

Effect of exercise dosages on adiposity indices in overweight girls

Stephanie Kellam, MS,⁽¹⁾ Norma Olvera, PhD,⁽¹⁾ Patrick Leung, PhD,⁽²⁾ Jian Liu, PhD,⁽³⁾ Dennis Smith, PhD.⁽¹⁾

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Abstract

Objective. The primary purpose of this study was to determine the impact of two exercise dosages on reducing adiposity in minority girls. **Materials and methods.** Sixty-two overweight Hispanic and African-American girls participated in one of two intense summer interventions in Houston, TX: Intervention A (exposure to about 40 hours physical activities) or Intervention B (exposure to 60 hours of physical activities). Adiposity indices (percent body fat, waist circumference, body mass index) were taken pre- and post-intervention. **Results.** Intervention B had a significantly greater decrease in adiposity indicators ($p=0.006$) when compared to Intervention A. Waist circumference displayed the most significant decrease ($p=0.001$). Both interventions significantly increased daily minutes of moderate-to-vigorous physical activity ($p=0.020$). **Conclusions.** Intense physical activity interventions may effectively reduce abdominal fat in minority girls.

Key words: physical activity; body mass index; adipose tissue; abdominal fat

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Resumen

Objetivo. Determinar el impacto de dos programas de ejercicio en la reducción de los índices de adiposidad en niñas de grupos minoritarios. **Material y métodos.** Sesenta y dos niñas latinas y africano-americanas participaron en una de dos intervenciones intensivas durante el verano: la intervención A (exposición a aproximadamente 40 horas de actividad física) o la intervención B (exposición a 60 horas de actividad física) en Houston, TX. Los indicadores de adiposidad (índice de masa corporal, porcentaje de grasa corporal y grasa abdominal) se midieron antes y después de cada intervención. **Resultados.** La intervención B tuvo una disminución más significativa en el nivel de adiposidad ($p=0.006$) comparado con la intervención A. La circunferencia abdominal fue la que más disminuyó ($p=0.001$). Ambas intervenciones aumentaron significativamente la actividad física moderada a intensa ($p=0.020$). **Conclusiones.** Las intervenciones cortas e intensas pueden ser efectivas en la reducción de la grasa abdominal en niñas de grupos minoritarios.

Palabras clave: actividad física; índice de masa corporal; tejido adiposo; grasa abdominal

(1) Health Program, College of Education, University of Houston. Houston, TX, USA.

(2) Graduate College of Social Work, University of Houston. Houston, TX, USA.

(3) Health and Human Performance, University of Houston. Houston, TX, USA.

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Corresponding author: Stephanie Kellam. Health Program, College of Education, University of Houston. 4800 Calhoun Rd, Houston Tx, 77204, USA
E-mail: stkellam@gmail.com

Between 1980 and 2002, the number of overweight children tripled in the US.^{1,2} Although obesity affects all children in the United States, minority children experience an increased risk of being overweight. Over the last 30 years, African-American (AA) and Hispanic children have experienced a much larger increase in overweight rate than Caucasian children.³ Estimates suggest that in 2007-2008, 39% of Hispanic and 36% of AA youth were overweight as compared to 29% of Caucasian children.¹ Even after controlling for socioeconomic status and demographic factors, AA and Hispanic children had 80% odds of becoming obese compared to 34% odds for Caucasian children.⁴

Physical inactivity is often considered a major contributor to the current obesity epidemic among US children and adolescents.^{5,6} The US Health and Human Services recommends that children and adolescents engage in 60 minutes of moderate-to-vigorous physical activity (MVPA) daily to obtain health benefits and develop healthy lifestyle habits.⁷ Despite the prescribed dosage of physical activity, only a small percentage of American children meet this recommendation. Troiano *et al.*,⁸ reported that only 42% of children ages 6-11 years engaged in at least 60 minutes of daily MVPA when measured objectively. However, by ages 12-15, the percentage of adolescents meeting MVPA recommendation decreased severely to only 12% of boys and 3% of girls. Hispanic and AA children reported lower levels of physical activity^{4,5} and were less likely than the Caucasian children to have participated in any type of organized physical activity in the past seven days.⁹ Furthermore, Butte *et al.*¹⁰ reported that among Hispanic children, overweight girls had the lowest rates of MVPA compared to non-overweight girls and boys. The risk for inactivity combined with the risk for being overweight in Hispanic and AA children, particularly girls, highlights the need to develop interventions to promote MVPA and healthy weight in such populations.

