/day of moderate-to-vigorous PA (MVPA); for 12–15-year-old adolescents, this number drops dramatically to <10% [9]. Further, the concomitant increase in the amount of time children spend in sedentary pursuits (e.g., in the classroom, watching television, or playing video games) is independently associated with lower levels of PA and daily PA energy expenditure (PAEE), lower CV fitness, increased risk for obesity, and obesity-related health consequences [10–15]. These associated risks are exacerbated by the reality that obese children have a preference for sedentary behaviors, spend more time being physically inactive, and may not spend as much energy during PA compared to their nonobese pairs [16–18].

Randomized-controlled intervention studies targeting obese children have successfully increased MVPA participation to enhance body composition and CV fitness [19, 20]. However, healthy developmental changes in body composition (e.g., increased fat-free mass with no change or a decrease in fat mass) and CV fitness (e.g., improved aerobic capacity) have not been demonstrated in studies of children with a wide range of adiposity [21]. These results may be attributed to (1) an insufficient PA dose to correct for energy imbalance in all children, (2) the imprecise measurements of body composition (anthropometric measures) that lack the sensitivity to detect changes in growing children, and (3) the short duration of the training program, limiting the capacity to detect either small decreases in weight gain or the small excessive increases in weight gain associated with childhood obesity [22, 23].

Therefore, we sought to evaluate the efficacy of a 10-month PA intervention on (1) the prevention of excessive age-related increases in body fatness and (2) CV fitness. We hypothesized that black boys who participated in a 10-month after-school PA intervention would prevent excessive age-associated changes in body fatness in addition to a concomitant increase in CV fitness, compared to black boys who did not participate in the 10-month PA program.

2. Research Methods and Procedures

2.1. Participants. Black boys (8–12 years of age) were recruited from five local elementary schools using study fliers. All 3rd through 5th grade black boys were eligible if they met the following criteria: (1) weigh <300 lbs (equipment limitation), (2) not taking any medications known to affect metabolism, body composition, or fat distribution (e.g., Ritalin or Concerta), and (3) have no known CV, metabolic, or respiratory disease or physical impairment that would limit their participation in regular PA. Twenty-eight percent (300 boys) of the targeted population (1050 boys in 3rd–5th grade) were screened by phone to determine their eligibility to participate in the study. Potential participants and their parent or guardian were invited to attend a group information session where they read and signed the informed consent/assent documents in accordance with the Medical College of Georgia Human Assurance Committee. Participants were given a monetary incentive for the testing portion of the study only; no additional monetary incentive was offered for attending the intervention. Although recruitment was not based on adiposity, the distribution was representative of the higher weight status in the state of Georgia.

Of the 157 boys who consented to be in the study, 122 underwent baseline testing. Although siblings were allowed to participate in the study, only one sibling per family was used in the analyses. Within each family, the sibling with the most data points was selected for analysis. In the case of ties, the sibling with the lowest identification number was selected. The identification numbers were not assigned in any specific order (e.g., oldest sibling first). After removing the siblings ($n = 4$) from the analyses and accounting for those participants who either (1) were unreachable for baseline or follow-up testing ($n = 26$), (2) declined participation ($n = 9$), (3) became ineligible for participation due to medical reasons ($n = 8$), or (4) were expelled for disciplinary issues ($n = 4$), 106 boys were included in the analyses.

2.2. Baseline and Follow-Up Testing. Participants reported to the Georgia Prevention Institute of the Medical College of Georgia for testing prior to the beginning of the study and again after 10 months. Baseline testing began during the summer months before schools started and continued until mid-fall with as many as three boys tested on any given day. The boys were integrated into the intervention on a rolling basis with each subject given the opportunity to participate in at least 10 months of the intervention. Follow-up testing for the intervention group was conducted within 1–3 days following the last day of the 10-month intervention. All testing was conducted by trained study personnel with an exercise physiology or related background.

2.3. Sexual Maturation Assessment. Pubertal status was assessed by study pediatricians based on the criteria established by Marshall and Tanner [24, 25]. Utilizing gonad and pubic hair development separately, the subject was then classified as immature (Tanner 1-2), peripubertal (Tanner 3-4), or mature (Tanner 5) for the analyses. Examination of the Tanner staging for pubic hair and gonad development was not refused by any of the boys.

2.4. Body Size and Composition Assessment. Height, to the nearest 0.1 cm, and weight, to the nearest 0.1 kg, were measured by standard methods using a wall-mounted stadiometer (Healthometer) and floor scale (Dectecto), respectively. Body mass index (BMI) was calculated as weight(kg)/height(m^2), and BMI percentile (BMI%) was obtained from the Centers for Disease Control age- and gender-specific growth charts [26]. Waist circumference was measured along the narrowest width between the rib cage and the umbilicus.

