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ORIGINAL RESEARCH

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Effects of the Girls on the Move randomized trial on adiposity and aerobic performance (secondary outcomes) in low-income adolescent girls

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Summary

Background: Limited, mixed evidence exists regarding the effectiveness of physical activity interventions on adiposity and aerobic performance in adolescent underrepresented populations.

Objective: To examine effects of Girls on the Move on body mass index z-scores (BMI-z), percent (%) body fat, and aerobic performance in fifth- to eighth-grade underrepresented girls.

Methods: A group randomized trial, involving 12 intervention and 12 control schools in low-income areas, was conducted. Participants (n = 1519) were low-active girls. The 17-week intervention included (a) a physical activity club, (b) two motivational interviewing sessions, and (c) one Internet-based session. BMI-z was determined from measured height and weight; % body fat was assessed using bioelectric impedance. Aerobic performance was assessed using a shuttle run. Demographics, physical activity (accelerometer), and pubertal development were assessed. Linear mixed models, adjusting for baseline, were used to examine group differences in postintervention.

Results: No significant between-group differences in BMI-z existed at postintervention, but % body fat increased less among intervention than control group girls (M_{change} = 0.43% vs 0.73%). Aerobic performance decreased less in intervention vs control (M_{change} = −0.39 vs −0.57).

Conclusions: Although the intervention positively impacted % body fat and aerobic performance in underrepresented girls, more research is necessary to determine optimal implementation for yielding greater effects.

KEYWORDS
adolescent, body mass index, female, fitness, percent body fat, school

1 | INTRODUCTION

According to the 2013 to 2014 US National Health and Nutrition Examination Survey (NHANES), the prevalence of obesity has stabilized among 6- to 11-year-old children[1] but increased among 12- to 19-year-old adolescents since 2007 to 2008. Furthermore, 6- to 11-year-old children who are Black or Hispanic and live in low-income environments have a greater likelihood of being overweight, compared with their White and more advantaged counterparts,[2] and odds of obesity are higher among 10- to 19-year-old low-income girls.[3] Thus, interventions to prevent obesity in underrepresented groups remain a high priority.

Higher physical activity (PA) in adolescence contributes to better aerobic performance,[4] and both have been associated with a reduction in obesity.[5] Neville et al found that if adolescents from low-income or resource-deprived environments were as fit as those from high-income or less-deprived areas, the differences in obesity would disappear.[6] Unfortunately, adolescents from low-income environments and racial/ethnic minority groups are less physically active than their White[7] and higher-income counterparts.[8] In addition, PA declines with age, and girls exhibit steeper declines in PA than boys, particularly during adolescence.[7] To attenuate the rising prevalence of obesity, several researchers have designed PA interventions for adolescents across different types of environments, especially schools.[9]

Schools are one of the most common and optimal settings for PA interventions, given the requirements for children and adolescents to attend regularly.[10,11] While some evidence suggests that school-based PA interventions can improve overall PA and cardiorespiratory fitness,[12] support for their effectiveness in improving variables related to body composition, especially body mass index (BMI), is limited, particularly for adolescent girls.[9,13]

Past school- and community-based research studies that have tested effectiveness of PA interventions for improving girls' adiposity, and aerobic performance outcomes have shown mixed results. Some investigations noted no effects,[9,14,15] while others showed improvements in girls' aerobic performance,[16] BMI,[16] and percent (%) body fat.[9,15] However, replication of intervention effects in underserved, minority adolescents is lacking,[11] particularly for girls. The purpose of this study was to examine the impact of the Girls on the Move Intervention, which was designed for fifth- to eighth-grade underrepresented girls, on secondary outcomes of BMI z-scores (BMI-z), % body fat, and aerobic performance (predicted VO_{2max}). Hypotheses were that the intervention would improve BMI-z, % body fat, and aerobic performance.