Several literature reviews conducted by van Sluijs, McMinn, and Griffin¹¹ indicated that few physical activity interventions have involved Hispanic and AA children, none of which included minority adolescents. Physical activity interventions have ranged from once per week for 12 weeks to three times per week for 12 months and the health outcomes (e.g., adiposity reduction) have been mixed. One explanation for the differing outcomes is the suggestion that the recommended physical activity dosage may have been insufficient to achieve weight loss.¹² Thus, research is needed to investigate the different types of exercise dosages required to reduce adiposity in youth, particularly, minority children. The purpose of this study was to assess the efficacy of two exercise dosage intervention (Intervention A: 40 hours,

25 minutes vs. Intervention B: 60 hours) on reducing adiposity indices in minority girls. It is hypothesized that the Hispanic and AA girls who engage in intervention B will exhibit a greater decrease in percent body fat, waist circumference, and body mass index (BMI) when compared to those girls who complete intervention A.

Materials and methods

Participants

The baseline sample consisted of 75 overweight [body mass index (BMI) $\geq 85^{\text{th}}$ percentile for age-sex specific] Hispanic and AA girls, ages 9-14 years. The target girls participated in one of two BOUNCE (Behavior Opportunities Uniting in Nutrition, Counseling, and Exercise) summer interventions conducted in 2007 and 2008, intervention A and B, respectively in Houston, TX. Study inclusion criteria required girls to be: 1) between ages 9-14 years; 2) of Hispanic or African American descent; 3) overweight (BMI equal to or greater than 85th percentile) status; 4) of low socioeconomic status as demonstrated by receiving free-lunch at school or government financial assistance, including WIC, Medicaid, or CHIP; 5) without physical activity restrictions that limit their active participation in the BOUNCE interventions as certified by a medical professional; and 6) willing to participate for the entire length of the intervention. Participants were recruited through referrals by school counselors, nurses, and teachers. Girls and their mothers signed an assent and informed consent respectively before administration of measurements. The University of Houston Committee for the Protection of Human Subjects reviewed and approved the research protocols and assent and consent forms.

Description of BOUNCE Interventions A and B

Both of the interventions were delivered from 9:00 AM to 5:00 PM, Monday through Friday during the month of July. A typical day at the BOUNCE intervention contained three-to four exercise sessions, one nutrition education session, and one behavioral counseling session as well as two healthy snacks and a healthy lunch. For the proposed study, we will focus on the description of the exercise component of the interventions.

Intervention A spanned a three-week period for a total of 15 days and offered 2 415 minutes (40 hours and 25 minutes) of exposure to a variety of physical activities (see Appendix A for a complete list); whereas Intervention B lasted four weeks and offered 3 600 minutes (60 hours) of physical activity exposure (see Appendix A for

a complete list). In both interventions A and B, participating girls engaged in physical activity group sessions of varied intensity based on Ridley's compendium¹³ for energy expenditure in youth (light = 2 METS, moderate = 3-5 METS, vigorous = \geq 6 METS). The BOUNCE exercise program consisted of 21 group physical activity sessions, categorized into *flexibility*, *sports skills*, *games*, *traditional fitness*, and *dancing* categories. Participants were exposed to traditional (e.g., sport skills, step aerobics, spinning) and nontraditional physical activities (e.g., yoga, pilates, ballet, cheerleading, rumba fitness, and salsa) with an aim to engage participants in diverse and fun ways to be active.

The BOUNCE exercise program was standardized with a typical day beginning with a *flexibility* session followed by a *sports skills* or *games* session. Lunch and a nutrition lesson were then followed by a *traditional fitness* session. Following a counseling session, the day would end with a *dancing* session. Schedule format and layout was similar across the two interventions. Each BOUNCE exercise session included a 5-minute warm-up, light to vigorous physical activity, and 5-minute cool-down phase. Instructors certified by the Cooper Institute led exercise sessions at a gymnasium and dance studio located on a university campus.

Several strategies to encourage active participation were employed. First, participants were asked to sign a contract at the beginning of the exercise program in which they agreed to engage in all physical activities. Second, beginning after the first week, participants received weekly reports of their levels of physical activity achieved in the previous week. Third, small prizes (e.g., notebooks, pencils, bracelets, etc.) were awarded to participants who reached their own weekly goals. Fourth, participants received handouts on exercise benefits, components of a healthy lifestyle, and strategies for overcoming barriers to being physically active. The Social Cognitive Theory¹⁴ guided the design of both BOUNCE interventions, with an emphasis on knowledge, skill building, social support, positive outcome expectations, and reinforcement.

Measures

Trained data collectors conducted the study assessments at the baseline and end of interventions A and B, with the exception of physical activity data that was collected during the entire duration of interventions to determine physical activity compliance.