Total body composition was measured in a 3-compartment model as total fat mass (FM), fat-free mass (FFM), and bone mineral content (BMC) using dual-energy X-ray absorptiometry (DXA; Hologic QDR-1000, Waltham, MA). The boys were measured in a supine position while wearing light clothing with no metal and no shoes or jewelry. Bone mineral density and %BF were derived from the three aforementioned components using the DXA scanner software (Hologic, version 2.3.1).

2.5. Cardiovascular Fitness Assessment. Cardiovascular fitness (VO_2 max) was assessed by the method of indirect calorimetry (Sensormedics Vmax 229 cardiopulmonary system, Yorba Linda, CA) using a multistage treadmill test. The treadmill protocol began with a 4-min warm-up at 2 mph and 0% grade. The speed was then increased 0.5 mph every 2 minutes to 3.0 mph followed by 2%-3% grade increases every 2 minutes until reaching 20% grade (maximum grade of the treadmill) or until voluntary exhaustion. Participants were asked to rate their perceived exertion using the 6–20 point Borg scale. Participants were considered to have attained VO_2 max if they met two of the following three criteria: (1) an increase in heart rate (HR) <5 bpm between the final two workloads, (2) an increase in oxygen consumption (VO_2) <100 ml/min between the final two workloads and (3) a respiratory exchange ratio >1.10. Although all participants were encouraged verbally to give a maximal effort, approximately half of them stopped the test voluntarily before reaching VO_2 max. In addition, only about half of the boys who attained VO_2 max at baseline also did so at followup. Because the achievement of maximal effort is not common in participants of this age [27], an alternate index of CV fitness was used: VO_2 at an HR of 170 bpm (VO_2-170). VO_2-170 was determined from individual regression analyses of the VO_2 and HR responses to all completed workloads during the treadmill test. Heart rate was monitored throughout the test using a Polar HR monitor (Polar USA, Lake Success, NY).

2.6. Physical Activity Assessment. Free-living PA was measured using a seven-day PA recall [28]. The boys were questioned about their activities, including sleep, over the seven days prior to the interview, starting with the previous day and working backwards. Thus, the seven-day recall included the PA associated with the PA program for the boys in the intervention group at followup. This interview, typically completed in 20–30 minutes, was conducted by trained study personnel. Values of hard PA (identified as PA that caused increased breathing and moderate movement including activities such as, dancing, aerobics, and soccer) and very hard PA (identified as PA that caused hard breathing and quick movements including activities such as, tennis, cycling, and running) were summed to derive an index of vigorous PA (VPA). MVPA was calculated as the sum of VPA and moderate PA (identified as PA that caused normal breathing and some movement including activities such as, walking briskly, volleyball, gymnastics, and gardening).

2.7. After-School Intervention. Following baseline testing, participants were randomized into either the intervention group (n = 62) or the control group (n = 44) with a ratio of three to two, respectively. In the instance of siblings, the first to be tested was randomized and the remaining sibling(s) was/were placed in the same group. Participants in the control group received no intervention and were not allowed to stay for the after-school intervention but rather instructed not to change their daily after-school routine. Participants in the intervention group stayed at their school at the end of each full school day (177 ± 8.6 days) to receive a 2-hour intervention over a 10-month period, excluding school holidays. The after-school PA intervention is described in detail elsewhere [29]. Briefly, the intervention was conducted by trained study personnel with exercise-related education plus 1-2 trained classroom teachers. The program consisted of 30 minutes of homework time during which the boys were provided with a healthy snack followed by 80 minutes of PA. All the snacks were individually packaged and every day the boys had a choice of something salty (e.g., crackers and cheese), something sweet (e.g., low-fat cookies), or a fruit or vegetable. The PA program included 25 minutes of skills development (e.g., how to dribble a basketball), 35 minutes of VPA, and 20 minutes of toning and stretching with 5 minutes rest between each component. Throughout the intervention, the boys wore a Polar S610 HR monitor (Lake Success, NY) to record their PA intensity and to estimate their EE during the sessions. During the VPA component, the boys were asked to maintain an HR of at least 150 bpm. Activities during the VPA component included games such as, basketball, tag, softball, and relay races, all of which were modified to keep all the boys sufficiently active (≥150 bpm) throughout the 35-minute period.

2.8. Statistical Analyses. For analyses, the intervention group was subdivided into boys who either attended ≥60% of the intervention (attenders, ATT; n = 31) or those who did not attend at least 60% of the intervention (nonattenders, NATT; n = 31). Group comparisons of baseline and follow-up values for all outcome variables (body composition, CV fitness, and PA variables) were conducted using a 3 × 2 repeated measures ANOVA using group (ATT, NATT, and Control) and test session (baseline and followup) as main effects. The relationships at baseline and for the change scores among the outcome variables were determined using Pearson correlation analyses. Within the intervention group, the relationships among the outcome variables, program attendance, and HR during the aerobic portion of the program were all assessed using Pearson correlation analysis. Statistical significance was set at alpha = 0.05.

