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Original Research

Feasibility, Acceptability, and Preliminary Efficacy of a Recess-Based Fitness Intervention in Elementary School Children

CHRISTINE W. ST. LAURENT†[1], SARAH BURKART†[2], and SOFIYA ALHASSAN‡[3]

[1]Department of Psychological and Brain Sciences, University of Massachusetts-Amherst, Amherst, MA, USA; [2]Department of Exercise Science, University of South Carolina, SC, USA; [3]Department of Kinesiology, University of Massachusetts-Amherst, Amherst, MA, USA

†Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 12(4): 1225-1243, 2019. Although fitness may benefit cognition in youth, most attention has been given to cardiorespiratory fitness despite the health benefits of muscular fitness. Few studies have examined interventions that incorporate both cardiorespiratory and muscular fitness or have been offered during school recess. Furthermore, most fitness intervention studies examining cognitive outcomes have not reported on implementation information. The purpose of this pilot study was to examine the feasibility, acceptability, and preliminary efficacy on fitness and cognition of a recess intervention in elementary school children. Two schools were randomized to either a 3-month cardiorespiratory and muscular fitness intervention (15 minutes/weekday during recess) or control condition (standard recess activities). Process evaluation (feasibility and acceptability) measures were recorded daily (research staff questionnaire), weekly (accelerometer and heart rate monitors), and post-intervention (participant and school-staff questionnaires). Preliminary efficacy measures included pre- and post-intervention inhibition/attention, working memory, and cardiorespiratory and muscular fitness scores. Some feasibility and acceptability measures were favorable (88% of the lessons were implemented, 78% of the lessons were implemented as planned, and the majority of students and school staff were satisfied with most aspects of the intervention). However, intensity adherence during the intervention sessions based on accelerometry (% of time spent in moderate-to-vigorous activity: 41.7 ± 14.5) and participation (19.4% attendance rate) were lower than expected. Preliminary efficacy of the intervention on cognitive and fitness outcomes was not demonstrated. This study provided evidence that some aspects of the fitness intervention were acceptable during school recess. However, important implementation factors (i.e., intervention exposure) should be targeted to improve youth fitness programs offered during this school setting.

KEY WORDS: Youth, physical activity, academic performance, cognition, process evaluation

INTRODUCTION

Fitness and physical activity have been linked to brain health, including cognition and academic performance in children (7). For example, higher levels of fitness have been associated with better executive functioning, academic achievement, and academic behaviors (19, 21). In a review by Tomporowski et al. (36), the authors noted that fitness may mediate the relationship

between physical activity and academic performance. Given that the majority of U.S. children are not meeting the recommended benchmarks for fitness and physical activity (25), there has been a recent emergence of more experimental research examining the effects of physical activity interventions designed to improve fitness and cognition in children (19).

Despite the increase in youth physical activity intervention studies, researchers have yet to determine the most effective program design (e.g., modalities and timing) for cognitive outcomes in children. Although activities that enhance muscular fitness are recommended for children, and some reports have noted positive associations between cognition with muscular fitness, most studies have only targeted cardiorespiratory fitness (9, 24, 37). Few studies have examined the impact of intervention programs that emphasize both cardiorespiratory and muscular fitness on cognition (1, 29). Furthermore, previous studies examining physical activity and cognition have mainly been implemented either during classroom time or immediately after-school (2, 3, 7, 15, 21, 31). However, non-academic school-day time such as recess may be an ideal time to promote physical activity and fitness.

An important component in reporting the impact of health behavior interventions includes an assessment of a program's implementation. Both the internal and external validity of a study can be impacted by the degree of intervention fidelity and therefore should be evaluated by collecting information on various process evaluation variables (8, 17). Process evaluation analyses can also provide information on the feasibility and acceptability of a program. Physical activity intervention studies examining academic performance should report these types of measures to fully inform the state of the evidence on the benefits of certain program designs and dosages (20). However, most experimental studies to date that have examined the impact of physical activity on cognition have not reported process evaluation outcome data (7). An analysis of process evaluation measures will provide valuable information to refine future recess-based interventions and assess the effectiveness and sustainability of such programs in larger studies.

The Strong Minds with Aerobic and Resistance Training during Recess (SMART Recess) intervention was designed as a school recess program that targeted both cardiorespiratory and muscular fitness. The purpose of this pilot study was to examine the intervention's feasibility (recruitment, retention, and fidelity), acceptability (participation and level of intervention enjoyment), and the preliminary efficacy on cognition and fitness outcomes in elementary school-age children. For feasibility, it was hypothesized that the study recruitment (n = 50) and retention goals (75% at 3-month data collection) would be met. We also hypothesized that participants would demonstrate high adherence (i.e., participants would maintain an average intensity level of moderate-to-vigorous physical activity for at least 50% of each intervention session and the majority of participants would participate in at least half of each session) and the intervention leaders would demonstrate high compliance and integrity (i.e., at least 90% of the sessions would be implemented, at least 90% of the intervention sessions would be implemented as planned, and leaders would provide encouragement in at least 90% of the sessions). For acceptability, we hypothesized that the intervention children would demonstrate high participation rates at the recess intervention sessions, a high degree of enjoyment of the

lesson plans, and satisfaction with the overall program. Finally, for preliminary efficacy, we hypothesized that compared to the control group, children randomized to the intervention would show greater improvements in executive control (i.e., inhibition/attention and working memory) and fitness (i.e., cardiorespiratory and muscular).