Demographic data were obtained through questions about age, date and place of birth, and self-described ethnicity. Anthropometric measures of body height and weight were measured to the nearest 0.1 cm and 0.1 kg

respectively, using a stadiometer and a scale. BMI [body weight (kilograms)/height² (meters)] was calculated using body height and body weight. BMI values were then used to identify the age and gender specific weight percentile for each child.¹⁵

Percent body fat (%BF) was obtained from a foot-to-foot bioelectrical impedance assessment using a scale. Waist circumference (WC) measurements to the nearest 0.5 cm were taken with a spring-gauge loaded, non-elastic flexible measuring tape at a point midway between the participant's last rib of the rib cage to the top of the iliac crest at the end of a normal expiration. Two WC measurements were taken and the average of both measurements was entered into the final analysis.

To assess changes in frequency, duration, and intensity of physical activity during the BOUNCE intervention, accelerometers were used. For the proposed study, protocols developed by Puyau *et al.*, 2004¹⁶ were followed. The accelerometer was programmed to collect data in 60-second epochs Monday thru Fridays from 9:00 AM until 5:00 PM each week of Interventions A and B. Participants did not wear accelerometers after 5:00 PM. Upon completion of each five-day intervention week, accelerometer data (activity counts per minute) were downloaded into the program and exported to a spreadsheet for initial analysis. In the initial examination, data completeness was verified against an exercise log and attendance roster. After initial data screening, activity counts were summed for each day and activity. Activity counts per minute were partitioned as moderate-vigorous (MVPA: \geq 1 500 counts·min⁻¹), light (LPA: >100 - <1 500 c·m⁻¹), and sedentary activity (SA: \leq 100 c·m⁻¹) intensities using cutoff points developed by Puyau *et al.*¹⁶

Statistical analysis

Descriptive statistics, including means and standard deviations, were performed to identify basic characteristics of the data and sample population. Assumptions of normality, homogeneity, linearity, and multi-collinearity were checked and met. A repeated measures analysis of variance was used to determine changes in the average daily minutes of MVPA for each successive week followed by a paired samples *t*-test to determine statistically significant differences across weeks. Differences between Intervention A and Intervention B with regards to each of the adiposity indicators (BMI, %BF, and WC) at pre- and post-intervention time points were tested using a repeated measures multivariate analysis of variance (RMANOVA). Alpha levels were set at 0.05. A power analysis was conducted to determine if the sample size was adequate to detect differences in the

impact of interventions on physical activity levels and adiposity indicators. The results of the power analysis indicated that a minimum of 50 and 52 subjects were required in the RMANOVA to achieve a statistical power of 0.80.

Results

Characteristics of the study sample

The baseline sample consisted of 75 (45 Latina and 30 AA) girls. Of those initial 75, 13 participants were excluded from the final sample due to missing pre- and post-physical activity or adiposity data. Thus, the final sample was reduced to 62 participants (39 Hispanic and 23 AA). As shown in table I, the mean age of 62 girls was 11.2 years + 1.5 years. Most of the participants were classified as obese (BMI \geq 95th percentile). No significant difference in obesity status was observed between participants in Interventions A and B ($p=0.152$). Thirty girls participated in Intervention A and 32 participated in Intervention B. The average attendance of the girls in Intervention A was 92% and 87% in Intervention B. Reasons for the participants' absences during intervention included family vacation, sickness, or transportation problems. The majority of the participants (90%) were low-income.

Physical activity compliance

As shown in figure 1, the average daily minutes of MVPA for Intervention A and B was similar (68.5 min and 67.5 minutes respectively). The combined MVPA improved each week. The repeated measures ANOVA indicated a significant time effect in daily MVPA ($p=$

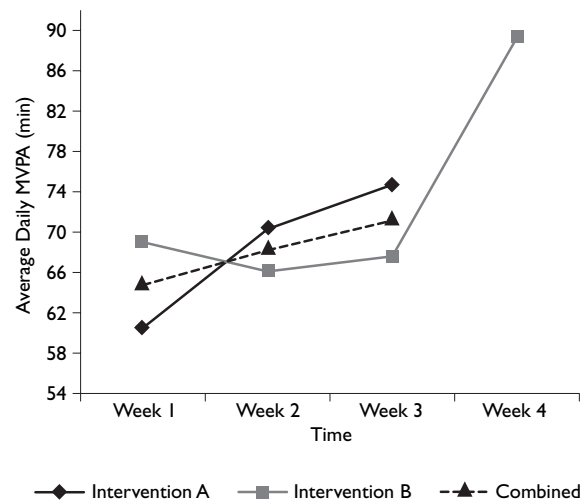


FIGURE 1. CHANGES IN DAILY MVPA MINUTES OVER INTERVENTION(S)

0.020). The polynomial contrasts indicated that there was a significant linear effect ($p=0.005$). A paired samples t-test indicated that there was only one significant daily minutes change between week 1 and week 3. These findings indicate that longer intervention duration results in a greater increase in daily MVPA.

