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Degree of implementation of a play-based curricular intervention affects children's movement in afterschool settings

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Abstract

Programs implemented in afterschool settings can support children's health; however, their effectiveness may depend on the degree of implementation which can vary by school. In this cluster-randomized controlled trial, we assessed the effect of a play-based curricular intervention on physical activity (PA) levels among children (N=133) attending seven intervention and seven comparison afterschool programs in Arizona (U.S.) using general linear mixed models, and examined how degree of intervention implementation impacted children's PA using linear regression models. PA was measured using wrist-worn accelerometers and degree of implementation was measured using a researcher-developed 100-point index with data from surveys and training attendance from each school. After the intervention, children receiving the curriculum increased their light PA by 4.7 minutes and decreased their sedentary time by an average of 10.2 minutes daily. When degree of implementation was considered, we found variability between schools in children's sedentary time and moderate-to-vigorous PA (MVPA) after the intervention. Based on the average time spent in the afterschool programs daily (2.9 hours), children averaged 5.2 more MVPA minutes and 7.0 less sedentary minutes for every 10-point increase in implementation index score. Considering the 30-point variability in scores between schools, this translated to children spending up to 16 minutes more in MVPA and 21 minutes less being sedentary of the average 2.9 hours spent in afterschool programs with the highest level of implementation compared to the lowest. Degree of implementation matters when integrating curricula in afterschool settings that target children's movement. Stronger implementation may reduce children's sedentary behavior and increase MVPA.

Keywords: physical activity; schools; sedentary behavior; movement

Afterschool programs serve approximately 7.7 million children in the United States (U.S.) (Afterschool Alliance, 2020). Programs are typically located on site in school buildings and available to all children, although the cost of enrollment is a growing challenge for families and the demand for afterschool programs often exceeds school capacity (Afterschool Alliance, 2020). Afterschool programs have facilities, staff, and structures in place to support extended learning and peer interaction for children after the traditional school day ends, making them viable settings for children's health improvement through interventions targeting behavior change. In particular, physical activity (PA) interventions in afterschool settings can reduce adiposity and improve cardiorespiratory fitness among children (Yin et al., 2012). Given that only approximately 24% of youth in the U.S. meet the recommended 60 minutes of daily moderate-to-vigorous PA (MVPA) (Centers for Disease Control and Prevention, 2022), and reaching the recommended 60 minutes of daily MVPA is possible when schools take a comprehensive approach to integrate movement before, during, and after school time (Carson & Webster, 2020), afterschool settings are particularly important for the promotion of integrated movement at school.

On average, U.S. children enrolled in public schools spend approximately four days per week (5.6 hours/week) in afterschool programs (Afterschool Alliance, 2020) and spend an average of 11.7 minutes/hour in MVPA compared to 4.4 MVPA minutes/hour during the regular school day (Tassitano et al., 2020). Children attending afterschool programs focused on PA have been shown to spend more time in MVPA (54%) afterschool compared to physical education during the school day (31%) (Kim & Lochbaum, 2017). A structured PA intervention at 12 afterschool programs showed an 11% decrease in sedentary behaviors and a 7% increase in walking among girls and 7% increase in MVPA among boys (Beets et al., 2013), suggesting the importance of structured programming for behavior change; however, integrating structured PA may be challenging as afterschool settings are generally focused on unstructured play and academic enrichment rather than movement (Moore et al., 2017).

Integrating quality curricula in afterschool settings has the potential to impact children's PA; however, the effectiveness of curricular interventions may depend on successful implementation which can vary as afterschool sites have differing systems and supports. The implementation of programs in schools requires considerable support from school administrators, teachers, and often parents and community partners (Szabo-Reed et al., 2019). At the same time, school administrators and teachers must weigh a variety of factors, such as school or district policies, available resources, time, priority of the intervention, and teacher knowledge or skills (Nathan et al., 2018), before supporting and fully adopting an external program (Figgis et al., 2000). These considerations are particularly complex due to the constant evolution of schools and the broader education system in general shifting over time as policies, funding, and political agendas change (Butler et al., 2010). Even when a program is adopted by schools, a wide array of factors can influence how a program of intervention is implemented, such as fidelity, dose (both delivered and received), quality, responsiveness, differentiation, and adaptation (Durlak & DuPre, 2008). Thus, rarely is a program fully implemented in practice as originally designed (Lendrum & Humphrey, 2012).