2 | METHODS

2.1 | Design

This group randomized trial occurred in 24 urban, public schools in Michigan. Schools included a high percentage of students from low-income backgrounds and underrepresented groups. Schools were matched in pairs based on similarity in academic grades, school size, racial/ethnic composition, and % eligible to receive free/reduced price lunch (indicator of socioeconomic status [SES]). Inclusion and exclusion criteria for schools were previously reported, as was sample size calculation.[17] The intervention was implemented across 3 years (2012-2015), with eight schools (four intervention and four control, randomly allocated by a statistician) participating each year. Control school girls received typical school offerings (similar to intervention schools), having normal physical education and school sports, although all participants were asked not to begin school sports once enrolled in the study. The study was approved by the Michigan State University Biomedical and Health Institutional Review Board, and all study participants and their parents provided written informed assent and consent, respectively.

2.2 | Participants

Recruitment took place in Septembers of 2012, 2013, and 2014. Prior to participation in the study, parents of girls completed a screening questionnaire to determine eligibility based on the following inclusion criteria: (a) not meeting moderate-to-vigorous PA (MVPA) recommendations of at least one hour per day,[18] (b) available and willing to participate in a PA club for 17 weeks, and (c) able to read and speak English. Two exclusion criteria included (a) participating in school or community sports, organized physical activities, or lessons involving MVPA on three or more days per week and (b) having a health condition preventing safe participation in MVPA. Overall, 1519 girls in grades 5 to 8 met eligibility criteria, provided written informed consent, and participated in baseline data collection, with randomization occurring after. Figure S1 shows the flow diagram of schools' and girls' participation. Primary outcome data were collected at baseline, postintervention, and 9-month follow-up; however, secondary outcome data were collected at baseline and postintervention only. Postintervention measures took place in March to May of 2013, 2014, and 2015.

2.3 | Intervention

Girls on the Move was a 17-week intervention designed to encourage insufficiently active middle school girls to increase time spent in MVPA. The primary outcome was MVPA, and results showed no significant improvement at postintervention or 9-month follow-up.[19] Secondary goals of the intervention were to improve adiposity outcomes and aerobic performance and examine if cognitive and affective variables served as mediators.[17] The intervention was designed to incorporate elements of the health promotion model[20] and self-determination theory.[21] Girls on the Move included three major components: (a) 90-minute after-school PA club conducted by community-based instructors 3 days/week at each girl's school, (b) two face-to-face motivational interviewing sessions with a trained counsellor, and (c) one motivational, interactive Internet-based session shortly after the intervention midpoint. Community-based instructors (PA club leaders) attended a 4-hour training session pre-intervention and then a 6-hour booster session near the midpoint of the intervention. The intervention coordinator led the training and met with instructors at each school throughout the intervention. The counsellors attended two 8-hour days of motivational interviewing training conducted by a member of the Motivational Interviewing Network of Trainers. All instructors and counsellors received a copy of the policy and procedure manual. Training for counsellors included role-playing until the trainer decided they were proficient. Each session of the PA club included time for a healthy snack and administrative tasks at the beginning and end (10 min each), warm-up (5 min), opportunity for MVPA (60 min), and a cool-down (5 min). The objective of the MVPA opportunity was to provide activities in which girls would engage in MVPA for at least 50% of the time (eg, dance and active games such as forms of tag). This was assessed using direct observation (dose delivered) and accelerometry (dose received) as part of the process evaluation. Accelerometers were fitted on a subset of girls to reflect actual PA (as opposed to just opportunity for PA, which was obtained by the direct observation). The measurement coordinator trained the PA club managers to randomly select (ie, choose every fifth girl in order of appearance to club on the first day of the week) five girls per school every other week to wear the monitors. Further details regarding the intervention components and process evaluation describing dose, reach, and fidelity to intervention implementation are published elsewhere.[17,22] Girls were encouraged to engage in MVPA outside of the PA club.