Effects of exercise dosages on adiposity indices

A repeated measures ANOVA was conducted to assess the differences in adiposity indicators between Intervention A and B from pre- to post-intervention periods.

Table I
BASELINE CHARACTERISTICS OF STUDY POPULATION

Characteristics	Intervention A N = 30	Intervention B N = 32	Total N = 62	p-Value
Age (yr)	10.8 ± 1.2	11.5 ± 1.4	11.2 ± 1.5	0.610
Ethnicity				
African American	27%	47%	37%	0.082
Hispanic	73%	53%	63%	
Obesity status				
Overweight	23%	9%	16%	0.152
Obese	77%	91%	84%	
BMI (kg/m ²)*	29.5 ± 6.6	31.8 ± 7.1	30.7 ± 6.9	0.148

* BMI ranged from 19.5 - 54.0 kg/m²

There was no significant effect of groups (Intervention A and B) on adiposity indicators ($p=0.069$). However, there was a significant interaction effect of groups (Intervention A and B) over time ($p=0.006$) on adiposity indicators. When looking more specifically at the interaction effect between time and group on the adiposity indicators, Intervention B group exhibited a significantly greater decrease in weight ($p=0.002$) and WC ($p=0.001$) as compared to Intervention A group. However, Group A exhibited a significantly greater decrease in BMI and %BF as compared to Group B. Table II depicts results of the paired-samples t-test of all adiposity indicators at pre- and post-intervention. The mean WC for Intervention B was also significantly lower at post-intervention (86.32 cm) than at pre-intervention (95.22 cm). However, Intervention A was more effective in reducing BMI ($p<.05$) and %BF ($p<.001$) at post-intervention.

Discussion

The purpose of this study was to assess the effects of two dosages of exercise interventions on reducing adiposity indicators in minority overweight/obese girls. Our findings indicated there was a significant effect of the interventions on WC over time and there were trends in the right direction on the reduction of %BF and BMI. Girls in Intervention B had a greater decrease of WC than girls in Intervention A. A decrease in WC is important given that recent research has shown that WC is a better

determinant of cardiovascular disease than BMI^{17,18} and is associated with metabolic syndrome,¹⁹ type 2 diabetes, hypertension, lower HDL, and high cholesterol.²⁰ Furthermore, WC has also been associated with abdominal fat. Kim and Lee²¹ identified the need for examining the impact of physical activity in decreasing abdominal obesity. Studies have demonstrated the positive effects physical activity has on abdominal obesity.²²⁻²⁴ Research has also reported that engaging in aerobic exercise attenuates age-related increases in visceral fat in children and adolescents.²⁵⁻²⁷ However, to our knowledge, there is no study that has examined the relationship between physical activity and abdominal obesity in Hispanic and AA girls. Thus, results from this study begin to fill the gap in our knowledge regarding the role of physical activity in reducing abdominal obesity in overweight minority girls.

A unique feature of the BOUNCE interventions is its implementation during the summer time. Research suggests that the summer time may be a period of increased weight gain and inactivity for children as compared to the school year. This weight gain can be as much as 2.8% of ideal body weight²⁸ and African-American and Hispanics children are at an increased risk for weight gain during the summer season.²⁹ The average BMI escalation is more than twice as fast during the summer months as it is for the school year.³⁰ Thus, despite limited changes in BMI in Intervention B in this study, the stabilization and/or positive trends in BMI reduction that were observed helped combat the expected summer weight gain. Therefore, weight stability as well as the increased MVPA achieved during the BOUNCE summer interventions should be viewed as encouraging. Results from this study also suggest the need for greater exposure to opportunities promoting engagement in physical activity during the academic school year to achieve recommended MVPA. Furthermore, while the BOUNCE interventions may be optimal alternatives to improve daily MVPA levels in minority girls, these types of interventions might not be feasible during the academic year, but they may have an impact the level of engagement in more physical activities after the interventions. Future studies should follow up with the girls participating in the BOUNCE program to address this issue.

Several limitations of this study are noteworthy, including a lack of a control or comparison group, which may present some potential problems in controlling for extraneous variables that can reduce the internal validity. While the inclusion of a control condition is commonly a preferable research design, we employed a one-group pretest post-test design due to the exploratory nature of this study and constrained resources.