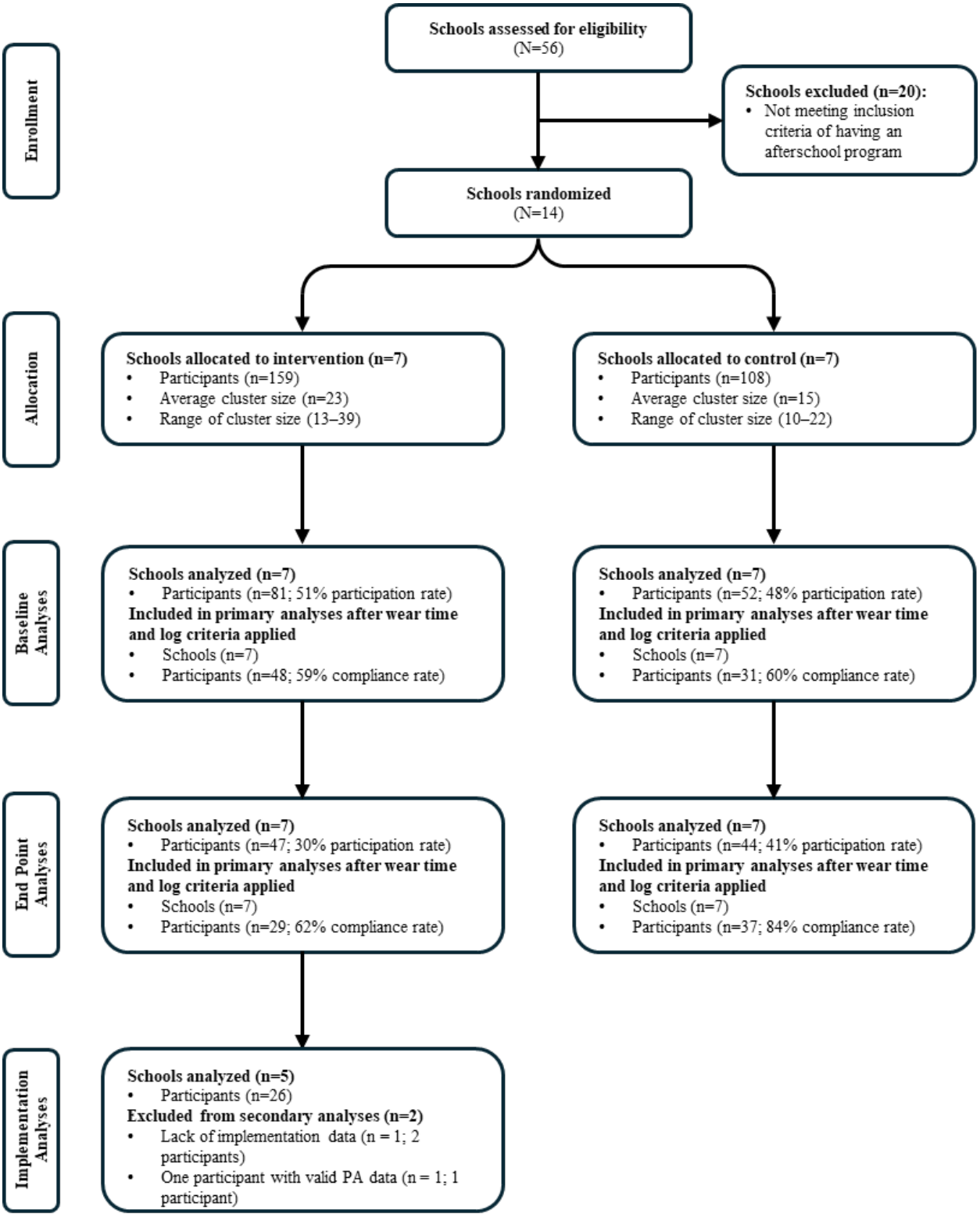
The degree of implementation of a program or practice is a determinant of effectiveness (Proctor et al., 2011), and using reliable, valid and practical measures of implementation is essential for monitoring and evaluating the success of program or practice implementation (Weiner et al., 2017a). Variability in implementation is an important consideration to understand the process of delivering effective interventions in school settings (Lendrum & Humphrey, 2012). Additionally, there is a need to link implementation to child health outcomes, such as PA (Naylor et al., 2015). Therefore, the first purpose of this research was to assess the effect of a play-based curricular intervention in afterschool settings on children's PA levels. The second purpose was to assess how degree of implementation of a play-based curriculum impacted children's PA in afterschool settings.