METHODS

Participants

This two-arm randomized controlled pilot study was conducted in third and fourth graders of two elementary schools in Western Massachusetts and was implemented during recess periods. Consent was received from adults (i.e., students' parents and staff members of the school) and assent was received from the student participants. Parents completed informed consent and parental permission forms. Parental forms were sent home with each student and research staff were available to answer questions during designated before and after school periods, as well as by phone and email. Student participants completed an assent form. At the beginning of the first measurement session, research staff members read the form to each student participant individually and provided an opportunity to answer questions before the student gave written assent. Research staff held information meetings with school staff, who completed the informed consent forms in person. The study protocol was approved by the University of Massachusetts Amherst Institutional Review Board and this research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (28).

The participating schools had similar curricula, enrollment, and student demographics. Among both schools, approximately 43% of the students were eligible for free or reduced lunch. Between 45 and 50% of the students were Caucasian, 22 to 23% were Hispanic, 13 to 16% were Asian, 8 to 9 % were African American, 0 to 1% were American Indian/Alaskan, and 5 to 8% identified as two or more races. Daily recess sessions at both schools were organized by grade level and were 30 minutes in duration. Randomization took place at the school level, with one school assigned to the intervention and the other school assigned to the control condition. Within the intervention school, all third and fourth grade children were invited to participate in the SMART Recess program. However, only students with parental consent and assent participated in the study (i.e., data collection). Participants were eligible to participate in the study if they were in third or fourth grade at one of the participating schools at the time of recruitment. Participants were excluded from all analyses if they were unable to participate in assessments or the intervention program due to physical limitations or were unable to wear the activity or heart rate monitors. Participants were excluded for executive function analyses if they had an individual education plan (IEP) or diagnosed cognitive or academic disability (e.g., attention-deficit hyperactivity disorder or autism spectrum disorder) or were unable to successfully complete the practice trials in the executive control measures.

A power calculation was completed to determine a sample size that would detect a small to moderate effect size in inhibition/attention as reported in other youth intervention studies (7). Using an analysis of covariance (ANCOVA) model, assuming a 0.80 correlation between baseline and post-scores, a sample size of 46 children would result in 95% confidence and 80%

power to detect a moderate effect size (Cohen's d = 0.5) in inhibition/attention. With an anticipated 10% loss to follow-up, we aimed to recruit 50 participants (25 per school).

Protocol

The 3-month intervention combined modalities to target various fitness components (cardiorespiratory endurance, muscular endurance and strength, balance, and coordination) and was developed using youth exercise training guidelines (Table 1) (14, 34). Sessions were integrated into the first 15 minutes of recess periods on five weekdays per week and were led by trained researchers that served as intervention leaders. Per recommendations of the participating schools, interventions sessions were not mandatory and therefore, daily participation was optional. All intervention sessions began with a short warm-up activity, followed by an introduction to a new muscle-strengthening movement. The main component of each session was an inclusive group activity (approximately 25-40% muscular fitness and 60-75% cardiorespiratory components). To encourage attendance in the intervention sessions, incentive prizes (e.g., collective toe tokens – small sneaker shaped plastic charms that can be attached to students' shoelaces or backpacks) were provided for participation. An inactive control condition (i.e., continue with standard practice, rather than offer an alternate program) was chosen due to the possibility of an active control program also exerting an influence on cognitive outcomes (32). The SMART Recess intervention program was offered to the control school at the end of all data collection.

Table 1. SMART Recess session components.

Length	Component
2 minutes	*Ice-breaker Activity:* Each session began with a warm-up activity (e.g., I Like Relay game) that included dynamic movements such as giant steps, Jumping Jacks, and side shuffles.
2 minutes	*Movement of the Day:* Each day new muscle-strengthening movement (e.g., body weight squat, elastic band chest press, and medicine ball torso twist) was demonstrated by intervention leaders and practiced by the students.
11 minutes	*Group Game/Activity (approximately 25-40% muscular fitness and 60-75% cardiorespiratory fitness components):* The majority of each session was comprised of a group activity or inclusive game that integrated movements that students had already been exposed to in the intervention program up to that point. Example: Fitness Bingo. (Students were split into small groups and each group received a Bingo game card. Each box on the card will had a number and a movement. A Bingo game was played with the students completing the repetitions and movement on each space.)

An overview of the measurement variables and data collection time points is presented in Table 2. At baseline, demographic information was obtained from parents via an online questionnaire. Process evaluation (i.e., feasibility and acceptability) measures were collected through a variety of questionnaires completed by research assistants, participants, parents, and teachers or school staff throughout the intervention period. Preliminary efficacy outcome measures (i.e., inhibition/attention, working memory, cardiorespiratory fitness, and muscular fitness) were assessed at baseline and immediate post-intervention. These variables were collected at three

assessment visits during each time point and conducted during the participants' regularly scheduled recess periods.