2.4 | Data collection

Trained data collectors assessed all variables at baseline and postintervention (1-4 weeks after the 17-week intervention was complete). All staff were certified prior to taking any measures in the field, and measures of quality control were employed during the measurement phases. The measurement coordinator retrained any staff members who experienced lapses in accuracy and ensured all staff were blinded to condition.

2.5 | Outcome measures

2.5.1 | BMI-z score and % body fat

To obtain BMI-z, height and weight were assessed according to standard procedures with shoes and socks off and heavy outer clothing removed. Height was measured to the nearest 0.1 cm using a portable stadiometer (Shorr Productions, Olney, MD). Weight and % body fat were assessed to the nearest 0.1 kg and 0.1% with a foot-to-foot bioelectric impedance analysis (BIA) scale (Tanita, Tokyo, Japan). Two measures within 0.4 cm and 0.2 kg were taken and averaged. BMI was calculated as kg/m^2, which was then converted into a percentile using age- and sex-specific reference values from the Centers for Disease Control and Prevention (CDC) growth charts (www.cdc.gov) to determine BMI-z and weight status. Validity ($r > 0.8$ with skinfolds) and reliability (Intraclass correlation coefficient (ICC) > 0.97) of the Tanita BIA scale in adolescents have been reported.[23]

2.5.2 | Aerobic performance

Aerobic performance was assessed via estimation of maximal oxygen consumption (VO_{2max}) using the progressive aerobic capacity endurance run (PACER). The PACER consisted of a 15- or 20-m endurance shuttle run, depending on space. Testing took place in a gymnasium with small groups of girls (10-20 girls, which was 3-4 per data collector). After number of laps completed was recorded, we determined the mile equivalency. The mile equivalency value was then entered into the Cureton equation,[24] according to FitnessGram recommendations at the time the study began.

2.5.3 | Covariates

Demographic information including age, academic grade, race, ethnicity, and eligibility for free/reduced-price lunch were obtained from student and parent self-report. Pubertal stage was used as a covariate and determined with the Pubertal Development Scale (PDS).[25] Validity and reliability of the PDS have been established with girls as young as those in 5th grade.[25,26] Girls rated themselves, as compared with other girls of similar age, on body hair, breast development, and menstruation. Girls reporting no menstruation and having a summed score for the three characteristics of 2, 3, or greater than 3 were in the prepubertal, early, or middle pubertal stage, respectively. A summed score of greater than or equal to 7 or 8 (hair and breast development plus menstruation) indicated the late or post-pubertal stage, respectively.

Baseline MVPA was used as a covariate in the analyses for both outcomes. MVPA was assessed using ActiGraph GT3X+ accelerometers that collected data in raw mode and were processed using ActiLife software. Girls were asked to wear the monitor for 7 days (five weekdays and two weekend days) on an elastic belt at the waist, with the monitor worn over the right hip. Monitors began collecting data at 5:00 AM on the day after they were distributed to girls by data collectors at each school, and data collectors picked up the monitors at school the following week. Data were reintegrated to 15-second epochs and processed using intensity cut-points for MVPA greater than or equal to 2296 counts per minute.[27] Accelerometer data were aggregated to minutes of MVPA per hour.

2.6 | Missing data and statistical analyses

Missing data existed at the individual level, mostly for MVPA. Sparse missing data were present in individual-level demographic, BMI-z (2% at baseline and 11% at postintervention), % body fat (<1% at baseline and 10% at postintervention), and aerobic performance data (<1% at baseline and 10% at postintervention). Missing data were imputed assuming a missing at random mechanism.[28] The imputation model included baseline demographics and baseline and postintervention outcomes. Linear mixed models were used to analyze the intervention effects on BMI-z, % body fat, and aerobic performance according to intention-to-treat, with school pairs treated as a random effect and students nested within school and treatment condition.