Methods

Study Design, Participants, & Setting

This study was part of a larger cluster-randomized controlled trial with a parallel group, two-arm design to assess the impact of a 16-week play-based curricular intervention on children's movement and social and emotional health at seven intervention and seven comparison afterschool programs in one public school district in Mesa, Arizona during the 2022-2023 school year (Poulos & Kulinna, 2022). Figure 1 displays an overview of enrollment, allocation, and participation for the study. Initially, all elementary schools in the district with afterschool programs were eligible to participate. A computer-generated random number program was used to generate 14 randomly selected schools, and all agreed to participate. While the larger trial also included an assessment of social and emotional health among all children, for outcomes related to PA, children between the ages of 8-12 years (grades 3-6) at study schools were eligible to participate. In fall 2022, flyers describing the study and parent consent forms were provided by the researchers and sent home with eligible children. Interested children returned written parental consent and provided written assent before participating. The number of children in grades 3-6 attending the 14 afterschool programs was 267 and ranged from 10-39 children in each school. At baseline, 133 children participated in device-based data collection to measure movement (50% participation rate). At post-data collection, 91 children participated in device-based data collection (34%). The study was approved by the IRB at Arizona State University. The effect of the intervention on children's PA was measured pre-post within intervention schools and between comparison schools. Implementation was measured only at the intervention schools.

Figure 1. *CONSORT flow diagram of study sample*



Intervention

Afterschool staff and University students were trained to implement PlayOn! (Carson et al., 2015) – a research-based curriculum to promote fitness and play aligned with national physical education standards developed by national organizations SHAPE America and PlayCore. The intervention was designed to be implemented over approximately one hour. It was delivered four days each week across 16 school weeks and included a variety of games and skills using playground equipment and play spaces. Games were preceded by short group discussions with prompts designed to encourage social and emotional skill development during game play. University students supported school staff to implement the curriculum two of the four days each week.

Assessment

Implementation

Elements of the overall project were continuously evaluated in alignment with the Reach, Effectiveness, Adoption, Implementation and Maintenance (RE-AIM) framework (Glasgow et al., 2019). Indicators were shared with partners at the participating schools during monthly meetings to guide collaborative decision-making to improve fidelity and allow for adaptation. For example, the team decided to provide one school with an additional two weeks of University support because the staff shared difficulties with initiating activities within the curriculum. This portion of the study specifically focused on adoption and implementation of the curriculum with the goal of determining how the extent of the intervention delivery affected our main health outcome - children's movement.