Table 2. List of variables, data collection methods, and timing of measures.

Variable(s)	Data Collection Method	Completed By	Measurement Time Point
Feasibility			
Fidelity: -Participation adherence -Compliance and integrity	Implementation Form	Research assistant	Daily during intervention sessions
-Intensity Adherence (% time in moderate and vigorous physical activity)	Accelerometers; Heart rate monitors	Students	Weekly during intervention session
Control group services/activities	Monitoring of Control Group Form	Research assistant	Weekly during recess session
Acceptability			
Participation/ Enjoyment	Implementation Form	Research assistant	Daily during intervention session
Satisfaction	Student and School Post-Surveys	Students and school staff	Post-intervention
Preliminary Efficacy			
Inhibition/attention	NIH Toolbox[a]	Research assistant (all measures)	Baseline and post-intervention (all measures)
Working memory	NIH Toolbox[b]		
Cardiorespiratory fitness	PACER		
Muscular fitness	7-movement battery		

Notes: [a]Flanker Inhibitory Control and Attention Test Ages 8-11 version 2.0; [b]List Sorting Working Memory Test Age 7+ version 2.0; PACER = Progressive Aerobic Cardiovascular Endurance Run

Study enrollment (i.e., recruitment and retention) and fidelity measures (i.e., intensity adherence, participation adherence, intervention leader compliance and integrity) and control school monitoring served as markers of feasibility. Recruitment and retention of participants was tracked throughout the study and post-intervention. Intervention intensity adherence was measured on one randomly selected day per week at the intervention school. A random subsample of intervention participants (n = 6 to 8) wore Polar A370 wrist monitors (Polar Electro Inc., Lake Success, NY) and GT3X+ accelerometers (ActiGraph, LLC, Pensacola, FL) to assess their heart rate and activity during recess sessions, respectively. Although the accuracy of wrist-worn heart rate monitors is more varied than chest sensors compared to electrocardiogram measurements, the Polar A370 wrist device takes less time to place on participants and provides feedback on intensity levels (18,35). Accelerometers were programmed to store data in 15-

second epochs and were worn on the right hip. In a calibration study in 5 to 8-year-old children by Evenson et al. (13), ActiGraph accelerometers demonstrated acceptable classification of intensity (area under the ROC curve = 0.83 to 0.98) when compared to indirect calorimetry. Therefore, percent time spent in moderate-to-vigorous physical activity was determined using the Evenson et al. activity count thresholds for children.

Participation adherence (i.e., attendance), intervention compliance, and integrity were assessed daily at the intervention school via a semi-structured questionnaire (i.e., the implementation form; Supplemental Content 1) completed by a trained research assistant who was not involved in the delivery of the intervention. Information regarding participation rates, how many sessions were implemented, how well the implemented sessions matched the originally designed program, if all intervention components were delivered clearly and correctly, and how much of the original intervention program was delivered was recorded. Control school monitoring was conducted on one day per week. A research assistant observed the recess session and completed a questionnaire to monitor the recess practices (Supplemental Content 2). Physical activity of the control group was measured for the full recess period using accelerometry in a randomly assessed sub-sample (n = 5 to 10 participants).

Measures of acceptability included participation, enjoyment, and satisfaction of the intervention. Questions on the daily intervention implementation form provided information on intervention session participation (i.e., the level of student participation) and enjoyment. Information regarding overall satisfaction of the intervention program was provided by both student participants and school staff on post-intervention evaluation surveys.

Outcome measures included executive control (i.e., inhibition/attention and working memory) and fitness (i.e., cardiorespiratory and muscular fitness). Executive control measures were assessed with the National Institutes of Health (NIH) Toolbox® for Assessment of Neurological and Behavioral Function on an iPad (version 11.1, Cupertino, CA) (27). Specifically, inhibition and attention were assessed using the Flanker Inhibitory Control and Attention Test Ages 8-11 version 2.0 and working memory was assessed using the List Sorting Working Memory Test Age 7+ version 2.0. Cardiorespiratory fitness was assessed using the Fitnessgram Progressive Aerobic Cardiovascular Endurance Run (PACER) test and was recorded as the total laps completed (26). To assess muscular fitness, we included a full-body series of resistance exercises appropriate for the pediatric population (including a front squat, push-up, lunge, bent-over row, shoulder press, calf-raise, and curl-up) that has been used in a recent cognition study by Kao et al. (24). For each exercise, participants were asked to complete as many repetitions (with correct form) as possible in 30 seconds with either a self-selected medicine ball or body weight. A strength index score was calculated for each exercise that took the medicine ball weight, body weight, and repetition number into account [i.e., strength index = (body weight + medicine ball)/number of repetitions].