2.7 | Models for BMI-z, % body fat, and aerobic performance analysis

Three separate models were used to examine the effects of the intervention on BMI-z, % body fat, and aerobic performance. All models included the main intervention predictor (binary predictor for control or intervention), incorporated the cluster random effect of the design specified school pairs via a random intercept for school pairs, and controlled for the following fixed effects: continuous predictors for baseline BMI-z, % body fat, or aerobic performance (depending on model), baseline age (centred around 12 years; % body fat model only), and baseline MVPA/hour, and dummy-coded categorical predictors, race (Black, with non-Black being the reference level), SES (enrollment in free/reduced-price school lunch, not enrolled as reference level), ethnicity (Hispanic, not-Hispanic as reference level), baseline pubertal stage (early onset as reference), and study year cohort (Year 1 as reference). Age was not included in the BMI-z or aerobic performance models because the measures inherently took age into account (ie, age is part of the calculation). The BMI-z model did not include aerobic performance because the prediction equation for VO_{2max} included BMI. Adiposity measures were not used as a covariate for aerobic performance because BMI was included in the variable calculation.

2.8 | Post hoc analyses

We conducted exploratory post hoc models to determine if the three outcomes differed for the intervention girls, based on club attendance. Girls who attended more than the median (38% of classes) were in the high attenders group, and girls who attended below the median were in the low attenders group, and this decision was made based on previous literature.[29] The percentage of girls who attended all 3 days per week was very small (~15%), and the overall average attendance was slightly over 1 day/week. These models controlled for the same characteristics as the main models, with the random term being the intervention school. In addition, we also conducted post hoc moderation models amongst the intervention girls: a BMI-z model to compare girls who were with obesity/overweight with those who are normal/underweight, a % body fat model to compare girls who had a higher % body fat (>32%) with those whose % body fat was lower,[30] and an aerobic performance model to compare girls with aerobic performance that was above the median reported baseline aerobic performance for this sample. Process evaluation showed that girls spent an average of approximately 22 minutes engaging in MVPA during club sessions.

All analyses were implemented in IBM SPSS Statistics for Windows [version 22.0] and R statistical software [version 3.2.4], using the MICE package for imputation[31] and the "lme4" package for mixed models.[32]

3 | RESULTS

Sample characteristics for the 1519 participants (753 intervention, 766 control) are reported in Table 1. Girls in the control group were slightly taller and heavier, with corresponding larger BMI (not statistically different), than those in the intervention group. A higher percentage of Black girls were in the control (54.3%) than intervention group (45.2%; $P < .001$).

TABLE 1 Sample characteristics at baseline (N = 1519), M (SD) or %

Characteristics	Control (n = 766)	Intervention (n = 753)	P value
Age (yr)	12.05(1.02)	12.05(0.99)	.909
Height (cm)	154.31(8.64)	153.08(8.14)	**.004**
Weight (kg)	56.97(18.23)	54.58(17.48)	**.009**
Ethnicity (%)			.099
Hispanic or Latino	12.5	15.5	
Race (%)			**.001**
Black	54.3	45.2	
White	25.8	28.4	
Other	19.8	26.4	
Pubertal stage (%)			.578
Prepuberty	3.3	4.5	
Early puberty	10.4	8.5	
Midpuberty	39.7	39.7	
Late puberty	46.5	47.1	
Post-puberty	0.1	0.1	
Qualified for free/ reduced-price school lunch (%)	83.3	83.6	.883
MVPA ($min \cdot day^{-1}$)	2.91(1.33)	3.03(1.34)	.063
BMI	23.59(6.13)	22.92(6.01)	**.035**
BMI-z score	1.02(1.08)	0.92(1.03)	.054
% body fat	30.44(9.83)	29.48(9.55)	.052
Aerobic performance ($ml \cdot kg^{-1} \cdot min^{-1}$)	37.61 (5.21)	38.12 (5.19)	.057

Abbreviations: BMI, body mass index; MVPA, moderate-to-vigorous physical activity; %, percent.