3. Results

3.1. Participant Characteristics. One hundred and six 3rd–5th grade boys participated in the study and were randomized into either the intervention (n = 62) or the control (n = 44) group. All of the boys were classified as prepubertal for gonad and pubic hair development. The descriptive data for baseline measures are presented in Table 1. There were no significant differences at baseline among the control group, ATT (n = 31), and NATT (n = 31) for all outcome variables.

3.2. Program Evaluation. All children in the intervention group participated in a minimum of 10 months of PA for the study. The average attendance for the intervention group was 57.7 ± 3.1%, which varied greatly between the ATT (82.9 ± 1.8%) and NATT (32.8 ± 4.5%). Heart rate during the VPA component of the daily intervention was not significantly different between ATT and NATT boys and averaged 162.0 ± 1.4 bpm. Additionally, no significant differences in total EE per session between the ATT and NATT boys were observed. The average EE during the 80-minute sessions was 369.8 ± 21.4 kcal/session, of which 192.3 ± 10.8 kcal/session was expended during the VPA component alone.

3.3. CV Fitness. The baseline and follow-up measures of CV fitness include VO_2-170 expressed both in absolute terms (L/min) and relative to body mass (ml/kg/min) (Table 2).

Table 1: Baseline Participant Characteristics (Means ± SE).

	ATT (n = 31)	NATT (n = 31)	Controls (n = 44)
Age (y)	9.7 (0.2)	9.8 (0.2)	9.9 (0.2)
BMI Classification			
Overweight/Obese (%)	48.4	48.4	45.5
Sexual Maturity			
Pubic	1.45 (0.11)	1.32 (0.10)	1.27 (0.09)
Organ	1.26 (0.12)	1.13 (0.06)	1.36 (0.11)
Height (cm)	143.2 (1.7)	141.0 (1.8)	140.9 (1.2)
Weight (kg)	43.0 (2.9)	41.6 (2.8)	40.1 (1.7)
Resting Vitals			
Systolic BP (mm Hg)	105.5 (9.5)	103.4 (9.8)	101.8 (7.2)
Diastolic BP (mm Hg)	59.9 (6.4)	57.6 (6.3)	57.6 (6.1)
HR (bpm)	71.8 (9.1)	76.3 (12.1)	74.0 (9.1)
Peak Vitals			
HRpk (bpm)	187 (3.3)	188 (2.4)	190 (2.1)
VO_2pka (L/min)	1.3 (0.07)	1.1 (0.06)	1.2 (0.04)
VO_2pkr (ml/kg/min)	30.5 (7.8)	28.3 (6.2)	30.2 (6.6)

ATT = >60% attendance; NATT = <60% attendance; BP = blood pressure; HR = heart rate; HRpk = peak heart rate; VO_2pka = peak oxygen consumption in absolute terms; VO_2pkr = peak oxygen consumption relative to body mass.

Table 2: Body Composition, CV Fitness and PA measures by Group (Means ± SE).

	Baseline			Follow-up		
	ATT (n = 31)	NATT (n = 31)	CON (n = 44)	ATT (n = 31)	NATT (n = 31)	CON (n = 44)
BMI (kg/m^2)	20.4 (5.4)	20.3 (4.9)	20.0 (4.4)^c	20.3 (5.5)	20.7 (5.2)	20.5 (4.6)^c
Waist circ. (cm)	66.4 (11.6)	66.1 (10.8)	65.7 (9.9)	66.9 (12.1)	67.5 (12.2)	67.1 (10.3)
FM (kg)	11.6 (9.3)	12.1 (8.8)	10.5 (6.8)^c	11.3 (9.9)	12.6 (9.5)	11.4 (7.7)^c
FFM (kg)	30.8 (7.6)^a	29.2 (7.3)^b	29.1 (5.2)^c	34.1 (9.0)^a	32.7 (9.0)^b	32.6 (6.9)^c
%BF	24.4 (9.5)^a	26.4 (9.3)^b	24.5 (9.7)	22.1 (9.5)^a	25.0 (9.4)^b	23.9 (10.4)
BMC (kg)	1.28 (3.27)^a	1.22 (2.92)^b	1.20 (2.24)^c	1.45 (4.06)^a	1.40 (4.27)^b	1.36 (2.98)^c
BMD (g/cm^2)	0.89 (0.07)^a	0.89 (0.06)^b	0.89 (0.06)^c	0.94 (0.08)^a	0.94 (0.13)^b	0.92 (0.06)^c
VO_2-170 (ml/kg/min)	25.5 (8.0)	22.6 (5.6)	23.4 (3.8)^c	26.8 (5.9)	24.3 (5.4)	25.9 (5.9)^c
VO_2-170 (L/min)	1.02 (0.28)^a	0.90 (0.25)^b	0.91 (0.16)^c	1.18 (0.35)^a	1.06 (0.32)^b	1.10 (0.22)^c
	(n = 27)	(n = 22)	(n = 36)	(n = 28)	(n = 23)	(n = 36)
MVPA (hrs/day)	0.91 (0.14)^a	0.83 (0.13)	0.83 (0.10)	1.49 (0.12)^a	0.98 (0.13)	0.91 (0.12)

PA = physical activity; SE = standard error; ATT = boys in the intervention group who attended ≥ 60%; NATT = intervention boys who attended < 60%; CON = control; BMI = body mass index; circ. = circumference; FM = fat mass; FFM = fat free mass; %BF = percent body fat; BMC = bone mineral content; BMD = bone mineral density; VO_2-170 = the VO_2 at a heart rate of 170 bpm during the graded treadmill test; MVPA = moderate-to-vigorous PA. Significant difference between baseline and follow-up for ^{a}ATT, ^{b}NATT, and ^{c}CON groups.