Physical measures included weight and height measured at baseline and demographic measures included student's age, sex, race, annual household income, and presence of a diagnosed developmental disorder or IEP. Height and weight were measured with shoes and bulky

clothing removed in a private location of the school or playground. Weight was measured using an electronic, portable scale (Scaletronix 5125 Model, White Plains, NY). A portable stadiometer (Shorr Height Measuring Board, Olney, MD) was used to measure height. BMI percentiles were calculated from the CDC growth charts using height, weight, sex, birth date, and measurement date (30). Demographic information was obtained from parents via an online questionnaire.

Statistical Analysis

Differences between groups in baseline characteristics were assessed with independent samples *t* tests (continuous variables) or chi square tests (categorical variables). For feasibility, descriptive statistics were calculated for research assistant reported study enrollment, fidelity, and control school monitoring measures. For acceptability, descriptive statistics were calculated for research assistant, student, and school staff reported measures and representative quotations were presented for student and staff satisfaction. To assess the preliminary efficacy of the intervention compared to the control group with respect to change over time in executive control and fitness we used ANCOVA models adjusted for baseline scores and age. Other covariates that were significantly correlated with the outcome variables were entered in the models. To compare the mean percentage of time spent in moderate-to-vigorous physical activity during recess between schools, an independent samples *t* test was used. The alpha level was set at $p < 0.05$ and analyses were completed in Stata (Stata 15.1, College Station, TX).

RESULTS

A total of 91 and 116 third and fourth grade students, respectively, attended the intervention and the control schools, and were eligible to participate in the SMART Recess study. Of this population, initial parental consent and permission was received for 56 students (intervention, $n = 27$; control, $n = 29$). Two control students did not complete assent and another student traveled out of the area before measurements began. Descriptive characteristics of the study sample are presented in Table 3.

Feasibility

The baseline sample size was 53 participants (intervention, $n = 27$; control, $n = 26$). Overall reach (enrolled participants out of eligible students) was 29.7% and 22.4% in the intervention and control schools, respectively. In the intervention school, two participants were not present for post-intervention measurements (illness, $n = 1$; travel, $n = 1$). In the control school, after baseline data collection six participants withdrew from the study because they did not wish to give up future recess time for the assessments. Therefore, the final overall retention level for study measures was 92.6% ($n = 25$) and 76.9% ($n = 20$) for the intervention and the control schools, respectively.

During the entire 30-minute recess session, accelerometer data indicated the average percent of time spent in moderate-to-vigorous physical activity at the intervention school was 41.7 ± 14.5% (mean ± SD: 9.5 ± 4.2 minutes). During the intervention portion of recess sessions, the average percent of time spent in moderate-to-vigorous physical activity was 44.8 ± 19.3% (i.e., 5.7 ± 2.8

minutes) in the intervention school. The average heart rate of participants during the intervention sessions was 122.5 ± 12.2 beats per minute (bpm).

Table 3. Baseline characteristics of participants in the two schools (n = 53).

Variable	Intervention School (n = 27)	Control School (n = 26)	p-value
Age (years)	8.8 ± 0.1	9.4 ± 0.1	0.0002*
Sex (% male)	66.7%	42.3%	0.08
BMI percentile	60.6 ± 6.0	64.0 ± 6.0	0.69
BMI category			
Underweight	3.7%	4.4%	0.99
Healthy weight	66.7%	65.2%	
Overweight/Obese	29.6%	30.4%	
Race			
Caucasian	63.0%	35.0%	0.03*
Asian	18.5%	10.0%	
Latino/Hispanic	11.1%	50.0%	
Black/African American	7.4%	5.0%	
Annual Household Income			
$0 - $19,999	11.1%	11.8%	0.30
$20,000-$39,999	11.1%	11.8%	
$40,000-$59,999	0%	17.6%	
$60,000 or more	77.8%	58.8%	
Diagnosed developmental disorder (% yes)	22.2%	0%	0.03*
Individualized education plan (% yes)	27.8%	5.0%	0.06

Note: Values are expressed as Mean ± SD or %. Between group differences were analyzed with independent samples t tests for continuous variables and chi square tests for categorical variables.
*$p < 0.05$

At the intervention school, the average number of students in attendance per intervention session was 4.5 ± 3.3 and 10.8 ± 4.6 among all third and fourth grade students, respectively. Although 89% of all students participated in at least one intervention session, the average attendance rate was below 50% for both participants enrolled in the study and all students. The average intervention school attendance rate was 19.4% for study participants and 30.1% for all students (ranging from 0 to 95.6% in both categories). Participation was higher among third graders compared to fourth graders in both study participants (mean students/session: 6.1 ± 3.1 vs. 3.1 ± 2.7) and all students (13.1 ± 4.4 vs. 8.6 ± 3.7).