Adoption and implementation were assessed using data from school staff surveys and training attendance to measure acceptability, appropriateness, feasibility, and fidelity of using the curriculum. Acceptability, appropriateness, and feasibility were assessed via survey at midpoint and end (weeks 12-16) using three valid and reliable scales: the Acceptability of Intervention Measure (AIM), Intervention Appropriateness Measure (IAM), and Feasibility of Intervention Measure (FIM) (Weiner et al., 2017b). Each scale contained four items measured on a five-point scale ranging from 'completely disagree' to 'completely agree'. Fidelity of implementation was assessed using a staff survey and training attendance. Afterschool staff reported frequency of implementation at the midpoint and in weeks 12-16 of the intervention using a five-point scale where 1=never, 2=sometimes without support, 3=sometimes with support, 4=most of the time, and 5=always. Trainings were conducted by community partner PlayCore and University researchers three times throughout the school year. Afterschool staff were expected to attend at least one training and were paid an hourly wage by the school district to attend. An attendance score was calculated for each school by dividing the number of staff attending at least one training by the total number of staff.

Development of an implementation index.

An implementation index was developed for each intervention school using data from the AIM, IAM, FIM, self-reported fidelity, and training attendance. The purpose of this index was to provide a score per school ranging from 0 to 100. To determine implementation index scores, we used a three-step approach. First, average scores for acceptability (AIM), appropriateness (IAM), feasibility (FIM), survey-reported fidelity, and training attendance were calculated for each school. Second, each survey score was multiplied by the constant of 20 to provide a school-level score on a consistent maximum 100-point scale. Third, all scores were averaged to provide each school with their unique implementation index.

Children's movement

Children's movement was measured with ActiGraph GT3X+ and GT9X accelerometers among participants attending the afterschool programs in September 2022 (before the intervention) and again in April 2023 (after the intervention). Participants were instructed to wear the device on their non-dominant wrist for seven days. Choi et al. (2011) cut points were used to calculate wear time. Although the PA outcome for this study was focused on movement levels during afterschool programming only, we followed stringent wear time criteria as the data for the larger project were collected over 24-hour periods. Participants were considered to have met the wear time criteria if they wore the device for a minimum of 10 hours per day on three weekdays and one weekend day. Participants that did not meet the wear time criteria were excluded from further analyses. Chandler (2016) cut points were used to classify PA levels based on 5-s epochs. Non-wear time was excluded from analyses. Wear time and PA cut point processing was conducted in ActiLife (Version 6).

To calculate PA levels during afterschool programming, staff at each school provided check-out logs that were used to determine the days each student attended the program and time each participant departed from the program during the data collection period. Check-out times were recorded by parents/guardians at pick up. Individuals who were absent from the afterschool program or did not have a written pick up time were excluded from analyses. The start time of the program at each school and the time each individual participant was picked up were used to calculate the duration and PA levels on valid wear days only.

Data Analysis

For the primary aim to examine the effect of the intervention on PA from baseline to post-intervention and between intervention and comparison groups, we included (1) the entire sample using a repeated cross-sectional approach (i.e., different participants over time), as well as (1b) a subset of participants with valid pre- and post-intervention accelerometry data using a longitudinal approach (i.e., same participants over time). Central tendency statistics were conducted for demographic

characteristics (age, gender, grade, race/ethnicity), duration of time in the afterschool program (minutes), and PA level proportions for participants included in statistical analyses only (e.g., met wear time criteria and had logged pick up times from afterschool programming). For both approaches, a series of general linear mixed models (GLMMs), nesting students within schools, was used to determine if there were differences within- and between-groups over time among the intervention and comparison groups for percentage of time (based on individual averages) spent in the afterschool program engaged in sedentary behavior (SB), light PA (LPA), and moderate-to-vigorous PA (MVPA). Group, time, and the group-by-time interaction were included as predictors of PA level, as well as student gender as a fixed covariate. Bonferroni post hoc analyses were used when applicable to compare significant differences between groups and time points adjusting for multiple comparisons. Ratios of change were calculated (change observed in intervention group / change in comparison group) for additional context on magnitude and direction of the rate of change between groups over time. Intracluster correlation coefficients (ICCs) were calculated to determine the amount of variance in each PA level that could be attributed to differences by school (i.e., school-level). Statistical analyses were performed using IBM SPSS 28.0.1.1 (15).