There was a similar improvement in VO_2-170 across all three groups from baseline to followup when expressed in L/min ($P < .001$). However, the control group demonstrated the only significant increase in VO_2-170 when expressed in ml/kg/min ($P < .0001$). Within the ATT group alone, there was a positive relationship between the EE during the VPA component of the intervention and changes in VO_2-170 expressed as L/min ($r = 0.56$; $P = .0018$) and when expressed as ml/kg/min ($r = 0.47$; $P = .012$). Additionally, a negative relationship was observed between the VPA component EE and the decrease in %BF ($r = -0.43$; $P = .02$). Interestingly, no relationships were observed between either the percent attendance or the average HR maintained during the VPA component of the intervention sessions and the changes in body composition or CV fitness measures in either the ATT or NATT.

3.4. Physical Activity. At baseline, the amount of MVPA reported by the boys was similar among the control, NATT, and ATT groups. Additionally, no relationships among

Table 3: Relationships between Body Composition, CV Fitness and Physical Activity levels at Baseline and Follow-up. (Pearson correlation coefficients).

		Body Composition				
	Time	BF (%)	BMI (kg/m^2)	FM (kg)	FFM (kg)	MVPA (hrs/day)
VO_2-170 (ml/kg/min)	BL	***−0.64***	***−0.63***	***0.64***	***−0.48***	0.01
	FU	***−0.76***	***−0.67***	***0.71***	***−0.32***	0.22
MVPA(hrs/day)	BL	0.20	0.22	0.24	0.22	—
	FU	−0.18	−0.08	-0.1	0.06	—

VO_2-170 = the VO_2 at a heart rate of 170 bpm during the graded treadmill test; BF = body fat; BMI = body mass index; FM = fat mass; FFM = fat free mass; MVPA = moderate-to-vigorous physical activity; BL = baseline; FU = follow-up; ***Bold italic*** font indicates a significant relationship (p < .05).

MVPA and measures of CV fitness and body composition were observed. At followup, the ATT reported a significant increase (P = .04) in MVPA by 34.8 min/day; however, no change in MVPA for the control group or the NATT group was reported (Figure 1). There were no significant relationships between the change in reported MVPA and changes in BMI ($r = -0.08$; P = .44), %BF ($r = -0.12$; P = .26), and VO_2-170 ($r = -0.03$; P = .73) among all three groups.

3.5. Body Size and Composition. There was a negative relationship among CV fitness and body composition measures at baseline for the entire population sample and these relationships were stronger at followup (Table 3). A significant group × time interaction was observed for %BF (Figure 2(a)), such that both the ATT (P < .0001) and NATT (P = .019) groups exhibited a decrease in %BF, whereas no significant change was observed in the control group (P = .18). Additionally, the decrease in %BF among the boys in the ATT group was significantly greater than the change in the control group (P = .029). A group by time interaction for BMI was also observed (Figure 2(b)) following the 10-month program, such that the control group exhibited a significant increase in BMI (P = .0034), whereas no change was observed in the NATT group (P = .06) or the ATT group (P = .33). The change in BMI in the ATT group, a slight decrease, was significantly different than the change in both the NATT group (P = .046) and the control group (P = .009). Further, a similar group by time interaction was observed for changes in FM (Figure 2(c)). Finally, the changes in FFM (P = .91) and BMD (P = .91) and BMC (P = .85) over the 10 months were similar across all groups.

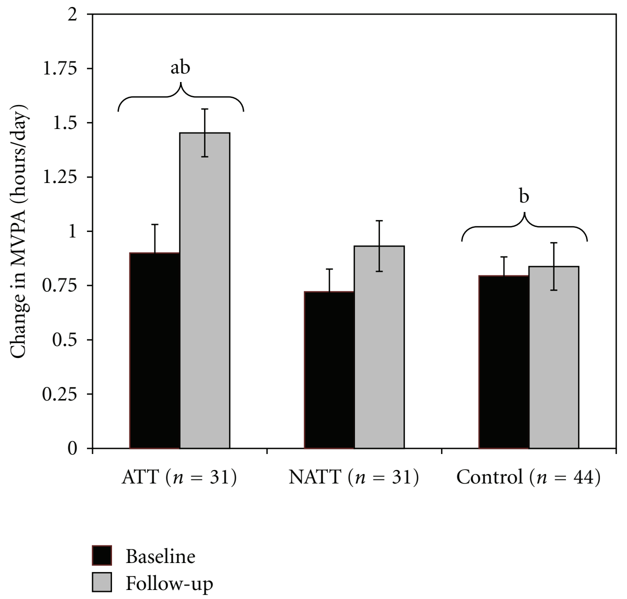

Figure 1: Baseline (black bars) and follow-up (grey bars) measures of MVPA by group. Values are means ± SE. (a) Significant difference from baseline to follow-up measures; (b) change from baseline to followup is significantly different between ATT and Control groups.