A summary of the research assistant responses on the daily intervention implementation form regarding feasibility are presented on the top half of Table 4. Intervention sessions were

implemented 88% of the time (i.e., 44 of a potential 50 days). Of the total intervention sessions (n = 44), two sessions were held indoors due to rain and the remaining sessions were held outdoors. The average intervention session length was 14.7 ± 4.6 minutes (ranging from 8 to 26 minutes). The intervention duration exceeded the planned 15 minutes 56.6% of the time in third grade and 58.2% of the time in fourth grade. The intervention was delivered as intended (n = 78.9% of sessions), including all the planned components (n = 76.1% of sessions). In addition, a significant portion of the intervention sessions were delivered clearly and correctly with adequate levels of intervention leader encouragement. Modifications (e.g., an alternative game was requested by the students or certain segments were extended or shortened based on student interest or weather conditions) were integrated into approximately one-third (n = 13) of the sessions by intervention leaders.

Table 4. Research Assistant Responses to the Daily Intervention Implementation Form.

Implementation Question	Yes (%)	No (%)
Feasibility		
Was the intervention implemented today?	70.5	29.5
Among students in study, did at least half participate?	29.8	70.2
Among all students, did at least half participate?	16.2	83.8
Was the intervention session delivered as planned?	78.0	22.0
Was the intervention session delivered clearly and correctly?	98.8	1.2
Were all planned components implemented?	76.1	23.9
Were modifications/adaptations implemented?	36.4	63.6
Did intervention leaders provide encouragement?	100.0	0
Acceptability		
Did the majority of the students participate in at least half of the session?	100.0	0
Did the majority of students appear to enjoy the session?	97.8	2.2
Did the intervention session appear to hold the interest of the majority?	95.4	4.6
Did intervention leaders recommend modifications/adaptations for the future?	33.7	66.3

At the control school, the average percent of time spent in moderate-to-vigorous physical activity was 30.4 ± 14.8% (or 8.6 ± 5.3 minutes). According to observation data, during this same time frame at the control school, the majority of control school students engaged in light physical activity during recess sessions. Of the observed recess sessions, 93.3% of the observed recess sessions consisted of unstructured activity.

Acceptability

According to research assistant responses on the daily implementation form (bottom portion of Table 4), the majority of students appeared to enjoy the intervention sessions and the activities seemed to hold their interest. Based on student verbal feedback and assessment of individual sessions, intervention leaders recommended future modifications to approximately one-third of the sessions. Student responses to the post-intervention survey are outlined in Table 5. Most students reported that they were likely to continue participating in the program if it were offered and would participate in the activities if they were offered in a different school setting (e.g., as classroom breaks or before school). Students were generally satisfied with most components of

the program. Although none responded, "extremely dissatisfied", 11.1% of the participants indicated that they were slightly dissatisfied with the timing of the intervention sessions, duration of the program, and facilitation by the intervention leaders. Intervention leaders were described by one student as "*kind and encouraging*" and completion of the assessments were described as "*easy to do*" by another student. Feedback concerning the intervention session length varied, with several reporting satisfaction with the daily length, some preferring to extend the length (i.e., "*longer than 15 minutes – the whole recess"),* and others expressing a concern that the length sometimes exceeded the planned 15 minutes (i.e., *"we should have more time for recess"*). Favorite games and activities varied among student participants. Some students indicated that while they were bored with some games, they would do the program again.

Table 5. Responses to the Post-intervention Survey

Question:	Responder:	Response (%):				
		EL	SL	L	SU	EU
If offered by your school, how likely would you be to continue participating in the recess activities that were included in our program?	Students	50	25	25	0	0
	Teachers	N/A	N/A	N/A	N/A	N/A
How likely would you be interested in participating in these activities during other times/settings during the school day?	Students	50	10	15	10	15
	Teachers	N/A	N/A	N/A	N/A	N/A
How satisfied are you each of the following components of the SMART Recess pilot study?		ES	SS	N	SD	ED
Timing of the sessions	Students	44.5	33.3	11.1	11.1	0
	Teachers	100	0	0	0	0
Length of the sessions	Students	36.8	47.4	5.3	10.5	0
	Teachers	100	0	0	0	0
Duration of the program	Students	55.6	27.8	5.6	11.0	0
	Teachers	100	0	0	0	0
Content of the sessions	Students	50.0	33.3	11.1	5.6	0
	Teachers	100	0	0	0	0
Leadership of the sessions	Students	66.7	16.7	5.6	11.0	0
	Teachers	100	0	0	0	0
Initial meeting with teachers	Students	N/A	N/A	N/A	N/A	N/A
	Teachers	100	0	0	0	0
Initial meeting with students	Students	58.8	23.5	17.7	0	0
	Teachers	100	0	0	0	0
Communication	Students	N/A	N/A	N/A	N/A	N/A
	Teachers	100	0	0	0	0

Note: Students (n = 20); Teachers = school teachers and staff (n = 2); EL = extremely likely; SL = slightly likely, L = likely; SU = slightly unlikely; EU = extremely unlikely; ES = extremely satisfied; SS = slightly satisfied; N = neither satisfied or unsatisfied; SD = slightly dissatisfied; ED = extremely dissatisfied