Note. Boldface in table indicates statistical significance ($P < .05$). Table includes non-imputed data; Some girls in "other" were multiracial, so 64% in the control group and 56% in the intervention group were included as "Black" for analyses.

3.1 | Intervention effects on BMI-z

No significant difference occurred between intervention and control groups in postintervention BMI-z (B = −0.02, .191, 95% confidence interval [CI; −0.05-0.01]) (Table 2). The estimated marginal means were 0.99 for the treatment group and 1.01 for the control group. BMI-z increased from baseline to postintervention in both groups, with the intervention group (baseline 0.92 vs postintervention 0.95) similar to the control group (baseline 1.02 vs postintervention 1.06; M change intervention = 0.03 vs M change control = 0.04). Further, results from post hoc analyses showed no significant difference between high and low attenders in postintervention BMI-z after controlling for baseline BMI-z and demographic factors (B = −0.01, .542, 95% CI [−0.06-0.03]). Similarly, the intervention effects on BMI-z did not differ significantly according to baseline weight status (B = −0.02, .466, 95% CI [−0.09-0.04]), even in comparison with the control group.

TABLE 2 BMI-z and % body fat model results (N = 1519)

Variable	Estimate	SE	95% CI	FMI
BMI-z				
Intercept	0.05	0.03	(−0.01-0.11)	0.14
Intervention (Ref: Control)	−0.02	0.01	(−0.05-0.01)	0.31
Black (Ref: No)	0.00	0.02	(−0.04-0.03)	0.29
Hispanic (Ref: No)	0.01	0.02	(−0.03-0.05)	0.14
Baseline BMI z-score	**0.95**	0.01	(0.94-0.96)	0.19
Puberty stage (Ref: Early)	−0.01	0.02	(−0.04-0.02)	0.25
Baseline MVPA	0.01	0.01	(0.00-0.02)	0.31
Lunch (Ref: No)	0.02	0.02	(−0.02-0.06)	0.32
Study Year 2 (Ref: Yr 1)	−0.01	0.02	(−0.05-0.04)	0.07
Study Year 3 (Ref: Yr 1)	0.00	0.02	(−0.05-0.04)	0.10
% body fat				
Intercept	13.44	2.60	(8.33-18.54)	0.07
Intervention (Ref: Control)	**−0.37**	0.14	(−0.64-−0.10)	0.26
Black (Ref: No)	−0.03	0.16	(−0.34-0.29)	0.34
Hispanic (Ref: No)	0.05	0.19	(−0.31-0.42)	0.15
Baseline % Body Fat	**0.84**	0.03	(0.79-0.89)	0.07
Puberty stage (Ref: Early)	0.20	0.15	(−0.10-0.50)	0.17
Age (centred)	−0.12	0.08	(−0.28-0.04)	0.11
Baseline MVPA	**0.15**	0.05	(0.05-0.25)	0.20
Lunch (Ref: No)	0.26	0.18	(−0.10-0.62)	0.25
Baseline aerobic performance	**−0.23**	0.05	(−0.32-−0.13)	0.05
Study Year 2 (Ref: Yr 1)	0.06	0.19	(−0.32-0.43)	0.11
Study Year 3 (Ref: Yr 1)	−0.16	0.17	(−0.50-0.19)	0.10

Abbreviations: BMI, body mass index; CI, confidence interval; FMI, fraction of missing information; MVPA, moderate-to-vigorous physical activity; %, percent; AIC, Akaike information criterion; BIC, Bayesian information criterion.

Notes: Boldface in table indicates statistical significance ($P < .05$). **BMI-z model**: Multiple imputations = 20; Null ICC = 0.0226; Residual ICC = 0.0076, Partial eta-squared effect size = 0.0018; Marginal R-squared = 0.9443, Conditional R-squared = 0.9447, Null model AIC = 4384, Full model AIC = 14, Null model BIC = 4400, Full model BIC = 78. **% body fat model**: Multiple imputations = 20; Null ICC = 0.0454, Residual ICC = 0.0027, Partial eta-squared effect size = 0.0067; Marginal R-squared = 0.9435, Conditional R-squared = 0.9437, Null model AIC = 11139, Full model AIC = 6815, Null model BIC = 11155, Full model BIC = 6890.