4. Discussion

The main finding of this study is that 10 months of after-school PA can prevent further accretion of undesirable levels of adipose tissue in black boys of varying adiposity levels. The boys who attended the intervention at least 3 days/week had a significant reduction in body fat, BMI, and fat mass compared to significant increases in BMI and fat mass observed in the control group. Although there were similar increases in FFM between the control and ATT groups, these findings indicated a beneficial effect of physical activity on overall body composition in young black boys.

A unique aspect of the present study included the statistical power to divide the PA intervention group and compare attenders versus nonattenders, those boys who attended at least 60% (ATT) and those who did not (NATT), respectively. This comparison lends support to the beneficial response of PA on body composition, only if consistency is maintained. Attenders exhibited a significant decrease in %BF of −2.25 ± 0.57% compared to a decrease of only −0.63 ± 0.44% in the control group over the 10-month PA intervention. Although the boys who did not attend at least 60% of the intervention gained less FM than the control group, the increase in BMI over the 10 months was similar to the control group. Consequently, this resulted in a similar and nonsignificant decrease in %BF in the NATT and control groups. Interestingly, this change in body composition was

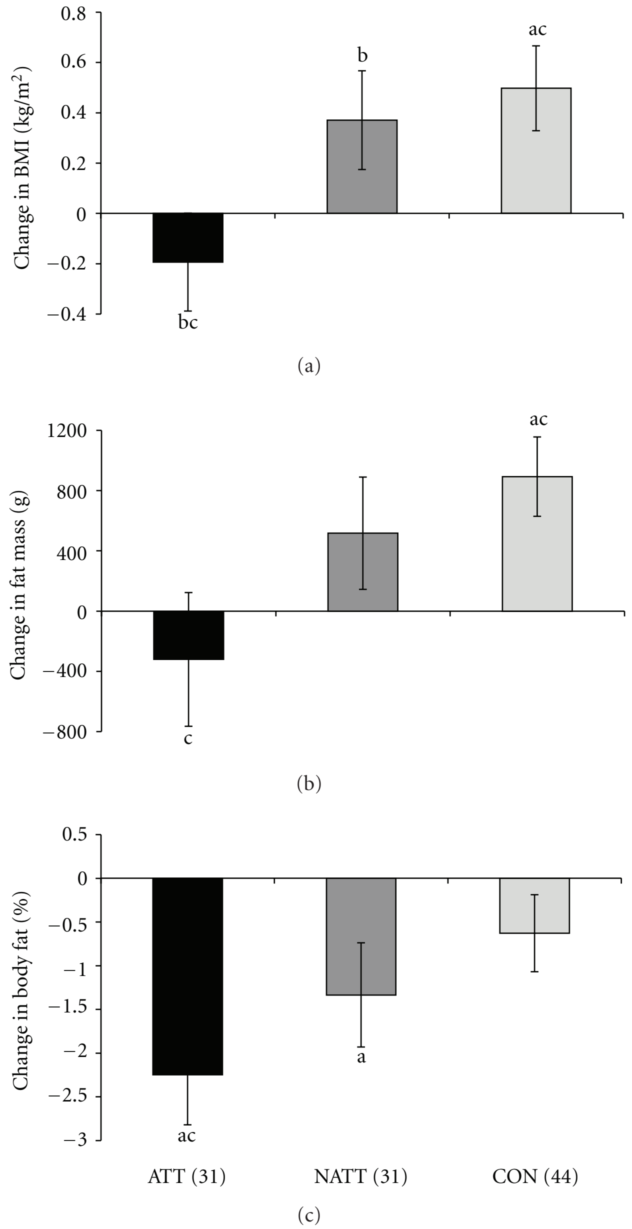

Figure 2: Baseline and follow-up measures of (a) BMI (kg/m^2), (b) fat mass (g), and (c) body fat (%) for the ATT group (black bars), NATT group (dark grey bars), and Control group (light grey bars). Values are means ± SE. (a) Significant difference from baseline to followup; (b) change from baseline to followup is significantly different between ATT and NATT groups; (c) change from baseline to followup is significantly different between ATT and Control groups.

independent of changes in FFM because all three groups had similar increases in FFM. Moreover, there were similar changes in BMC, BMD, and FFM across all three groups of boys which indicates that although there was an increase in reported MVPA in the ATT group compared to the control group, this increase in EE associated with participation in the intervention did not hinder increases of lean tissues related to normal growth patterns over the 10 months [30].