School staff expressed general satisfaction with various components of the intervention and measurements of the study (Table 5). Responses provided affirmative support for continuation of the program such as, *"I think it was great to have an organized movement-related option for students to participate in. Along with that, the interaction between college students and third graders is highly valuable!"* Another response provided similar support with additional future recommendations

regarding programming focus, *"I'd love to see the program become a permanent fixture and include attention to interpersonal relations to be sure the kids are able to participate and not focus on any type of competition."*

Preliminary efficacy

Due to diagnosed developmental disorders or the presence of an IEP (intervention, n = 5; control, *n* = 1), six participants were excluded from the executive control analyses. Baseline, adjusted post-intervention means, and ANCOVA results are presented in Table 6. Overall, there were no significant differences in adjusted mean post-intervention scores between schools for any of the outcome variables. The average percent time spent in moderate-to-vigorous physical activity during recess sessions was significantly higher in the intervention group (41.7 ± 2.1%), compared to the control group (30.4 ± 0.2, $p < 0.001$).

Table 6. Baseline Means and Adjusted Post-intervention Means from ANCOVA Models.

	Intervention School		Control School		
	Baseline	Adjusted Post	Baseline	Adjusted Post	*P*-value
Inhibition (score)	6.9 ± 0.9	7.7 ± 0.1	7.9 ± 0.7	7.6 ± 0.2	0.74
Working memory (score)	14.8 ± 2.8	16.8 ± 0.6	15.6 ± 2.5	15.8 ± 0.9	0.35
PACER (completed laps)	19.7 ± 13.3	9.2 ± 1.9	12.9 ± 3.9	13.9 ± 2.2	0.15
Muscular fitness (score)	15.7 ± 3.1	19.1 ± 1.1	16.6 ± 5.2	22.1 ± 1.7	0.17

Note: Values are presented as means ± standard deviation (baseline) or standard error (adjusted post). Post means are adjusted for baseline and age (working memory and muscular fitness), baseline, age and BMI percentile (inhibition), baseline, age, and sex (PACER). Abbreviations: PACER = progressive aerobic cardiovascular endurance run; MVPA = moderate-to-vigorous physical activity

DISCUSSION

The purpose of this pilot study was to evaluate the feasibility, acceptability, and preliminary efficacy of a fitness intervention offered during recess in elementary school children. Although preliminary efficacy was not demonstrated, possibly due to implementation challenges that were faced (i.e., low participation adherence), other process evaluation measures demonstrated mixed findings for feasibility and acceptability. Some findings related to feasibility were favorable (i.e., study enrollment and intervention leader compliance), whereas the intensity (according to accelerometry) and participation adherence did not meet the original study goals. Overall, most acceptability findings met expectations, but they also provided insight into areas for intervention improvement.

Recruitment (26%; 53 participants out of 207 eligible students) and retention goals (75% of 53 participants) were met, although some parents expressed frustration with the paperwork required to enroll their children into the study. Originally, 68 families expressed interest, but 12 did not complete all the necessary forms for study enrollment. Participant retention was lower at the control school compared to the treatment school, which could be related to offering a traditional control condition (i.e., schools were not matched for attention). This type of control design was selected because an "active" control condition (e.g., offering an alternative program for the control school) could possibly impact the cognitive outcomes in the study. An active

control condition is sometimes considered the preferred option to reduce loss to follow-up (32). However, because more time was spent with participants at the treatment school in our study, this probably contributed to the higher retention rate in the intervention school. A greater loss to follow-up has also been reported by some studies examining fitness interventions in children with non-attention matched control groups (5, 22).

Some fidelity measures, such as implementation rate and implementing sessions as planned, successfully reached our pilot study goals. First, our planned intervention implementation percentage target (75%) was met. As expected, the remaining sessions (12% of scheduled sessions) were missed due to school cancellation related to inclement weather (n = 3), field trips (n = 1), or University conflicts for the research staff (n = 2). Second, more than 75% of the time, the intervention was led as planned and all components of the sessions were delivered. However, occasionally some of the activities (e.g., Capture the Flag and some tag games) would get more competitive than intended, resulting in some arguments among students that impacted the activity portion of intervention sessions (i.e., more time was spent on group management rather than group activity). During these sessions, the activity was either ended early (if most of the session had already been completed) or was changed to a different activity, which in part contributed to the reported 25% of intervention sessions not implementing all of the planned components. When describing the implementation of the Playworks curriculum in 17 schools (a structured, game-based recess program), Forton et al. (16) acknowledged some similar challenges to our pilot study. They also noted that conflict resolution was sometimes a concern during the intervention sessions and that teachers recommended that future intervention leaders receive training in behavior management.