For the secondary aim to examine the degree of implementation on PA, children attending intervention schools only were included. A series of three linear regressions were used to examine the impact of degree of curricular implementation (index score) on children's mean movement levels (SB, LPA, MVPA), including student gender as a covariate, at the end point at five intervention schools. One intervention school was not included in the analysis because of lack of complete implementation data, and a second intervention school was not included in the analysis because the PA data included only one participant after wear-time criteria exclusions were applied. Proportions of time spent in each activity level and rates of change were converted into minutes based on overall average time spent in the afterschool program across all participants.

Results

The repeated cross-sectional sample contained only children who participated at either baseline or post-data collection and met wear time criteria (Figure 1). At baseline 133 participants completed device-based data collection (Intervention = 81; Comparison = 52). After excluding based on wear time criteria, 79 individuals were retained for analyses (Intervention = 48; Comparison = 31). At end point, 91 participants completed device-based data collection (Intervention = 47; Comparison = 44). After excluding based on wear time criteria, 66 individuals were retained for analyses (Intervention = 29; Comparison = 37). The subsample of participants who completed both baseline and post-data collection included 43 children (Intervention = 21; Comparison = 22).

Table 1 presents demographic information for participants in the intervention and comparison groups who met wear time criteria for accelerometry. The average age of participants in the larger sample was 9.06 years (SD = 1.05) for the intervention and 9.11 (SD = 1.15) for the comparison group with the majority (>75%) in both groups in third and fourth grade. Most participants identified as White or Caucasian (48% intervention; 58% comparison). A slightly higher percentage of participants identified as girls in the intervention group (51%), while most identified as boys in the comparison group of the larger sample (58%). Demographic characteristics of the subsample (not shown in table but available as supplementary file) were similar with the average age of 8.86 years (SD = 0.85) in the intervention and 8.80 (SD = 0.73) comparison groups. The majority of participants in the subsample (>75%) were also in third and fourth grade and most identified as White or Caucasian (45% intervention; 60% comparison). More participants identified as girls in the intervention group (52%) and as boys in the comparison group (63%).

Table 1.
Demographic characteristics of participants at baseline

	Intervention (*n* = 48)		**Comparison (*n* = 31)**	
Item	*n*	(%)	*n*	(%)
Age *(M/SD)*	*9.06*	*(1.05)*	*9.11*	*(1.15)*
Grade				
Third	18	(38.30)	14	(45.16)
Fourth	19	(40.43)	10	(32.26)
Fifth	5	(10.64)	4	(12.90)
Sixth	5	(10.64)	3	(9.68)
Gender				
Boy	22	(46.81)	18	(58.06)
Girl	24	(51.06)	13	(41.94)

Neither	0 (0.00)	0 (0.00)
Prefer not to answer	1 (2.13)	0 (0.00)
Race/Ethnicity		
Black/African American	6 (13.04)	1 (3.23)
Asian/Asian American	0 (0.00)	2 (6.45)
White/Caucasian	22 (47.83)	18 (58.06)
Hispanic/Latino/ Mexican American	4 (8.70)	2 (6.45)
American Indian/Native Pacific Islander	2 (4.35)	3 (9.68)
More than one	12 (26.09)	5 (16.13)

Impact of Intervention on Physical Activity

Participants spent an average of 2.9 hours (171.8 minutes) in afterschool programming each weekday. At baseline, students at the intervention and comparison schools spent approximately equal amounts of time in the afterschool program on average - 183.00 v. 184.80 minutes, respectively; however, this decreased to 147.00 and 172.20 minutes at end point, respectively. Among both groups at baseline, most time was spent in SB (58.10% and 59.26%). Compared to baseline, both the intervention and comparison groups engaged in more MVPA and LPA, and less SB. The amount of variation in children's PA that could be explained at the school level was highest for MVPA (ICC=20%), followed by SB (11%). The ICC for LPA was less than 1%.