The results of this intervention are comparable, but less dramatic, to another study conducted in our laboratory with young black girls using a similar after-school intervention [29]. The success of these PA interventions, compared to less successful interventions [21], is, in part, attributed to the exercise dose (duration and intensity) provided by the program. The average daily energy cost of the program (370 ± 21 kcal/session) is more than twice the magnitude of the proposed energy surplus associated with childhood obesity (100–165 kcal/day) [23, 31]. It is speculated that small increases in total daily EE over time will abate the excessive increases in body mass associated with obesity. This is supported by the fact that only the boys who attended the intervention program on a regular basis reduced their adiposity levels over the 10 months, whereas the boys in the control or NATT groups both exhibited an increase in FM over the same time period. Although small, there was a positive change in BMI as a result of attending the program. If these positive changes are compared to the CDC's age- and gender-specific growth charts, this small reduction or prevention of increasing BMI may have significant physiological and health implications. For example, at age 8, a child with a BMI of 21 kg/m^2 is classified as obese according to these standardized charts. A year later, if that same child increased his BMI by the amount observed in our control group (0.5 kg/m^2), he would continue to be classified as obese by age 9. Instead, if that same child a year later slightly reduced his BMI as seen in our ATT group (−0.2 kg/m^2), he would be classified as overweight rather than obese by age 9. If this trend was to continue, by age 12, that child who participated in regular PA similar to our intervention would have a BMI of 20.2 kg/m^2 and would be classified as a healthy weight, thus reducing his potential risk for obesity-related diseases. Although these findings are promising, with half of the participants in the intervention group not acquiring the desired PA dose (<60% attendance), it is unclear if this program is generalizable across populations.

In the current study, the children were asked to play at a vigorous intensity by maintaining an HR of at least 150 bpm during the 35-minute VPA component of the intervention. Using a standardized maximal HR (HRmax) of 200 bpm for children, the average HR achieved during the intervention (162 bpm) was 81% of predicted HRmax, which is classified as vigorous intensity PA (70%–89% HRmax) [32]. Recent studies along with data from our laboratory suggest that VPA might have a favorable impact on body composition which is to some degree independent of EE [14, 33]. The energy cost of the present intervention was derived from individual linear regressions developed from the HR and VO_2 responses during the graded treadmill tests. In support, the results suggest that the EE was sufficient to abate deleterious changes in body composition and improvements in CV fitness [29]. Additionally, these results are consistent with descriptive studies indicating that accelerometry-measured VPA is strongly related to lower levels of fatness and better fitness than moderate PA (MPA). In the current study, there were no relationships between the measure of exercise intensity (HR during the VPA component) and either body composition or CV fitness; however, there was a weak relationship between these same factors and the EE during the VPA component.

Although the intervention promoted healthy changes in body composition, the intervention had little impact on CV fitness. The improvements in absolute measures of CV fitness (L/min) were similar across all three groups; however, in contrast to our hypothesis, when expressed relative to body mass, the control group had the greatest increase in CV fitness (9.8%) compared to both the ATT group (5.5%) and the NATT group (5.3%). Although we cannot explain this increase, the effort of the control group during follow-up exercise testing may have been greater than baseline testing. In support of similar postintervention CV fitness changes, a recent review of the literature revealed that endurance training at a frequency of 1 to 5 days/week, 20 to 60 min/session, at an intensity of 70% to 90% of maximal HR is necessary for improving CV fitness from 5% to 15% [34]. However, the most common activities in these studies involved more endurance training, steadystate-type activities (e.g., aerobics, running, cycling, etc.) rather than common children's games (e.g., nonsteady-state games) employed in the current intervention. The review further states that boys needed at least 60 min/day of MVPA to promote higher CV fitness. This suggests that the current intervention, although sufficient to counterbalance the energy surplus of obesity, was not sufficient in intensity and/or duration per session to enhance CV fitness in young boys.

The implementation of this intervention study and its choice of some outcome measures, to our knowledge, have never been implemented and add to the strength of the present findings. The length of the program allowed for revealing the impact of small daily changes in MPA and VPA on body composition as children go through the growth process. The magnitude of the sample size, focusing only on a single gender and race, allowed for the power to emphasize the changes in a population that is at higher risk for obesity and obesity-related diseases. Finally the sensitivity of some of the outcome measures, specifically the DXA, allowed for the detection of small but significant changes in body composition that would not be detected via other measures (e.g., skinfolds) [35, 36]. The levels of PA participation in this study exceed the PA dose recommended in the most recent PA guidelines published by the U.S. Department of Health and Human Services (60 min/day of MVPA of which VPA should be included at least 3 days/week) [37]. However, using self-report assessments in the form of questionnaires have demonstrated low-to-moderate validity for assessing PA levels in children [38]. In the current study, the increase in MVPA in the ATT group at followup may be attributed to the regularity of the after-school program and the investigators cues about whether or not the subject participated in the program during the administration of the recall at followup. Objective monitoring of MVPA is warranted to assess changes in MVPA in future intervention studies.