Despite effectively meeting the above feasibility goals, the overall intervention dose did not meet the expected level. The intensity adherence measured via accelerometers during the 15-minute intervention session (41.7% of the average time was spent in moderate to vigorous physical activity) fell short of our goal of 50%. In a trial that examined the effect of another youth fitness program (FITKids) on fitness and cognitive outcomes, intensity adherence was reported as higher than in our study (22). The FITKids trial reported an average heart rate of 137 ± 8.8 beats per minute, whereas in our study the average was 122.5 ± 12.2 beats per minute. The primary focus of their program was aerobic activity and the length of the daily sessions in the FITKids trial was also longer (i.e., 2 hours with a goal of 70 minutes of intermittent moderate to vigorous physical activity) and therefore, their participants received a greater dosage from the intervention. However, the lower than expected intervention dosage was probably mainly driven by participation adherence. With the average attendance rate of just under 20% for study participants, the overall exposure to the intervention was well below the typical attendance rate described in other fitness and cognition intervention studies of over 80% (5, 22, 29). In the current study, students had the option to participate in the intervention or other unstructured activities (provided through the school) each day during recess. It is likely that providing participants with an option could have contributed to the low participation rate (versus requiring all students to participate as in other school recess studies). However, as this was a pilot study, an agreement was made with the participating schools to make it an optional program. In a recent report by Donnelly et al. (6) describing the findings of their 3-year, teacher-implemented Physical Activity

Across the Curriculum intervention study (i.e., activity integrated into academic lesson plans), the authors also indicated challenges with the actual exposure versus planned exposure. The intended dose of activity was an accumulation of 150 minutes per week, but lessons were only delivered for about 55 minutes per week. Authors indicated that their planned exposure was not met because the teachers in the study did not comply with the intervention delivery, whereas in the current study, the planned exposure was not met because students chose not to participate in the intervention every day that it was offered. Previous fitness interventions that have observed positive effects on cognitive outcomes have generally reported strong compliance among the participants or limited the analysis to students with adequate attendance (7). Therefore, we strongly speculate that the low compliance in the present study contributed to the lack of significant intervention benefits on preliminary efficacy.

One of the initial barriers related to overall participation was recruiting students to join the program during recess sessions. This again may be largely due to students having a choice of what activities to partake in during school recess. Recess is one of the few (if only) times during the otherwise structured school day that children have opportunities for free play and self-selected activities (12, 33). Therefore, offering an optional structured program competes with free play and other unstructured opportunities. This may be why most school-based physical activity studies with academic-related outcomes have elected to use other settings (7, 31). Our program also occasionally competed with alternative options offered during recess (i.e., computer technology club, talent show rehearsals, and student meetings).

At the beginning of the study, research staff asked students directly if they would like to join the intervention activities, but this protocol was not effective. However, once the daily activities or games began, students watching from the side or initially partaking in other activities started to join in. This unplanned participation pattern sometimes posed as a challenge to track the number of students participating in each session. As mentioned, the overall participation rate of the students enrolled in the study was lower than the students not enrolled in the study. Based on informal verbal feedback from teachers and students, some of the students that were most interested in enrolling in the study were unable to obtain parental permission and consent. Furthermore, there were some students that enrolled because they were excited more about the measurements than the actual program, and others that did not enroll even though they were interested in participating in the intervention sessions, because they were not interested in completing the measurements. Consequently, some of the students that were most compliant and enthusiastic with the intervention (i.e., had attendance rates of over 60%) were not enrolled in the study and therefore, we did not have measures on them to track the efficacy of the intervention.

Another obstacle faced was completion of study measures during school recess. This was arguably the greatest contributor to participant attrition as students expressed refusal to complete many measures during their recess period, particularly at the post-intervention time point. Some students said "*no*" as soon as they were approached and explained that they had other plans (e.g., a basketball, lacrosse, kickball, or tag game), but expressed they would complete the measures after recess if that were an option. The use of collective toe tokens was

helpful at first, but general enthusiasm for this incentive prize decreased with time. Collecting the measures during recess was initially planned 1) to have consistent timing of the cognitive measures, 2) to avoid interrupting classroom time, and 3) to reduce participant burden (i.e., if before or after school appointments were requested). However, future studies offering a program during recess should discuss other potential measurement periods with the school collaborators. There was also a greater rate of measurement refusals at the control school. In addition to reasons stated above, this again could also be related to having a non-attention matched control condition, whereas anecdotally the research staff developed stronger relationships with the intervention students, and it was therefore easier to recruit them for measures. It is hard to determine if this barrier was experienced by other recess studies as most either did not report when the measures were collected (11) or they were assessed at different times (i.e., at the beginning of the school day or during physical education) (4, 10, 23, 29).

Despite these difficulties, research assistant responses on the daily intervention questionnaire and student and school staff responses on the post-intervention survey regarding enjoyment and acceptability were generally positive. Most of the participants completed at least half of the intervention activities during all sessions, which provides additional support that the activities were able to hold the interest of the students. Similar to the current study, other studies have shown that recess-based structured physical activity programs that are designed to meet student needs are acceptable and well-received (10, 23). For example, in a 9-week quasi-experimental study examining the effects of a structured recess intervention on physical activity in third grade students (n = 43), Howe et al. (23) reported positive responses from teachers regarding children's enjoyment. Furthermore, teacher responses also indicated satisfaction that the Howe et al. program addressed additional skills (e.g., social and teamwork skills) with the students. In our pilot study, open-ended responses on the school staff post-intervention survey, as well as verbal feedback, expressed appreciation that social skills and inclusion were integrated into the program and that the intervention provided more students with a comfortable opportunity to participate in recess activities, as well as be more active.