Proportions of time spent in each PA level during afterschool programming at baseline and end point are shown by group in Table 2. After controlling for gender, children at intervention schools had increased MVPA and LPA, and decreased SB at post-testing, although changes in MVPA were not statistically significant over time or between school groups. Statistically significant changes were found in SB from baseline to post-test [$F(1,137) = 8.047$, $p = 0.005$] with post hoc analyses showing children in the intervention group spending 6.0%, or 10.2 minutes, less time in SB ($p = 0.012$, 95% CI [-.091, -0.11]), compared to a statistically non-significant 2.6% decrease at comparison schools ($p > 0.05$). Statistically significant changes in LPA from baseline to post-test were found among children in the intervention group [$F(1,137) = 10.815$, $p = 0.001$], with children spending 2.74% more time, or 4.7 minutes, in LPA ($p = 0.004$, 95% CI [0.008, 0.042]), compared to a statistically non-significant 1.24% decrease at comparison schools ($p > 0.05$). Lastly, children in the intervention group increased their MVPA by 3.3%, or 5.6 minutes, compared to an increase of 1.2%, or 2.1 minutes in the comparison group, although differences were not statistically significant different over time or between groups.

Matched subsample results.

The results of the analysis were similar to the larger cross-sectional analysis, with participants spending an average of 2.9 hours in the afterschool programming across the intervention period. The pre-post change in all activity levels was similar in direction to the repeated cross-sectional sample, but lower in magnitude. The amount of variation in children's PA that could be explained at the school level among the subsample was similar and highest for MVPA (ICC = 25%), followed by SB (12.5%). The ICC for LPA was less than 1%.

Proportions of time spent in each PA level during afterschool programming at baseline and endpoint among the matched subsample were similar to the results of the full sample analysis (table included as supplementary file) - no statistically significant differences were found between school groups in the proportion of time children spent in MVPA, LPA, or SB during the afterschool program. After controlling for the impact of gender, children at intervention schools had increased MVPA and LPA, and decreased SB, although differences were statistically significant for LPA only [$F(1,79) = 9.110$, $p = 0.003$). LPA also significantly differed from baseline to post-test among children at comparison schools [$p = .030$, 95% CI [0.002, 0.043] The increase in LPA was slightly higher (2.3% or 4.0 minutes) among children in the intervention group ($p = 0.040$, 95% CI [0.001, 0.043] compared to increases (2.1% or 3.6 minutes) in the comparison group ($p = 0.030$, 95% CI [.002, .043]. Although not statistically significant, children at intervention schools had greater increases in MVPA (2.7% or 4.6 minutes compared to 1.6% or 2.8 minutes at comparison schools) and greater decreases in SB (-4.9% or -8.5 minutes compared to -3.7% or -6.4 minutes at comparison schools).

Degree of Implementation and Physical Activity

No significant differences in children's movement levels between the five included schools were observed at baseline (MVPA = 15.29% - 23.22%; LPA = 20.21% - 24.44%; SB = 52.34% - 64.50%), nor post intervention (Table 3). The degree of implementation of the PA curricular intervention at the five schools varied between 48-78 on a scale of 0-100.

Table 2.
Average proportion of time (percentage and minutes) children spent in various activity levels during afterschool programming among all participants