In conclusion, young black boys who attended the 10-month after-school PA intervention at least 3 days/week exhibited healthy weight management compared to both the boys who did not attend the intervention and the control group. Although there were no relationships between the changes in MVPA and body composition, the postintervention decrease in BMI and %BF observed in the ATT may be indicative of an improved energy balance over the 10 months. These findings implicate the importance of engaging in physical activity at least 3 days per week to prevent age-associated increases in BMI, FM, and body fat and reduce the risk of childhood obesity. Research should continue in this area, using more objective means of assessing changes in PA participation and assessing program intensity to determine the impact of such a program on total daily energy expenditure.

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References

[1] C. L. Ogden, M. D. Carroll, and K. M. Flegal, "High body mass index for age among US children and adolescents, 2003–2006," *Journal of the American Medical Association*, vol. 299, no. 20, pp. 2401–2405, 2008.

[2] P. T. Katzmarzyk, L. A. Baur, S. N. Blair, E. V. Lambert, J. M. Oppert, and C. Riddoch, "Expert panel report from the International Conference on Physical Activity and Obesity in Children, 24–27 June 2007, Toronto, Ontario: summary statement and recommendations," *Applied Physiology, Nutrition, and Metabolism*, vol. 33, no. 2, pp. 371–388, 2008.

[3] W. H. Dietz, "Health consequences of obesity in youth: childhood predictors of adult disease," *Pediatrics*, vol. 101, no. 3, pp. 518–525, 1998.

[4] D. S. Freedman, W. H. Dietz, S. R. Srinivasan, and G. S. Berenson, "The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study," *Pediatrics*, vol. 103, no. 6, pp. 1175–1182, 1999.

[5] W. H. Dietz, "Overweight and precursors of type 2 diabetes mellitus in children and adolescents," *Journal of Pediatrics*, vol. 138, no. 4, pp. 453–454, 2001.

[6] O. Pinhas-Hamiel, L. M. Dolan, S. R. Daniels, D. Standiford, P. R. Khoury, and P. Zeitler, "Increased incidence of non-insulin-dependent diabetes mellitus among adolescents," *Journal of Pediatrics*, vol. 128, no. 5, pp. 608–615, 1996.

[7] A. Fagot-Campagna, K. M. Venkat Narayan, and G. Imperatore, "Type 2 diabetes in children," *British Medical Journal*, vol. 322, no. 7283, pp. 377–378, 2001.

[8] M. I. Goran, "Metabolic precursors and effects of obesity in children: a decade of progress, 1990-1991," *American Journal of Clinical Nutrition*, vol. 73, no. 2, pp. 158–171, 2001.

[9] R. P. Troiano, D. Berrigan, K. W. Dodd, L. C. Mâsse, T. Tilert, and M. Mcdowell, "Physical activity in the United States measured by accelerometer," *Medicine and Science in Sports and Exercise*, vol. 40, no. 1, pp. 181–188, 2008.

[10] L. H. Epstein, J. N. Roemmich, J. L. Robinson et al., "A randomized trial of the effects of reducing television viewing and computer use on body mass index in young children," *Archives of Pediatrics and Adolescent Medicine*, vol. 162, no. 3, pp. 239–245, 2008.

[11] T. N. Robinson, "Behavioural treatment of childhood and adolescent obesity," *International Journal of Obesity*, vol. 23, supplement 2, pp. S52–S57, 1999.

[12] D. R. Bassett Jr., M. S. Tremblay, D. W. Esliger, J. L. Copeland, J. D. Barnes, and G. E. Huntington, "Physical activity and body mass index of children in an old order Amish community," *Medicine and Science in Sports and Exercise*, vol. 39, no. 3, pp. 410–415, 2007.

[13] M. S. Tremblay, J. D. Barnes, J. L. Copeland, and D. W. Esliger, "Conquering childhood inactivity: is the answer in the past?" *Medicine and Science in Sports and Exercise*, vol. 37, no. 7, pp. 1187–1194, 2005.

[14] B. Gutin, Z. Yin, M. C. Humphries, and P. Barbeau, "Relations of moderate and vigorous physical activity to fitness and fatness in adolescents," *American Journal of Clinical Nutrition*, vol. 81, no. 4, pp. 746–750, 2005.

[15] B. Gutin, Z. Yin, M. C. Humphries et al., "Relations of body fatness and cardiovascular fitness to lipid profile in black and white adolescents," *Pediatric Research*, vol. 58, no. 1, pp. 78–82, 2005.

[16] A. Stunkard and J. Pestka, "The physical activity of obesegirls," *American Journal of Diseases of Children*, vol. 103, pp. 812–817, 1962.

[17] L. H. Epstein, A. M. Valoski, L. S. Vara et al., "Effects of decreasing sedentary behavior and increasing activity on weight change in obese children," *Health Psychology*, vol. 14, no. 2, pp. 109–115, 1995.