3.2 | Intervention effects on % body fat

Postintervention % body fat was significantly lower among intervention group girls than control group girls (*B* = −0.37, .007, 95% CI [−0.64-−0.10]) (Table 2). The estimated marginal means were 30.30% for the treatment group and 30.67% for the control group. % body fat increased from baseline to postintervention in both groups, but the increase was significantly less for the intervention group (baseline 29.48% vs postintervention 29.91%) than control group (baseline 30.44% vs postintervention 31.17%; M change intervention = 0.43% vs M change control = 0.73%). Further, results from post hoc analyses indicated that the intervention effects on % body fat were significantly influenced by club attendance (*B* = −0.56, .006, 95% CI [−0.95-−0.16]). Specifically, after adjusting for baseline % body fat and demographics, high club attenders had significantly lower % body fat than low club attenders at postintervention. However, the intervention effects did not significantly differ between girls with high vs low % body fat (*B* = −0.08, .809, 95% CI [−0.71-0.56]).

3.3 | Intervention effects on aerobic performance

Postintervention aerobic performance was significantly higher among intervention group girls than control group girls (*B* = 0.20, .018, 95% CI [0.03-0.36]) (Table 3). The estimated marginal means were 37.51 $ml{\cdot}kg^{-1}{\cdot}min^{-1}$ for the treatment group and 37.32 $ml{\cdot}kg^{-1}{\cdot}min^{-1}$ for the control group. Aerobic performance decreased from baseline to postintervention in both groups, but the decrease was significantly less for the intervention (baseline 38.12 vs postintervention 37.73) than control group (baseline 37.61 vs postintervention 37.04; M change intervention = −0.39 vs M change control = −0.57). Further, results from the post hoc analyses showed that the intervention effects on aerobic performance were significantly influenced by club attendance (*B* = 0.30, .014, 95% CI [0.06-0.54]), with high club attenders having significantly better aerobic performance than low club attenders. The intervention effects did not significantly differ between girls with high vs low aerobic performance (*B* = −0.21, .162, 95% CI [−0.50-0.08]).

4 | DISCUSSION

Intervention girls who participated in Girls on the Move experienced maintenance in % body fat (versus modest increase in the control

TABLE 3 Aerobic performance model results (N = 1519)

Variable	Estimate	SE	95% CI	FMI
Intercept	**0.58**	0.31	(−0.04-1.19)	0.11
Intervention (Ref: Control)	**0.20**	0.08	(0.03-0.36)	0.35
Black (Ref: No)	0.02	0.09	(−0.16-0.21)	0.36
Hispanic (Ref: No)	0.01	0.10	(−0.19-0.21)	0.10
Baseline aerobic performance	**0.97**	0.01	(0.96-0.99)	0.14
Puberty stage (Ref: Early)	−0.01	0.09	(−0.18-0.16)	0.32
Baseline MVPA	−0.04	0.03	(−0.10-0.02)	0.31
SES (Ref: High)	−0.11	0.11	(−0.32-0.10)	0.30
Study Year 2 (Ref: Yr 1)	0.01	0.10	(−0.18-0.20)	0.15
Study Year 3 (Ref: Yr 1)	0.14	0.09	(−0.05-0.32)	0.13

Abbreviations: CI, confidence interval; FMI, fraction of missing information; MVPA, moderate-to-vigorous physical activity; SES, socioeconomic status.