Table II
PAIRED-SAMPLES T-TEST FOR ADIPOSITY INDICATORS

Measure	Group	Time	Mean	t	DF	p
Weight (kg)	A	Pre	68.39	1.876	31	.07
		Post	68.05			
	B	Pre	77.74	3.349	32	
		Post	76.84			
BMI (kg/m ²)	A	Pre	28.80	2.12296	31	.042
		Post	28.49			
	B	Pre	31.50	1.082	32	
		Post	31.04			
%BF	A	Pre	42.52	7.196	31	.000
		Post	38.31			
	B	Pre	42.24	.794	32	
		Post	41.88			
Waist (cm)	A	Pre	92.05	1.974	31	.057
		Post	89.76			
	B	Pre	95.22	8.0444	32	
		Post	86.32			

Another limitation is the lack of control for sexual-maturity and developmental stages, dietary intake, and physical activity levels outside of the BOUNCE intervention, which may play a key role in adiposity levels. Use of a 1-minute epoch is another limitation of this study. When the study was initiated, this was the recommended methodology; however, more recent studies suggest using 30-second epochs for children and adolescents due to their short activity bouts. Measurement errors are always of concern and should be taken into consideration particularly with the measurement of the adiposity indicators, such as WC. To address potential measurement issues in this study, special attention was given to train our research assistants in collecting adiposity indicators data, including WC. For instance, two measurements were taken and the average of both measurements was entered into the final analysis.

Although changes in adiposity indicators over time were observed during the BOUNCE summer program, future research is needed to assess the effect of physical activity interventions on health outcomes in minority populations using stronger research designs and a larger sample size. Despite the limitations, this is an exploratory study that provides valuable information regarding different exercise dosages and their effects on decreasing WC. Constant exposure to physical activity can lead to an increase in MVPA levels among overweight minority girls. By achieving the recommended 60 minutes of MVPA each day, overweight minority girls can reduce their WC despite not losing weight or reducing BMI. The reduction of WC has a major impact on decreasing risk factors, including high blood pressure, cardiovascular disease, and type II diabetes.

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Appendix A
BOUNCE EXERCISE INTERVENTION A

Category		Duration (minutes)				Total
		Week 1	Week 2	Week 3		
Flexibility	Yoga	30	30	60	120	
	Pilates	30	30	30	90	
	Ballet	30	30	30	90	
Sports skills	Basketball	60	0	60	120	
	Walking	60	0	0	60	
	Soccer	60	60	60	180	
	Badminton	0	60	60	120	
	Tennis	0	105	0	105	
	Self defense	60	60	60	180	
	Survivor game	75	0	0	75	
Games	Amazing race	0	75	0	75	
	Step aerobics	60	60	60	180	
Traditional fitness	Spinning/Circuit	60	60	60	180	
	Circuit training	0	60	60	120	
	Kickboxing	60	60	0	120	
	Rumba fitness	60	0	0	60	
Dancing	Salsa	0	0	60	60	
	Hip hop	60	60	60	180	
	Cheerleading	60	60	60	180	
	Modern dance	0	0	60	60	
	Line dancing	0	60	0	60	
	Total	765	870	780	2415	

BOUNCE EXERCISE INTERVENTION B

Category		Duration (minutes)				Total
		Week 1	Week 2	Week 3	Week 4	
Flexibility	Yoga	60	60	120	60	300
	Pilates	30	90	60	30	210
	Ballet	30	30	0	30	90
	Budokon	60	60	60	60	240
Sports skills	Basketball	60	60	0	60	180
	Soccer	60	60	0	60	180
	Volleyball	60	60	60	60	240
	Tennis	0	120	0	0	120
	Self defense	60	0	60	60	180
	Survivor game	60	0	0	0	60
Games	Amazing race	0	60	0	0	60
	Relays	0	0	120	60	180
Traditional fitness	Step aerobics	60	0	60	60	180
	Latin aerobics	60	60	60	0	180
	Spinning	60	60	60	60	240
	Core training	60	60	0	60	180
	Kickboxing	60	60	60	60	240
	Circuit training	0	0	0	60	60
	Rumba fitness	0	60	0	0	60
Dancing	Hip hop	0	60	60	0	120
	Cheerleading	60	60	60	60	240
	Modern dancing	60	0	0	0	60
	Total	900	1020	840	840	3600

AVERAGE DAILY MVPA (MINUTES) PER PARTICIPANT

Intervention type	Week 1	Week 2	Week 3	Week 4
Intervention A	60.5	70.3	74.7	-
Intervention B	69	66.1	67.6	89.3