	Baseline (n = 79)		End Point (n = 66)		Change over Time		
	Intervention (n = 48)	**Comparison (n = 31)**	**Intervention (n = 29)**	**Comparison (n = 37)**	**Intervention**	**Comparison**	**Change Ratio[1]**
Item	***M(SD)***	***M(SD)***	***M(SD)***	***M(SD)***	**(%)**	**(%)**	**(ratio)**
Activity Level (%)							
MVPA	19.86(6.99)	18.73(6.00)	23.12(7.18)	19.96(5.61)	3.26	1.23	2.65
LPA	22.05(3.63)	22.01(3.79)	24.79(4.03)	23.43(3.34)	2.74*	1.42	1.93
SB	58.10(9.71)	59.26(9.08)	52.15(10.01)	56.63(7.81)	-5.95*	-2.63	2.26
Activity Level (minutes)[2]							
MVPA	34.11(12.01)	32.17(10.31)	39.71(12.33)	34.28(9.64)	5.60	2.11	2.65
LPA	37.87(6.23)	37.80(6.51)	42.58(6.92)	40.24(5.74)	4.71*	2.44	1.93
SB	99.79(16.68)	101.78(15.59)	89.57(17.19)	97.26(13.41)	-10.22*	-4.52	2.26

*Indicates significant difference between baseline and end point based on $p < .05$.
[1]Change ratio represents change in intervention group divided by change in comparison group
[2]Activity minutes converted from activity proportions to represent total minutes out of 2.9 average hours spent in afterschool programming across the intervention period.

Table 3.
Implementation index scores and average proportion of time children spent in various activity levels during afterschool programming (N=5 schools; 26 participants)

	Proportion of time spent in various activity levels (baseline)			Proportion of time spent in various activity levels (post-intervention)			Implementation Index Score (0 - 100)
	MVPA (%)	LPA (%)	SB (%)	MVPA (%)	LPA (%)	SB (%)	
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	
Intervention School							
A (n = 4)	16.35 (4.72)	21.39 (3.47)	62.26 (7.67)	16.69 (5.33)	22.61 (6.96)	60.83 (12.14)	48.0
B (n = 7)	23.22 (11.02)	24.44 (5.27)	52.34 (16.09)	20.47 (3.73)	23.63 (2.17)	55.99 (4.85)	54.4
C (n = 5)	15.29 (5.38)	20.21 (3.41)	64.50 (7.93)	23.08 (7.12)	26.12 (4.39)	50.88 (11.42)	65.0
D (n = 5)	22.15 (4.71)	22.52 (2.76)	55.34 (5.07)	25.78 (5.68)	27.11 (2.72)	47.18 (6.94)	70.7
E (n = 5)	22.29 (6.27)	23.29 (3.18)	54.42 (7.56)	27.66 (10.95)	24.6 (5.06)	47.67 (13.72)	77.8

A series of linear regressions were conducted to determine the impact of curriculum implementation on the average proportion of time spent in MVPA, LPA, and SB in the afterschool programs (Schools A - E). After controlling for the impact of gender, statistically significant relationships were found between degree of implementation and both SB and MVPA. Degree of implementation was associated with decreased SB [β = -.004, $t(23)$ = -2.167, p = 0.041] and increased MVPA [β = .003, $t(23)$ = 2.129, p = .044]. Given participants spent an average of 2.9 hours daily in afterschool settings, this equated to an average increase of 5.2 minutes of MVPA, and a decrease of 7.0 minutes being sedentary per day for every 10-point increase in implementation index score. Considering the 30-point variability in implementation index scores between schools, this translates to children spending up to 16 minutes more in MVPA daily and 21 minutes less being sedentary daily in afterschool programs at schools with the highest level of implementation compared to the lowest. Although LPA increased as a function of implementation, implementation was not a statistically significant predictor [β = .001, $t(23)$ = 1.805, p = .084].

Discussion

The purpose of this study was to determine the effect of a curricular intervention to impact children's PA in afterschool programs and assess the impact of the implementation degree of the intervention on PA. Compared to baseline measurements, children attending intervention schools had higher levels of MVPA and LPA and spent less time being sedentary after the intervention, although changes in MVPA were not statistically significant. When degree of implementation was considered, children's MVPA increased and SB decreased as level of implementation improved. Given that children attending schools with strong implementation increased their daily MVPA by 16 minutes, an amount equivalent to more than 25% of all daily recommended movement, and decreased daily sedentary time by 21 minutes, the intervention is worth considering in future studies and settings.