Note. Boldface indicates statistical significance ($P < .05$). Multiple imputations = 20; Null ICC = 0.0642, Residual ICC = 0.0013, Partial eta-squared effect size = 0.006; Marginal R-squared = 0.9393, Conditional R-squared = 0.9394, Null model AIC = 9284, Full model AIC = 5095, Null model BIC = 9300, Full model BIC = 5159.

group) at postintervention, but no change in BMI-z. They also experienced lower decline in aerobic performance than girls in the control group. These outcomes occurred despite no intervention effect on overall MVPA. Barbeau et al,[16] found intervention girls had a small but significant increase in aerobic performance based on assessment via a multistage treadmill test, and Barbeau[16] and Bayne-Smith et al[15] noted a small but significant decline in % body fat among intervention girls at postintervention, compared with controls. Both the Barbeau et al and Bayne-Smith et al studies included a high percentage of Black girls from low-income backgrounds with high % body fat, similar to the current investigation. However, PA sessions were offered 5 days/week in those studies versus 3 days/week in the current study. Regardless, minimal intervention effects may limit the clinical significance of the three studies, indicating that more investigations are needed to identify optimal implementation approaches.

Average attendance in the Barbeau et al study was 54% (~2.5 days/week),[16] while average attendance in the current investigation was 41% (~1.2 days/week). Although Bayne-Smith et al did not report attendance data, other researchers who have conducted PA interventions noted similar attendance rates.[33] The findings of the present study are particularly noteworthy, given that the dose of the intervention was higher in both the Barbeau et al and Bayne-Smith et al studies than the present investigation. In contrast to this study, Barbeau et al found that higher attendance was not associated with greater cardiovascular fitness, suggesting that taking advantage of a PA opportunity may not always translate directly into desired effects when the intervention ends. Similar findings emerged in our study and Barbeau et al showing that better attendance was related to greater changes in % body fat. Although the average effect size was small in the Barbeau et al study,[16] the authors noted that changes in central (visceral), but not peripheral, adiposity occurred due to their intervention and suggested that measuring intervention-related changes in visceral fat may be important. Other researchers have also noted that central adiposity is more related than peripheral adiposity to health outcomes such as cardiovascular risk factors.[34,35] Although central and peripheral adiposity were not specifically assessed in the present study, measurement in future investigations may be warranted.

The lack of significant BMI-z effects was not surprising. Several previous studies[14] and literature reviews[9,36] noted that PA interventions have minimal effects on BMI. One probable reason is that BMI-z as a measure may not possess the appropriate level of sensitivity to change[37] in a 17-week intervention, especially when adolescents are undergoing physical changes due to growth and maturation, because BMI-z does not account for changes in lean body mass and fat mass. Similar to a previous study,[16] we controlled for effects of pubertal development in analyses, so it is not likely that pubertal development played a role. However, it should be noted that some researchers have shown that BMI-z is not appropriate for assessing longitudinal data,[38] and others have noted it does not work well in populations with severe obesity, particularly those greater than or equal to 97th percentile.[39] In general, any BMI-related measure is not likely to account for changes in fat mass and fat-free mass as well as a measure of % body fat does.[40]

Our team encountered several challenges with engaging adolescent girls in PA of at least moderate intensity, but we were able to elicit approximately 22 minutes of MVPA during club (37% of allotted time). Process evaluation data showed that instructors also spent approximately 22 minutes of club time managing the girls (coaxing them to line up, moving them to the next activity, etc). Anecdotal evidence from PA club instructors indicated that despite offering several choices of activities, girls did not always want to engage. Also, despite repeated discussions with club leaders regarding how to optimize time spent in MVPA, we were not able to reach our desired goal of 50% of time in MVPA. On the other hand, it is quite common in the literature on physical education and after-school programmes not to reach the 50% goal.[41] Girls also experienced difficulties at home that often prohibited their club attendance (eg, babysitting younger siblings). Process evaluation data also showed excellent participation in counselling sessions (98% for face-to-face and 95% in online sessions) and that sessions were well-received. However, it remains unknown if participating in the counselling sessions motivated girls to engage in more MVPA.