[18] L. S. Vara and L. H. Epstein, "Laboratory assessment of choice between exercise or sedentary behaviors," *Research Quarterly for Exercise and Sport*, vol. 64, no. 3, pp. 356–360, 1993.

[19] B. Gutin, P. Barbeau, S. Owens et al., "Effects of exercise intensity on cardiovascular fitness, total body composition, and visceral adiposity of obese adolescents," *American Journal of Clinical Nutrition*, vol. 75, no. 5, pp. 818–826, 2002.

[20] M. A. Ferguson, B. Gutin, N.-A. Le et al., "Effects of exercise training and its cessation on components of the insulin resistance syndrome in obese children," *International Journal of Obesity*, vol. 23, no. 8, pp. 889–895, 1999.

[21] R. V. Luepker, C. L. Perry, S. M. McKinlay et al., "Outcomes of a field trial to improve children's dietary patterns and physical activity: the Child and Adolescent Trial for Cardiovascular Health (CATCH)," *Journal of the American Medical Association*, vol. 275, no. 10, pp. 768–776, 1996.

[22] N. F. Butte, E. Christiansen, and T. I. A. Sørensen, "Energy imbalance underlying the development of childhood obesity," *Obesity*, vol. 15, no. 12, pp. 3056–3066, 2007.

[23] Y. C. Wang, S. L. Gortmaker, A. M. Sobol, and K. M. Kuntz, "Estimating the energy gap among US children: a counterfactual approach," *Pediatrics*, vol. 118, no. 6, pp. e1721–e1733, 2006.

[24] W. A. Marshall, "Growth and maturity," *Developmental Medicine and Child Neurology*, vol. 11, no. 4, pp. 517–518, 1969.

[25] W. A. Marshall and J. M. Tanner, "Variations in the pattern of pubertal changes in boys," *Archives of Disease in Childhood*, vol. 45, no. 239, pp. 13–23, 1970.

[26] R. J. Kuczmarski, C. L. Ogden, L. M. Grummer-Strawn et al., "CDC growth charts: United States," *Advance Data*, no. 314, pp. 1–27, 2000.

[27] D. A. Cunningham, B. M. Van Waterschoot, and D. H. Paterson, "Reliability and reproducibility of maximal oxygen uptake measurement in children," *Medicine and Science in Sports and Exercise*, vol. 9, no. 2, pp. 104–108, 1977.

[28] J. F. Sallis, P. R. Nader, S. L. Broyles et al., "Correlates of physical activity at home in mexican-american and anglo-american preschool children," *Health Psychology*, vol. 12, no. 5, pp. 390–398, 1993.

[29] P. Barbeau, M. H. Johnson, C. A. Howe et al., "Ten months of exercise improves general and visceral adiposity, bone, and fitness in black girls," *Obesity*, vol. 15, no. 8, pp. 2077–2085, 2007.

[30] R. M. Malina, C. Bouchard, and O. Bar-Or, *Growth, Maturation, and Physical Activity*, Human Kinetics, Champaign, Ill, USA, 2004.

[31] J. O. Hill, H. R. Wyatt, G. W. Reed, and J. C. Peters, "Obesity and the environment: where do we go from here?" *Science*, vol. 299, no. 5608, pp. 853–855, 2003.

[32] D. E. R. Warburton, C. W. Nicol, and S. S. D. Bredin, "Prescribing exercise as preventive therapy," *Canadian Medical Association Journal*, vol. 174, no. 7, pp. 961–974, 2006.

[33] D. Moliner-Urdiales, J. R. Ruiz, F. B. Ortega et al., "Association of objectively assessed physical activity with total and central body fat in Spanish adolescents; The HELENA Study," *International Journal of Obesity*, vol. 33, no. 10, pp. 1126–1135, 2009.

[34] J. Dollman and T. S. Olds, "Secular changes in fatness and fat distribution in Australian children matched for body size," *International Journal of Pediatric Obesity*, vol. 1, no. 2, pp. 109–113, 2006.

[35] B. Gutin, N. Cucuzzo, S. Islam, C. Smith, and M. E. Stachura, "Physical training, lifestyle education, and coronary risk factors in obese girls," *Medicine and Science in Sports and Exercise*, vol. 28, no. 1, pp. 19–23, 1996.

[36] M. S. Litaker, P. Barbeau, M. C. Humphries, and B. Gutin, "Comparison of hologic QDR-1000/W and 4500W DXA scanners in 13- To 18-year olds," *Obesity Research*, vol. 11, no. 12, pp. 1545–1552, 2003.

[37] U.S. Department of Health and Human Services, "Physical Activity Guidelines Advisory Committee Report," Washington, DC, USA, U.S. Department of Health and Human Services, Office of Disease Prevention & Health Promotion, pp. 15–20, U.S. GPO, Washington, DC, USA, 2008.

[38] J. F. Sallis and B. E. Saelens, "Assessment of physical activity by self-report: status, limitations, and future directions. Research quarterly for exercise and sport," *Research Quarterly for Exercise and Sport*, vol. 71, supplement 2, pp. 1–14, 2000.