The results of our study are similar to other research of afterschool PA interventions showing increased PA levels along with decreased SB measured using accelerometry (Kim & Lochbaum, 2017; Tassitano et al., 2020) and systematic observation (Beets et al., 2013); although the impact of our intervention on MVPA was not as substantial. This is likely due to two reasons. First, although the curricular intervention occurred for approximately one hour daily over four days, our movement data included all time children attended afterschool programs (2.9 hours on average) as schools had the autonomy to integrate the curriculum at different points in their schedule depending on preference. Because we were not able to isolate data collection during the exact time the curriculum was offered, the total movement data collection period in the study also included various activities such as doing homework, snacking, and engaging in arts and crafts that are generally sedentary. Second, unique aspects of our play-based curriculum included a focus on both movement and social and emotional learning and utilized the playground structure as the primary setting for activities. While movement was an important target behavior, many activities focused on strength, balance, and motor skill development which are not able to be assessed by accelerometry. School-based play research has been largely centered on organized and free play occurring during recess interventions which largely overlook the role of the playground (Coolkens et al., 2018; Massey et al., 2021). This study found that play, through the implementation of playground activities facilitated by trained staff, is an effective way to impact movement on playgrounds. Teacher and staff training is also an effective strategy to improve the degree of implementation and sustainment of youth PA interventions (Carson et al., 2020). Maximizing the utilization of the playground through the implementation of play-based school curriculum with trained staff is a strategy to replicate in future studies. Additionally, while this intervention impacted PA during the school year, we note the need to consider extending programming over summer months as changes in children's behavior and related health outcomes may not be maintained without consistent exposure (Yin et al., 2012).

The current study substantiates the afterschool youth PA literature and importance of utilizing afterschool time to offer greater opportunities for PA among children (Weaver et al., 2015). Reaching the recommended 60 minutes of daily PA for youth is possible when schools take a comprehensive approach to integrate movement before, during, and after school time (Carson & Webster, 2020). Our findings that much of the variance in children's PA levels could be attributed to factors at the school level aligns with other research suggesting that implementation of school-based interventions must be tailored to align with existing needs and supports of individual school contexts (Jago et al., 2023; Naylor et al., 2015). In particular, our results showing that 20% of the variance in children's MVPA during afterschool time was explained by school-level factors suggests that interventions targeting increased movement may be highly dependent on individual school support systems. In our study for example, the schools with the lowest degree of implementation were also the schools with the largest afterschool enrollment suggesting that adequate staffing to facilitate programming with a large number of children was a challenge.

We consider our cluster randomized controlled trial design and the delivery of a 16-week intervention in afterschool settings as valuable given the limited comparable research; however, we also acknowledge limitations to this study. While our baseline sample size of 133 participants represented 50% of the children in grades 3-6 attending afterschool programs across 14 schools, participation decreased to 91 participants by post-data collection to represent 34% of children. We also note that our sample size was affected by our application of stringent wear time criteria when processing accelerometer data which resulted in the exclusion of 40% of baseline and 27% post-intervention data. After applying these criteria, 43 children participated in both data collection time points

which is representative of approximately 16% of the study population.

Conclusion

Implementing interventions in schools is complex, and degree of implementation impacts intervention effectiveness. Afterschool time is an important segment of the school day to implement youth PA interventions through expanding and enhancing PA opportunities in current programming (Beets et al., 2016). The studied intervention broadened the pre-existing PA opportunities in an afterschool program with new play-based curricula and playground enhancements delivered by trained staff that aimed to increase time allotted for youth PA. The potential for daily improvement in time spent in MVPA (+16 minutes) and reduction in sedentary time (-21 minutes) is practically relevant when considering the potential accumulated benefit on youth PA behaviors over a week, month, semester, and school year. Using a play-based curriculum is a promising youth PA intervention. In this study context, higher levels of implementation provided more MVPA and less sedentary behaviors which may be an important consideration for youth PA interventions in schools.

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