Our study had several strengths and limitations. Strengths included a large percentage of Black girls, assessment of pubertal development, school-level randomization to conditions after baseline data collection, and use of multiple imputation to address missing data. Limitations included an inability to isolate effects of different intervention components, no longer-term follow-up to see if intervention effects were sustained over time, and possibly reduced generalizability of findings due to sampling from a limited geographical area. Although considerable pilot work took place prior to designing the intervention, the intervention itself still had a few limitations. One was that space for conducting intervention-related activities was not optimal across sites. All schools signed a memorandum of understanding agreeing that they would provide space, but at some schools, spaces to which our team thought they would have access were taken by other, existing activities. Although some type of space was provided, intervention staff sometimes needed to modify how activities were delivered due to less-than-optimal conditions. Another limitation was ability to conduct counselling sessions, which was sometimes challenging in terms of matching counsellors' schedules with school schedules, ability of girls to leave class, and availability of space. Sometimes, a counselling session had to be conducted during PA club time. This happened on a limited basis. A third limitation was the initial manner by which our staff offered choice of activities to girls. Too many choices were initially offered, and girls needed to be provided with a limited number of choices instead. A fourth limitation was that some girls, despite agreeing to participate in the study, simply did not want to engage in PA, even when offered choices of activities. A final limitation was the fact that girls had external factors outside of their control affecting their participation in the PA club. If parents/guardians needed or wanted them to do other things (eg, babysit younger siblings) after school, girls could not attend the club.

Also, some researchers may view use of BIA, in addition to our purposeful inclusion of low-active girls, as limitations. Although reliability of BIA has been reported as adequate (intraclass correlations ≥0.82), contradictory evidence exists regarding validity.[40] Beyond this, there has been inadequate validation of BIA in racially diverse samples.[40] One study that did examine BIA validity in a racially diverse sample noted that Black girls had 1.6 kg more fat-free mass than Hispanic, non-Hispanic, and mixed-race girls.[42] We acknowledge the potential limitations of BIA but also note that % body fat would have been underestimated in Black girls according to Going et al.[42] Given that the control group in this study had more Black girls than the intervention group, it is likely that the effects on % body fat in this sample were underestimated, since the control group had a significantly higher proportion of Black girls. However, in field-based studies, the two most feasible assessment methods for % body fat are skinfolds and BIA. We decided not to use skinfolds in the current investigation because of potential presence of weight-related body image concerns in an all-adolescent female population. Additionally, Barreira et al noted that there were no differences between BIA and dual-energy X-ray absorptiometry in Black boys and girls.[43] In future studies, use of a more accurate BIA device (eg, RJL Systems) and a race-specific equation could improve estimates of % body fat.[42]

5 | CONCLUSION

Findings from the present study suggest that it was possible for a PA intervention alone (with no nutrition component), delivered in an after-school setting, to positively impact % body fat and aerobic performance in underrepresented adolescent girls. Because effect sizes were small, increasing intervention dose, particularly through attendance, along with adding other components, such as environmental- or family-based approaches that also focus on diet, may improve effects and potentially decrease BMI-z, which is likely less amenable to change than % body fat. Additionally, programmes need to be tailored to the unique needs of underrepresented populations, which may include offering programmes at alternate times such as before school, summer, or other times their presence may not be required at home. It may also be time to consider different outcome variables more relevant to the population such as stress reduction, improvement in mood, classroom behaviour variables, or resilience.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest. The contents of this manuscript are solely the responsibility of the authors and do not necessarily represent the official views of National Institutes of Health (NIH).

AUTHOR CONTRIBUTIONS

K.A.P., L.B.R., and K.R. contributed to study design. K.A.P., L.B.R., and D.D.M. contributed to data collection. All authors contributed to data interpretation and writing of the manuscript. K.A.P., L.B.R., and V.R.V. contributed to the literature search. D.B.S., D.D.M., and J.L. contributed to data analysis and generation of figures.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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