A strength of this pilot study is the use of objective measurements to assess heart rate and physical activity fidelity measures and observations of the intervention sessions were conducted daily. Additionally, the process evaluation data collected in this study can also serve as valuable information to make improvements to the intervention program and inform future studies. However, some limitations regarding the evaluation of its implementation should be addressed. First, although some verbal feedback was recorded on daily implementation sheets, we could formally collect immediate feedback from students throughout the intervention (rather than just at post) in the future. Some of the immediate feedback that we received (i.e., during or immediately after individual recess sessions) was more specific and informative than the brief, overall responses that were received from students in the post-intervention questionnaire. Second, the teacher response rate to the post-intervention survey was low (percentage = 50%) and could potentially be addressed by providing an incentive or collecting the responses in person (rather than emailing a survey link). Third, due to staffing limitations, only one research assistant completed the intervention implementation form each day. However, with two data collectors we would have been able to assess inter-rater agreement between observers for the

process evaluation questions that we used to ensure reliability of these measures. Fourth, heart rate assessment was only conducted at the intervention school. Finally, the research assistants completing observations at both schools were not blinded to the treatment conditions. Although this could contribute to potential bias in the responses to the daily observation form (particularly in the open-ended responses), the research team completed a thorough training in each of the measurement protocols.

The accumulation of the process evaluation information examined in this paper is important to inform future work by addressing concerns and suggested modifications of a school fitness program offered during recess. This evaluation demonstrated that recruitment and retention goals were successfully met and some aspects of fidelity of the current intervention were good (i.e., implementation rate and implementing sessions as planned), while other factors need improvement (i.e., the intervention exposure due to overall low participation rates in most enrolled participants). Furthermore, the acceptability was satisfactory regarding a recess fitness program, but less than ideal for other study components. Future studies may want to examine a similar fitness intervention implemented as a mandatory recess program (particularly in schools that are underserved regarding recess opportunities or space) rather than an optional program, conduct measurements during another school setting if possible, or compare implementation to a different school setting (e.g., before-school) to determine if recess is the most feasible time.

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Supplemental Content 1. SMART Recess Pilot Study Implementation Form.

These items are to be recorded during each intervention session.

Today's Date:_____ Research Assistant Initials:_____
Was intervention implemented today? Yes ____ No_____ If not, why?_____
Grade:_____ Indoor/Outdoor Recess:_____ Temperature:_____
Intervention Week:_____ Day:_____ Weather Conditions:_____

1. Among those with consent/assent, record participants that are in attendance. Number of participants in attendance: _____
2. How many students participated in the intervention session? _____
3. Intervention start time: _____:_____ am/pm; Intervention end time: _____:_____ am/pm
4. Were heart rate and/or activity monitors used today? Yes___ No____

If yes, record participant IDs and corresponding monitor #s.

Participant ID	Monitor #	Participant ID	Monitor #

These items are to be recorded within 20 minutes after the end of an intervention session.

Question:	Yes	No
1a. Did at least 50% of the enrolled participants (present during recess) participate in the intervention?		
1b. Did at least 50% of all students (present during recess) participate in the intervention?		
1c. If no, (to 1a and/or 1c) why?	N/A	N/A
2. Did the majority of students participate in at least half of the intervention session? If not, approximately how many minutes did the majority of the students participate in? _____		
3. Did the majority of the students seem to enjoy the intervention session?		
4. Did the intervention session appear to be hold the interest/attention of the majority of the students participating? If not, explain.		
5. Did the intervention leader(s) provide encouragement during the intervention session?		
6. Was the intervention session implemented as intended? If no, why not?		
7. Did the intervention leader implement the intervention session clearly and correctly?		
8. Did the intervention leader implement all of the planned session components? If no, which components were not implemented and why?		
9. Were modifications/adaptations made from the original intervention session plan? If yes, what modifications were made?		
10. Did the intervention leaders recommend modifications or changes for the future? If yes, explain.		

Supplemental Content 2. SMART Recess Pilot Study Control School Monitoring Form.

Today's Date:_____ Research Assistant Initials:_____

These items are to be recorded during each observation session.

Grade:_____ Indoor/Outdoor Recess:_____ Weather:_____

Teacher/Room (if Indoor):_____

1a. Accelerometer start time: _____:_____ am/pm

1b. Accelerometer end time: _____:_____ am/pm

1c. Record the participant ID numbers below if they wore an accelerometer today.

1.	5.	9.	12.
2.	6.	10.	13.
3.	7.	11.	14.
4.	8.	12.	15.

2. Select the category of activities that were offered during the recess session:

_____ Unstructured _____ Structured _____ Combination

2a. If structured or combination was selected, what activities were offered:

2b. If structured or combination was selected, approximately what percentage of the students participated in the structured activities?

3. Select the category of physical activity that describes the majority of the students during the recess session.

_____ Sedentary _____ Light _____ Moderate-to-Vigorous

4. Please note any additional observations: