Feasibility of the InPACT Intervention to Enhance Movement and Learning in the Classroom

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INTRODUCTION

School environments in the United States have historically provided many opportunities for children to be physically active through comprehensive programs, including recess, intramural physical activity clubs, interscholastic sports, after-school programs, and physical education (PE) (1). Since 2002, however, an increased emphasis on standardized testing in schools (1,2) has reduced time allocated for physical education in favor of additional academic instruction time (2). Cuts to public school funding have also contributed to economic disparities in school physical activity policies and practices (3–7). For example, socioeconomically disadvantaged schools are less likely to offer more structured recess (3), have a certified PE teacher (4,7), or provide after-school sports programming (4) compared with more affluent schools. Higher socioeconomic schools are on the other hand more likely to have higher quality gymnasiums (8) and playground facilities (5). When comparing children’s physical activity during school, students in higher socioeconomic schools have better recess practices (5) and spend more time engaged in moderate to vigorous physical activity (MVPA) during PE classes (6) than students in lower socioeconomic schools. An unintended consequence of these policies and practices is increased classroom sitting (1,9), particularly in low socioeconomic schools (7). It is important to consider interventions that create opportunities for increased physical activity in this context.

In recognition of the critical role that schools play in promoting student health, preventing childhood obesity and combating problems associated with poor nutrition and physical inactivity, the U.S. Congress passed “The Child Nutrition and WIC Reauthorization Act” in 2004 (10) and the “Healthy, Hunger Free Kids Act of 2010” (11) mandating that school districts across the country establish a local school wellness policy. The “Let’s Move Campaign,” launched in 2010 by former first lady Michelle Obama, was a call to action for more comprehensive physical activity programming, which included physical activity in the classroom (12). More recently, the reauthorization of the Elementary and Secondary Education Act, "..."
known as the “Every Student Succeeds Act (ESSA),” signed into law on December 10, 2015, by Congress currently provides increased funding to states and school districts for health education and physical education programs (13). In response, school administrators are searching for low-cost or free opportunities to provide health-enhancing physical activity in their classrooms (1).

Widely implemented classroom-based physical activity interventions are built around teacher-implemented academic lessons (14–22) that are designed to incorporate 10–15 min of continuous physical activity as a compliment to daily lessons. Several programs have been developed that combine MVPA with the teaching and review of academic content across the United States and globally, including Happy 10 (19), Take 10! (18), Physical Activity Across the Curriculum (14), The Class Moves (16), Texas Initiatives for Children’s Activity and Nutrition (I-CAN!) (15), Activity Bursts in the Classroom (17), Instant Recess (20), FUNtervals (21), and Kinder-Sportstudie (KISS) (22). These classroom-based physical activity interventions have demonstrated success in increasing in-school physical activity, improving fitness, weight status, on-task behavior, and academic achievement in children, and are helping schools achieve local wellness policies (14–22).

The ongoing challenge to promoting physical activity in the classroom is ensuring that each child has sufficient space to participate in physical activity without increasing their risk of injury or potential for disruptive behavior (23). Low-income schools are particularly vulnerable to space limitations due to overcrowding (24) with some schools packing as many as 40 students into a classroom (25). Some teachers are also concerned about the additional time required to incorporate physical activity into lesson plans, (14,15), whereas others share the belief that using movement in classrooms could lead to a lack of control and an increase in discipline problems (23). Most activity break programs do not have an explicit component to address space constraints or a teacher training program to overcome these constraints. In addition, few programs have developed effective classroom management procedures to reduce disruptive behaviors (17,26,27).

Finally, few in-class programs have attempted to optimize the dose of activity prescribed (time, frequency, and duration) as it relates to improvements in health (1). Laboratory studies examining the health benefits associated with intermittent physical activity breaks (e.g., 2 or 3 min) in children are limited and mixed. Saunders et al. (28) observed no significant differences in circulating levels of insulin, glucose, or lipids in healthy children ages 10–14 yr who were exposed to 2 min of low-intensity physical activity every 20 min for 8 h. Belcher et al. (29), however, demonstrated that 3 min of MVPA every 30 min for 3 h resulted in lower postprandial glucose, insulin, and lipid concentrations in normal weight children ages 7–11 yr. Our laboratory examined the potential influence of intermittent physical activity breaks performed at varying intensities on total daily physical activity energy expenditure, dietary intake, psychological mood, physical activity enjoyment, and math performance in elementary-age children. Thirty-nine children (18 males, 21 females; ages 7–11 yr; 33% overweight/obese; 59% non-white) completed four experimental conditions in random order: 8 h of sitting interrupted with twenty 2-min low-, moderate-, or high-intensity activity breaks and 8 h of sitting interrupted with 2 min of sedentary screen time breaks. In response to high-intensity activity breaks, children maintained their habitual physical activity levels away from the laboratory, increasing total daily physical activity energy expenditure by an additional 153 calories (30) without any compensatory changes in their food intake (31). Children reported higher enjoyment after completing the activity breaks of any intensity (low, moderate, and high) compared with sedentary screen time breaks, with mood improving throughout the day in overweight/obese children (32). In addition, activity breaks of any intensity elicited the same level of math performance compared with action-based video game breaks (33). Together, these findings suggest that brief bouts of activity are an enjoyable form of exercise that elicits significant metabolic benefits without a negative effect on academic performance in elementary school-age children. The question remains, however, can findings from the laboratory be translated to a real-word setting? More specifically, is implementing multiple activity breaks in an elementary classroom a feasible intervention strategy to increase children’s MVPA in schools?

The objective of this study was to determine the feasibility of Interrupting Prolonged Sitting with Activity (InPACT), an intervention that includes no-cost architectural modifications (i.e., redesigned floor plans and furniture rearrangement) and novel classroom management strategies to reliably and safely increase children’s MVPA in the classroom (34). More specifically, we tested the feasibility of implementing ten 3-min activity breaks, 5 d-wk−1 in the elementary school classroom. The Institute of Medicine’s current recommendations for schools are to provide 30 min of structured physical activity throughout the school day (1,35). Hence, we modified the study protocol used in the laboratory (30) by reducing the number of activity breaks implemented from 20 to 10 activity breaks and increasing the duration of the activity breaks from 2 to 3 min. This reduced the total volume of activity prescribed from 40 to 30 min.

As an exploratory aim, we sought to identify school-level factors that influenced InPACT implementation by using the 23-item factor list of Lau et al. (36). Factors were classified as organizational characteristics, implementation processes, provider characteristics, program characteristics, and community-level factors. Understanding the factors that influenced InPACT implementation can aid in future development of intervention supports designed to enhance the effectiveness of the intervention.

METHODS
Study Design

The study time line is presented in Figure 1. InPACT was a 16-wk pilot intervention implemented in three schools across Southeast Michigan. Classrooms followed an incremental protocol where teachers were asked to complete one activity break per day during the first week of the intervention and increased by one activity break each following week until classrooms reached a total of 10 activity breaks per day. This was carried out to allow adequate time for teacher and student familiarity with InPACT and to establish classroom procedures. Before the start of the intervention, research staff conducted a 2-d in-service training for the teachers to provide them resources on successfully implementing InPACT in their classrooms. The research team also conducted teacher check-ins at each school during week 5 of the intervention to answer any questions and troubleshoot any problems that arose. Postintervention, students and teachers answered
end-of-study questionnaires, and teachers attended an end-of-study meeting with the principal investigator and research staff to discuss their questionnaire answers. This study was considered Exempt Human Research by the Institutional Review Board at the University of Michigan since deidentified data were used.

Recruitment

Three elementary schools in Southeast Michigan agreed to participate in the InPACT intervention. School 1 was selected based on the principal’s interest in promoting health and wellness in his students and staff. School 2 and school 3 were selected based on their current participation in Project Healthy Schools, a health promotion program housed in elementary and middle schools throughout the state of Michigan (37). Diversity in location, student demographics, and achievement were additional factors used in school selection. School 1 was located in a suburban setting with a predominantly white student body (90%), with 25% of students eligible for free and reduced-price lunch. School 2 was located in a rural setting with a predominantly white student body (90%), with 50% of students eligible for free and reduced-price lunch. School 3 was located in an urban setting with a predominantly black student body (59%), with 74% of students eligible for free and reduced-priced lunch. According to the Michigan School Data 2015–2016 Accountability Results, school 1 received an 86-overall statewide percentile ranking (i.e., they ranked higher than 86% of schools ranked statewide). School 2 received a 73-overall percentile rank, and school 3 received a 16-overall percentile rank (38).

Before the start of the intervention, research staff met with the principal and/or wellness coordinator of each school to provide a detailed description of the study and to identify teachers who may be interested in participating in the 16-wk intervention. At each school, participating teachers were selected by the school principal. Six to seven teachers who taught third through sixth grade at each school were recruited to participate in InPACT. A total of 20 classrooms across all three schools participated in this intervention, representing a reach of approximately 500 students. For the eligible classrooms that participated at each school, see Table 1.

InPACT Teacher Training

Teachers in all three schools were trained to deliver InPACT before the implementation of the intervention. The teachers were compensated for their time during the 2-d, 8-h professional training at a rate of $25 per hour, totaling $400 each. Payments were given to the teachers before the start of the intervention. The principal investigator as well as research team members led all training sessions. More specifically, teachers were provided the scientific rationale for InPACT as well as study objectives, protocol, negotiables, and nonnegotiables (see Table 2). Teachers were also given instructions on the potential risks of the study and were taught how to prevent, treat, and address any injuries or health concerns, such as asthma or type 1 diabetes, for example, during an activity break. In addition, teachers were trained on how to integrate physical activity breaks into their curriculum. A written training manual and all study materials were made available through the study website (inpact.kines.umich.edu).

InPACT Architectural Modifications

To address the concerns of space constraints in the classroom, our architectural studio calculated the range of motion of exercising children ages 6–12 yr. It was determined that each child required approximately 36–48 inches to move at a moderate to vigorous intensity (39). We then completed analog and digital surveys of the classroom dimensions at each pilot school and determined that the typical square footage of an elementary classroom is 900 ft². Using this information in concert with the Physical Activity Design Guidelines for School Architecture (28), we developed a series of floor plans (standard grid, U-shaped, or small group format) (40). The standard grid floor plan arranged desks and chairs at equal distance from each other in a gridlike format, providing space on the right-hand or left-hand side of the classroom for children to be active. The U-shaped floor plan arranged the desks and chairs in the shape of a “U” on the outermost sides of the classroom resulting in increased open space for movement in the middle of the classroom. The small group floor plan arranged the desks and chairs in groups of six to eight desks spaced throughout the room to create pockets of open space for movement throughout the classroom. Each teacher was asked to select a classroom floor plan that best fit their teaching style, after which the classroom desks and furniture were rearranged to provide enough open space to reliably and safely implement activity breaks. On the basis of teacher feedback, the small group floor plan provided the best learning and movement environment (Fig. 2).

Table 1. Participating/Eligible Classrooms per School and Grade.

<table>
<thead>
<tr>
<th>Grade</th>
<th>School 1</th>
<th>School 2</th>
<th>School 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2/3</td>
<td>2/3</td>
<td>2/2</td>
</tr>
<tr>
<td>4</td>
<td>3/3</td>
<td>3/3</td>
<td>3/3</td>
</tr>
<tr>
<td>5</td>
<td>1/3</td>
<td>1/3</td>
<td>1/2</td>
</tr>
<tr>
<td>6</td>
<td>0/0</td>
<td>1/3</td>
<td>1/1</td>
</tr>
</tbody>
</table>
TABLE 2.
InPACT Study Negotiables and Nonnegotiables.

<table>
<thead>
<tr>
<th>Negotiables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Teachers and students can create their own activity breaks.</td>
<td></td>
</tr>
<tr>
<td>2. Classroom setup is at the teacher’s discretion.</td>
<td></td>
</tr>
<tr>
<td>3. Teachers can implement the activity breaks at any time but needed to have at least 20 min of sedentary time in between each break.</td>
<td></td>
</tr>
<tr>
<td>4. Activity breaks could be completed in areas outside of the classroom (hallways, cafeteria, etc.).</td>
<td></td>
</tr>
<tr>
<td>Nonnegotiables</td>
<td></td>
</tr>
<tr>
<td>1. Teachers should participate in all activity breaks to model active behavior for students.</td>
<td></td>
</tr>
<tr>
<td>2. Teachers should encourage students to participate.</td>
<td></td>
</tr>
<tr>
<td>3. Follow the 16-wk incremental protocol.</td>
<td></td>
</tr>
<tr>
<td>4. Activity breaks need to be 3 min in duration.</td>
<td></td>
</tr>
<tr>
<td>5. Activity breaks need to be performed at a moderate to vigorous intensity level.</td>
<td></td>
</tr>
<tr>
<td>6. Teachers should complete end-of-study questionnaires.</td>
<td></td>
</tr>
<tr>
<td>7. Teachers should administer questionnaires to their students at conclusion of study</td>
<td></td>
</tr>
<tr>
<td>8. Teachers are not allowed to use the “Academic” section of the Compendium of Physical Activities. These were of lower intensity and developed to supplement the prescribed number of breaks.</td>
<td></td>
</tr>
</tbody>
</table>

InPACT Compendium of Physical Activities, Videos, and Target Heart Rate Zone Posters

On the basis of the start of the intervention, the InPACT research team developed a compendium of physical activities in compliance with health enhancing exercise physiology principles. It included 200 MVPA breaks of 3 min for teachers to use and adapt for their classrooms. “The Compendium of Physical Activity for Youth” (41) and “The Kinesthetic Classroom” (42) were used as references for developing the InPACT compendium. The InPACT compendium was divided into three main categories: basic, advanced, and academic, as well as into four subdivisions: individual (a single person activity), pairs (a two-person activity), group (three or more children performed the activity break together), and equipment (an object was required). The criteria for moderate to vigorous intensity was determined based on the American College of Sports Medicine’s guidelines of 64% of heart rate maximum as the lower cutoff for moderate-intensity exercise and the CDC recommendations that suggest moderate intensity starts at 50% of heart rate maximum (43). Thus, we combined these recommendations and classified MVPA as 60%–85% of heart rate maximum. To ensure that all activities met the criteria of MVPA intensity, we pilot tested a subset of the activities in children in a laboratory setting (31–34). Because of funding limitations, the remaining activities were tested using adult research staff who completed each activity break wearing a heart rate monitor. If heart rates were below the intensity threshold for third through sixth graders (125–179 bpm), modifications included increasing arm movements or adding a jumping activity. If heart rates were above the moderate- to vigorous-intensity range, modifications included adding lower-intensity movements to the break and decreasing the tempo. Examples of InPACT activities are presented in Figure 3.

The InPACT compendium’s purpose was to offer teachers a planning resource. Teachers were not required to use the specific activity break ideas but were simply asked to ensure that their students performed the prescribed number of activity breaks at a moderate to vigorous intensity. Because exercise intensity was a new concept to many teachers and students, InPACT exercise videos were also developed to help guide intensity using tempo and visual cues. The videos included research staff modeling the activities at the correct intensity, encouraging prompts to motivate the students to continue exercising the entire time, and a 3-min activity lapse countdown with music and a heart rate guide. A total of seven videos were developed for the intervention and were made accessible to teachers on the study website.

Teachers were also taught how to manually take their carotid pulse to calculate heart rate to ensure both students and teachers were in the moderate to vigorous heart rate zone during the activity breaks. Teachers were also provided with posters that displayed the target heart rate zones for each grade level based on age to help students meet their target heart rate zone. For example, the target heart rate zone for third-grade classrooms was 127–179 bpm.

InPACT Classroom Procedures

Classroom management procedures were introduced that could be used to efficiently implement the activity breaks, and posters were distributed to teachers that displayed verbal cues to transition students to and from an activity break. To help students transition into beginning an activity break, the cue word “MOVE,” which stood for materials down, open space, voices quiet, and ears listening, was used. To transition students to return to their seats after an activity break, the cue word “FOCUS” was used. “FOCUS” stood for find your seat, open your books, calm your breathing, use your ears to listen, and silence your voices, prompting students to return to their classroom activities.

Outcome Measures

TEACHER OUTCOMES

Research staff participated in classroom observations twice a week at each of the three schools in random order to assess teacher participation in the activity breaks and whether they were exercising at the prescribed intensity. The end-of-study questionnaire assessed 1) perceived effectiveness of activity break implementation in their classroom, 2) perceived effectiveness of classroom management protocols, 3) return to task postactivity break, and 4) physical activity attitudes of teachers and students. Example questions included the following: “Are you still implementing activity breaks after the study had finished?” and “What was the average number of breaks implemented per day?” These questions specifically pertained to the last 4 wk of the intervention when teachers were instructed to complete 10 activity breaks per day. The end-of-study questionnaire used in the present study was similar to previous questionnaires developed by Project Healthy Schools (44).

CLASSROOM MANAGEMENT OUTCOMES

Research staff visited classrooms twice a week at each of the three intervention schools in random order to assess transition time and number of students returning to task after an activity break via direct observation. Transition time was calculated as the teacher’s initiation of activity break instructions to the onset of the activity break (45). To measure the number of students returning to task, the research staff started a 30-s timer at
the completion of each activity break and listened for the teacher’s instructions. At 30 s, the research staff completed a direct observation scan of the boys and another scan of the girls to determine the number of students complying with the teacher’s request to complete a task. Examples of teacher directions observed were 1) return to your seat or 2) grab a snack from your locker, and if they were transitioning to another classroom, 3) line up at the door. Examples of students who were coded as not returning to task were 1) those who continued to roam the room when instructed to return to their seat and 2) those who talked with their peers instead of taking out their book.

**STUDENT OUTCOMES (DIRECT OBSERVATION)**

Direct observation via the System for Observing Play and Leisure Activity in Youth (SOPLAY) was used to assess intensity level of activity breaks. Direct observation was also used to assess duration of activity, percent of students returning to task after an activity break, transition time to start an activity break, and fidelity of the intervention. Over repeated time intervals, SOPLAY uses visual scans of the classroom from left to right at a rate of about one person per second followed by noting characteristics of the activity levels within the area. Activity levels were coded as sedentary (e.g., sitting, standing, and lying down), light activity (e.g., walking), and moderate to vigorous activity (e.g., more than walking). SOPLAY was designed to record physical activity levels in open environments and has been shown to be highly reliable in youth (46). Separate scans were completed for boys and girls, so that activity levels within each of these gender categories could be considered. The interrater reliability was 0.89 (boys), 0.89 (girls), and 0.97 (teachers) across all MVPA observational scans.
The InPACT research team visited each classroom on average six to eight times throughout the 16-wk intervention for a period of 4 h to directly observe teachers and students engaging in activity breaks. Observers did not stay in the classrooms all day but observed a random sample of activity breaks throughout the course of the intervention. Each school was scheduled for six to

Figure 3: Example of a basic individual, basic academic, advanced individual, and basic pair activity break. Taken from the InPACT Compendium of Physical Activities.
eight observation days, but the exact number of observations coded was dependent on the teacher performing an activity break during the scheduled observation. The range of completed activity breaks observed from each classroom in total was between 1 and 16. Of the 194 scans completed, 25 scans or 13% were completed by two or more staff members for reliability (47). A total of 194 observations were successfully recorded from the three schools combined (school 1, 78 observations; school 2, 65 observations; and school 3, 51 observations).

**PHYSICAL ACTIVITY ENJOYMENT AND CONFIDENCE**

After completing the 16-wk intervention, teachers distributed the revised Physical Activity Enjoyment Scale (48) to their students to assess enjoyment of participating in the activity breaks. Students were asked to reflect on how they felt about the physical activity breaks. Example questions included the following: “When I was active … I enjoyed it; When I was active … I felt bored; When I was active … it frustrated me.” The scale is a combination of 16 positive and negative statements. The responses were scored on a 5-point Likert scale (1 = disagree a lot, 5 = agree a lot). Seven of the 16 statements were reverse scored. An enjoyment score was calculated by averaging the scores. The revised Physical Activity Enjoyment Scale have been validated in children (48) and demonstrated high reliability in the present analysis (Cronbach $\alpha = 0.89$).

Students were also asked “How confident are you that you can complete 30 minutes of physical activity at a moderate to vigorous level every day of the school week?” The responses were scored on a 10-point scale (0 = not at all confident, to 5 = kind of confident, to 10 = completely confident). This was a single-item question from the Physical Activity Self-Efficacy Scale to measure physical activity confidence (49).

**IMPLEMENTATION ANALYSIS OUTCOMES**

The 23-item factor list of Lau et al. (37) was used to identify the factors that were most important in achieving successful implementation of youth physical activity interventions. This list included seven factors that were classified as “organizational
characteristics," nine factors as “implementation processes,” two factors as “provider characteristics,” three factors as “program characteristics,” and two factors as “community level factors.” Only 20 of the 23 factors were relevant to our study. The factors that were irrelevant were as follows: 1) goal setting, 2) technical assistance, and 3) parental support for physical activity. The 20 items on the list were scored based on three levels of influence: 1) low, 2) moderate, and 3) high. Five researchers who directly observed the implementation of activity breaks in the classrooms at each school independently scored all three schools in each of the 20 factors for the analysis.

**DATA ANALYSIS**

MVPA via direct observation was calculated by dividing the percentage of students and teachers participating in MVPA by the total number of students and teachers coded for MVPA, light physical activity, or sedentary. Average MVPA was then calculated.

### TABLE 3.
School 1 Intervention and End-of-Study Teacher Questionnaire Outcomes by School/Classroom.

<table>
<thead>
<tr>
<th>School 1</th>
<th>% Students in MVPA during an AB</th>
<th>% Teachers in MVPA during an AB</th>
<th>Most Frequently Cited Barriers</th>
<th>Average No. of AB Completed per Day</th>
<th>Total Observed AB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third grade teacher 1</td>
<td>87.87</td>
<td>93.94</td>
<td>Assemblies, testing, late starts, half days</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Third grade teacher 2</td>
<td>97.49</td>
<td>96.67</td>
<td>Holiday activities</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Fourth grade teacher 1</td>
<td>94.45</td>
<td>88.00</td>
<td>Time, &gt; 6 AB per day</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Fourth grade teacher 2</td>
<td>97.7</td>
<td>44.44</td>
<td>Exchanging of classes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourth grade teacher 3</td>
<td>88.11</td>
<td>64.71</td>
<td>Half days, late starts, assemblies</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Fifth grade teacher 1</td>
<td>90.67</td>
<td>100.00</td>
<td>Schedule changes</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>School 1 Average</td>
<td>92.14% ± 0.008%</td>
<td>83.23% ± 0.09%</td>
<td>—</td>
<td>4.4 ± 0.60</td>
<td>78</td>
</tr>
</tbody>
</table>

AB, activity break; —, not applicable.

*Unanswered question.

### TABLE 4.
School 2 Intervention and End-of-Study Teacher Questionnaire Outcomes by School/Classroom.

<table>
<thead>
<tr>
<th>School 2</th>
<th>% Students in MVPA during an AB</th>
<th>% Teachers in MVPA during an AB</th>
<th>Most Frequently Cited Barriers</th>
<th>Average No. of AB Completed per Day</th>
<th>Total Observed AB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third grade teacher 1</td>
<td>71.40</td>
<td>63.64</td>
<td>Rotating classrooms, too many breaks</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Fourth grade teacher 1</td>
<td>94.48</td>
<td>92.59</td>
<td>Transitions</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Fourth grade teacher 2</td>
<td>72.81</td>
<td>92.86</td>
<td>Time/schedule change</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Fourth grade teacher 3</td>
<td>95.50</td>
<td>100.00</td>
<td>Time</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>Fifth grade teacher 1</td>
<td>76.86</td>
<td>23.53</td>
<td>10 not fitting into natural transition times</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Fifth grade teacher 2</td>
<td>90.59</td>
<td>83.33</td>
<td>Schedule changes, break variation</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Sixth grade teacher 1</td>
<td>69.31</td>
<td>100.00</td>
<td>Transition/participation</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>School 2 average</td>
<td>84.22% ± 0.014%</td>
<td>82.52% ± 0.03%</td>
<td>—</td>
<td>5.7 ± 1.7</td>
<td>65</td>
</tr>
</tbody>
</table>

AB, activity break; —, not applicable.
calculated by taking the average of all values. In addition, subanalyses were performed by gender, teacher, school, and grade for student and teacher MVPA participation. It is important to note that due to differing class sizes, \( n \) (total number of students in class) was not necessarily the same for each subcategory for the secondary analyses.

**STATISTICAL ANALYSIS**

All analyses were conducted in IBM SPSS Version 24. Independent *t*-tests were used to evaluate potential school-level, grade-level, and gender-level differences for the following outcomes: 1) total activity breaks implemented per day, 2) duration of activity break, 3) student MVPA participation, 4) teacher MVPA participation, 5) transition time, 6) student physical activity enjoyment, and 7) student confidence. An ANOVA with Bonferroni corrections was calculated to establish which factors on Lau's 23-factor implementation list were significantly different between the three schools. For all statistical analyses, \( P < 0.05 \).

**RESULTS**

Figure 4 displays a summary of the InPACT study results given to teachers, students, and school administrators at the end of the study. Tables 3–5 display the following outcome measures organized by school and classrooms within each school. Tables 6 and 7 display the following outcome measures organized by school and grade for all schools combined.

**Implementation Rate of Activity Breaks**

Of the activity breaks observed by research staff, 64% of activity breaks were video led while 36% of activity breaks were either student or teacher led. Across all three schools, the average number of self-reported activity breaks completed per day was 4.5 ± 1.8 (range: 1 to 8 activity breaks). There was a significant difference between school 2 and school 3, with school 2 able to complete more activity breaks per day \( (P = 0.02) \), see Table 6. There were no significant differences between the number of activity breaks completed per day by grade level \( (Ps > 0.05) \), see Table 7.

**Duration and Intensity of Activity Breaks**

Results using direct observation demonstrated that 79% of the activity breaks were completed at the correct duration (3 min or more) across all three schools. The average activity break duration was 202 ± 42 s (i.e., 3 min 22 s ± 42 s). Activity breaks ranged in length from 120 s (i.e., 2 min) to 387 s (i.e., 6 min 27 s). There was a significant difference between school 1 and school 2, with school 2 implementing longer activity breaks \( (P = 0.04) \), see Table 6. There were significant differences between fifth- and sixth-grade classrooms \( (P < 0.01) \) as well as between fourth- and sixth-grade classrooms, with sixth-grade classrooms implementing the longest activity breaks \( (P < 0.01) \), see Table 7.

Results using the SOPLAY direct observation system also demonstrated that students were exercising at a moderate to vigorous intensity level 85.3% ± 0.01% of the time across all three schools (range: 59.5%–98.0%). This range represents the variability in the percentage of students who were observed to be exercising at a moderate to vigorous intensity across classrooms in all three schools. Students were exercising at the light physical activity intensity level 9.7% ± 0.01% of the time and were sedentary at 5.0% ± 0.004% across all three schools. The intensity of activity breaks performed was similar across gender (girls: 85.8% ± 0.01% vs boys: 84.5% ± 0.01%, \( P > 0.05 \)). There were significant differences between school 1 and school 3 \( (P < 0.001) \) and school 1 and school 2 \( (P < 0.001) \), with students at school 1 participating in MVPA a higher percentage of the time during the activity breaks. There was also a significant difference between school 2 and school 3 \( (P = 0.001) \), with students at school 1 participating in MVPA a higher percentage of the time during the activity breaks, see Table 6. There were significant differences between third-grade and sixth-grade classrooms \( (P < 0.001) \),

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### TABLE 5.
**School 3 Intervention and End-of-Study Teacher Questionnaire Outcomes by School/Classroom.**

<table>
<thead>
<tr>
<th>School 3</th>
<th>% Students in MVPA during an AB</th>
<th>% Teachers in MVPA during an AB</th>
<th>Most Frequently Cited Barriers</th>
<th>Average No. AB Completed per Day</th>
<th>Total Observed AB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third grade teacher 1</td>
<td>78.55</td>
<td>69.57</td>
<td>Behavior issues, time</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Third grade teacher 2</td>
<td>85.11</td>
<td>75.00</td>
<td>Behavior issues, time</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Fourth grade teacher 1</td>
<td>88.11</td>
<td>46.88</td>
<td>Time</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Fourth grade teacher 2</td>
<td>73.35</td>
<td>44.44</td>
<td>Behavior issues, time</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Fourth grade teacher 3</td>
<td>64.31</td>
<td>31.25</td>
<td>Student behavior × 3</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Fifth grade teacher 1</td>
<td>59.5</td>
<td>66.67</td>
<td>N/A</td>
<td>—</td>
<td>6</td>
</tr>
<tr>
<td>Fifth grade teacher 2</td>
<td>69.04</td>
<td>50.00</td>
<td>Time, student behavior</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>School 3 average</td>
<td>76.72% ± 0.017%</td>
<td>53.10% ± 0.05%</td>
<td>—</td>
<td>3.2 ± 1.7</td>
<td>51</td>
</tr>
</tbody>
</table>

AB, activity break; —, not applicable.
### TABLE 6.
Outcome Measures by School.

<table>
<thead>
<tr>
<th>School</th>
<th>Average No. AB per Day</th>
<th>AB Duration</th>
<th>% Students in MVPA during AB</th>
<th>% Teachers in MVPA during AB</th>
<th>Transition Time to an AB</th>
<th>% Students Return to Task post-AB</th>
<th>Enjoyment Level of AB</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.4 ± 0.24</td>
<td>194 ± 41 s</td>
<td>92.14% ± 0.008%</td>
<td>83.23% ± 0.09%</td>
<td>46 ± 30.6 s</td>
<td>98.55% ± 0.62%</td>
<td>4.25 ± 0.06</td>
<td>8.47 ± 0.21</td>
</tr>
<tr>
<td>2</td>
<td>5.7 ± 0.64</td>
<td>207 ± 41 s</td>
<td>84.22% ± 0.014%</td>
<td>82.52% ± 0.03%</td>
<td>41 ± 24.8 s</td>
<td>98.80% ± 0.57%</td>
<td>4.23 ± 0.15</td>
<td>8.23 ± 0.31</td>
</tr>
<tr>
<td>3</td>
<td>3.2 ± 0.70</td>
<td>206 ± 43 s</td>
<td>76.72% ± 0.017%</td>
<td>53.10% ± 0.05%</td>
<td>101 ± 65 s</td>
<td>98.15% ± 0.93%</td>
<td>4.01 ± 0.07</td>
<td>7.84 ± 0.28</td>
</tr>
</tbody>
</table>

*AB, activity break.*

### TABLE 7.
Outcome Measures by Grade.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Average No. AB per Day</th>
<th>AB Duration</th>
<th>% Students in MVPA during AB</th>
<th>% Teachers in MVPA during AB</th>
<th>Transition Time to an AB</th>
<th>% Students returning to task post-AB</th>
<th>Enjoyment Level of AB</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3.6 ± 0.40</td>
<td>196.9 ± 6.7 s</td>
<td>86.58% ± 0.016%</td>
<td>84.76% ± 0.04%</td>
<td>69.6 ± 57.2 s</td>
<td>99.06% ± 0.31%</td>
<td>4.27 ± 0.10</td>
<td>8.57 ± 0.20</td>
</tr>
<tr>
<td>4</td>
<td>5.1 ± 0.77</td>
<td>197.2 ± 3.2 s</td>
<td>86.88% ± 0.009%</td>
<td>70.72% ± 0.03%</td>
<td>52.0 ± 39.0 s</td>
<td>99.33% ± 0.26%</td>
<td>4.19 ± 0.08</td>
<td>8.00 ± 0.19</td>
</tr>
<tr>
<td>5</td>
<td>4.5 ± 0.96</td>
<td>190.7 ± 5.12 s</td>
<td>85.82% ± 0.015%</td>
<td>73.61% ± 0.05%</td>
<td>37.0 ± 27.3 s</td>
<td>95.37% ± 2.28%</td>
<td>4.09 ± 0.23</td>
<td>8.34 ± 0.20</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>225.5 ± 10.6 s</td>
<td>63.96% ± 0.053%</td>
<td>81.82% ± 0.08%</td>
<td>64.0 ± 35.0 s</td>
<td>98.40% ± 0.94%</td>
<td>3.90 ± 0.03</td>
<td>7.38 ± 0.34</td>
</tr>
</tbody>
</table>

*AB, activity break.*
between fourth-grade and sixth-grade classrooms ($P < 0.001$), and between fifth- and sixth-grade classrooms ($P < 0.001$), with students in sixth-grade classrooms participating in MVPA a lower percentage of the time during the activity breaks, see Table 7.

Results using the SOPLAY direct observation system also demonstrated that teachers were exercising at a moderate to vigorous intensity level $74.8\% \pm 0.02\%$ of the time across all three schools (range: $23.5\%-100.0\%$). There was a significant difference between school 1 and school 3 ($P < 0.001$) as well as between school 2 and school 3 ($P < 0.001$), with school 3 teachers participating in MVPA a lower percentage of the time during the activity breaks, see Table 6. There was a significant difference between third- and fourth-grade classrooms, with students in fourth-grade classrooms participating in MVPA the least amount of the time during the activity breaks ($P = 0.01$), see Table 7.

### Transition Time to and From Activity Breaks

The average transition time from seated instruction to activity break onset across all three schools was $55 \pm 44$ s (range: $2 \pm 5$ min 3 s). There was a significant difference in transition time between school 1 and school 3 ($P < 0.001$) as well as between school 2 and school 3 ($P < 0.001$), with school 3 taking the longest to transition starting an activity break, see Table 6. There was a significant difference in transition time between third- and fourth-grade classrooms ($P = 0.02$), with third-grade classrooms taking longer to transition starting an activity break. There were also significant differences between third- and fifth-grade classrooms ($P < 0.003$) and fourth- and fifth-grade classrooms ($P = 0.04$), with fifth-grade classrooms taking the least amount of time to transition starting an activity break, see Table 7.

Across all three schools, $98.6\% \pm 0.4\%$ (range: $20\%-100\%$) of students returned to task within $30$ s of completing an activity break. There were no significant differences of students returning to task postactivity break by school ($P > 0.05$), see Table 6. Students returning to task postactivity break were similar in both genders across all three schools with $99.4\% \pm 0.3\%$ of girls and $97.3\% \pm 0.7\%$ of boys returning to task $30$ s postactivity break ($P > 0.05$). There were significant differences in students returning to task postactivity break between third- and fifth-grade classrooms ($P = 0.04$) and fourth- and fifth-grade classrooms ($P < 0.003$), with a lower percentage of fifth-grade classrooms returning to task postactivity break, see Table 7.

### Student Enjoyment of Activity Breaks

Average enjoyment of the activity breaks, as reported by students, across all three schools was $4.2 \pm 0.04$ out of 5. There was a significant difference between school 1 and school 3 ($P = 0.02$), with school 1 students enjoying the activity breaks more, see Table 6. There were no significant differences by grade for student enjoyment of the physical activity breaks ($Ps > 0.05$), see Table 7.

In addition, student’s confidence in their ability to complete $30$ min of physical activity every day at school was $8.2 \pm 0.1$ out of 10. There were no significant differences by school in student’s confidence in their ability to complete $30$ min of physical activity every day at school ($Ps > 0.05$), see Table 6. There was a significant difference between third- and fourth-grade classrooms ($P = 0.05$), with third-grade classrooms enjoying the activity breaks more. There were also significant differences between third- and sixth-grade classrooms ($P = 0.002$) as well as fifth- and sixth-grade classrooms ($P = 0.01$), with sixth-grade classrooms having the lowest confidence in their ability to complete $30$ min of physical activity every day at school, see Table 7.

### Teacher Reported Successes of Activity Breaks

Of the 20 teachers who participated in the intervention, 19 attended the end-of-study meeting and answered the end-of-study questionnaire. These questions were open ended, with teachers answering with similar responses. Approximately $58\%$ of teachers responded to the question “How did your students respond in general to the breaks?” with students loved them or students enjoyed them, and $42\%$ of teachers responded with students enjoyed them but toward the end of the intervention started getting silly. Approximately $11\%$ of teachers responded to the question “Please share one success story related to InPACT from your classroom” with the activity breaks encouraged students to be active outside of school. One fourth-grade teacher from school 2 mentioned a few of her students were getting their families involved in completing activity breaks at home. Another fourth-grade teacher from school 1 reported that many of her students stated they were more active and played outside after school as opposed to staying inside. Approximately $11\%$ reported that the activity breaks were an outlet for energy, and $11\%$ noted that when students were feeling unfocused, they would ask for an activity break to help themselves regain focus.

Data from end-of-study teacher questionnaires also suggested that teachers who implemented more than five activity breaks per day used the InPACT exercise videos and/or located other activity videos online (i.e., Go Noodle and Just Dance) rather than develop their own activity breaks. In addition, teachers who implemented a higher number of activity breaks established classroom procedures and used the InPACT “MOVE” and “FOCUS” posters more frequently than teachers who struggled with implementation. Finally, having students take their heart rates immediately following each break seemed to contribute to quicker transition times as students used this activity to self-regulate their behavior and get back on task after the activity break. All three of these classroom procedures allowed for better classroom management resulting in positive student behavior and increased movement in the classroom. At the beginning of the intervention, teachers were cautious of potential injuries that could be sustained with participation. Despite teacher’s preintervention concerns, there were no injuries reported throughout the 16-wk intervention.

### Factors Influencing Implementation Rates

The most frequently reported barrier to the successful implementation of InPACT reported by the teachers was “lack of time.” Factors that contributed to a lack of time across all three schools were 1) disruptive student behaviors reported by $25\%$ of the teachers, 2) school activities including assemblies reported by $35\%$ of teachers, 3) curriculum requirements reported by $25\%$ of teachers, and 4) rotating classrooms reported by $15\%$ of teachers. It is important to note that $83\%$ of school 3 teachers reported student behavior as a barrier to implementation. Despite these barriers, $14$ of $20$ teachers reported they were currently still implementing activity breaks in their classrooms $1$ month after the completion of the intervention period. In school $1$, $67\%$ of teachers were still implementing breaks (two third-grade, one fourth-grade, and one fifth-grade teachers). In school $2$, $86\%$ of teachers were still implementing breaks (one third-grade, three fourth-grade, and two fifth-grade teachers). In school $3$, $67\%$ teachers were still implementing breaks (two third-grade and two fourth-grade teachers).

During the postintervention discussion, teachers noted on their end-of-study questionnaires that the activity breaks were more beneficial than harmful because the activity breaks increased focus and attention in their students. In addition, teachers found that having the students take their own pulse was both time and cost-effective as well as helped with classroom management.
Table 8 presents the scores (1 = low, 2 = moderate, 3 = high) of the 20 factors developed by Lau et al. (37) that were used to assess implementation in the present study. Of the 20 factor scores, factor 1, “leadership, motivation, and engagement,” significantly varied between the three schools ($P < 0.001$), with school 1 and school 2 scoring the highest with a score of 3 followed by school 3 with a score of 1. Outcomes of “leadership, motivation and engagement” are scored based on the organization administrator’s motivation to implement the intervention as well as their involvement in the planning and training segments of the intervention. In addition, factor 6, “communication,” significantly varied between school 1 and school 3 ($P < 0.001$), with school 1 scoring 3, school 2 scoring 2, and school 3 scoring 1. Outcomes of “communication” were scored based on the effectiveness of mechanisms to encourage frequent and open communication between all involved parties in the intervention. The following factors resulted in similar scores across the three schools: 1) available space, 2) available facilities and equipment, 3) available staff, 4) engaging program champion, 5) training, 6) reflecting and evaluating, 7) sustainability plans, 8) provider knowledge, 9) fun and inclusive design, 10) empirical evidence, 11) adaptability, and 12) competing programs in the community.

### DISCUSSION

Over the course of this 16-wk classroom-based physical activity intervention, teachers were unable to implement ten 3-min MVPA breaks into their classroom each day. If the average activity break was 202 s and 85% of students were in MVPA and 9.7% of students were in light physical activity according to the SOPLAY data, this equates to approximately 192 s of activity per activity break. If an average of five activity breaks were accumulated per day, this would result in approximately 960 s or 16 min of additional physical activity, 13 min and 36 s of which is MVPA. Therefore, this enables teachers to provide approximately half of the school-based recommendations for physical activity in their classrooms (1). In addition,
students reported a high level of enjoyment and confidence in their ability to perform the activity breaks, which may have positive implications for student participation for in-school physical activity time as well as out-of-school physical activity time. Variation in the implementation of the intervention occurred between the three schools, with school 3, the lower income, lower academically achieving, more racially diverse school reporting the lowest level of implementation. Across all schools, teachers identified a few common barriers to full implementation, including lack of time and student behavior. Implementation factors such as buy-in from school principal and clear communication between the principal and teachers were additional barriers experienced by school 3. Additional intervention support may be needed to maximize intervention implementation in low socioeconomic schools.

The majority of student feedback suggested that children enjoyed participating in the activity breaks. This finding was similar to our previous observations in the laboratory where we examined the acute effects of intermittent physical activity (2-min bouts at low, moderate, and high intensities) on mood and enjoyment in elementary school–age children. After completing twenty 2-min activity breaks during the day, overall positive mood and enjoyment scores were reported after 10 breaks and again after 20 breaks. In addition, children rated the activity breaks as more enjoyable compared with the twenty 2-min screen-time breaks (32). It is important to also note that although most students were not accumulating 30 min of MVPA per day in their classroom, students on average reported being “fairly confident” in their ability to accumulate 30 min of MVPA per day at school. Taken together, these findings suggest in-class activity programs should consider including multiple activity breaks as an intervention strategy to promote children’s activity as this age-group rates this form of activity as enjoyable both in laboratory and classroom settings.

Another success of the intervention was that boys and girls participated in the intervention at similar rates. These findings are similar to previous studies conducted in classroom settings. Reznik et al. (50) demonstrated that participation in a 10-min, education-focused aerobic activity that was led by teachers three times per day was equally effective in increasing step counts for both kindergarten and first-grade boys and girls. Pangrazi et al. (51) showed a significant increase in girls’ step counts after the PLAY intervention where participants received a 15-min MVPA classroom activity break. Although the boys did not show a significant increase in step counts, their baseline step counts were higher than girls at the start of the intervention. Hence, girls became more physically active than they were before the intervention and increased their step counts to similar rates as boys by the end. These findings are in contrast to other school-based physical activity programs (recess and PE) where gender disparities have been observed. For example, in a study that looked at the association between gender, perceived athletic competence, and enjoyment of physical activity, PE enjoyment was found to be lower and declined the most overtime in girls therefore contributing to lower rates of participation in PE class for this group (52). In addition, girls have been found to participate less during recess in comparison with boys (33). These findings suggest that classroom-based physical activity interventions are effective at increasing physical activity participation in both boys and girls and may help to eliminate gender disparities in physical activity participation. This is particularly relevant for low-income or ethnic minority girls who may lack safe places to be active outside of school (54).

Similar to other classroom-based physical activity interventions, implementation rate varied among teachers and was lower than recommended. Donnelly et al. (26) previously examined the implementation of academic physical activity lesson plans in the classroom over a period of 3 yr. Results showed 60% of teachers were able to implement 55 min of the intervention per week, with a goal of 100 min wk⁻¹. This variation in implementation was also shown to have an effect on health outcomes. Donnelly et al. reported that the schools who implemented more than or equal to 20 min of the intervention per week showed a significantly smaller increase in body mass index over the 3 yr compared with the schools that implemented less than 75 min wk⁻¹. In the present study, we observed significantly lower rates of intervention implementation than the stated goal of ten activity breaks, with an average of five activity breaks completed a day. Variation in implementation by classrooms was also evident. Some teachers were able to implement up to eight activity breaks per day while others were only able to implement one activity break. Interestingly, classroom-level barriers were similar across teachers with the most frequently reported barriers being 1) time, 2) schedule changes, and 3) student behavior. Teacher reports from other interventions have shown similar barriers to implementation as well (14, 15). Teachers from the classroom-based physical activity intervention Texas I-CAN and Physical Activity Across the Curriculum have expressed similar concern about the additional time required to incorporate physical activity into lesson plans. Results from the Comprehensive School Physical Activity Program also found similar barriers with teachers expressing the belief that incorporating movement in the classroom could lead to student misbehavior (55). Despite these limitations, it is important to note that teachers were able to implement five activity breaks per day in their classrooms, thereby providing their students with almost half of the school recommended activity per day. Future research should continue to explore the optimal dose of activity breaks that can be feasibly implemented in classroom settings.

Teachers noted that 10 activity breaks were not feasible. However, a suggestion they had was increasing the duration of activity breaks from 3 to 4 min to allow for more activity in the classroom while minimizing the number of interruptions to the teaching curriculum. Four-minute activity breaks also coincided with the average duration of most activity videos teachers found online. Ma et al. (21) has tested a 4-min high-intensity interval activity break protocol called “FUNtervals” in a second- and fourth-grade classroom and found that this brief activity break, three times per week, improved off-task behavior in the students, particularly in the students who previously had a high prevalence of off-task behavior. In third- through fifth-grade students, Ma et al. (56) found that one “FUNterval” activity break also reduced selective attention. On the basis of our teacher feedback and the findings of Ma et al., future studies should continue to examine the utility of implementing five 4-min activity breaks in elementary school classrooms as this may be a more feasible prescription of activity given the current constraints on teacher’s time.
Previous researchers have also identified significant variations in implementation by socioeconomic status. Texas I-CAN teachers were trained to incorporate physical activity during scheduled academic time in three elementary schools composed of primarily minority and low-income students. During the intervention, the researchers found less than 25% of teachers met the goal of implementing lessons on a daily basis, and despite teacher reports of supporting the intervention, the lack of planning time and available resources was a significant barrier to implementation (15). In the present study, when examining implementation rates by socioeconomic status and student demographics, we observed many differences, for example, higher frequency of breaks implemented per day, higher percentage of student MVPA participation, higher percentage of teacher MVPA participation, and more efficient classroom management skills within the two predominantly white, higher-income intervention schools (schools 1 and 2) in comparison with the predominantly black, lower-income school (school 3). In addition, 83% of the teachers at school 3 reported student behavior to be a major barrier to implementation. It is important to realize that this may not be from actual misbehavior but from teacher perceptions of students and classroom culture. Future research should look to examine teachers’ perceptions and expectations of misbehavior in their students to determine whether there are concrete differences in student behavior across different schools or if misbehavior results from teacher perceptions, thereby affecting intervention implementation.

School-level barriers identified in the present study included lack of “leadership, motivation, and engagement” as well as “communication.” We noted that the principals of school 1 and school 2 played a more supportive role in the study compared with school 3. For example, the principal at school 1 attended both days of the teacher training before the start of the intervention and scheduled time for the research team to meet with the Board of Education to discuss the program and get buy-in from school administrators. In addition, the teachers at school 1 and school 2 felt supported by their principal as it related to their participation in InPACT. By contrast, the principal of school 3 approved of the study but was absent during the duration of the intervention. This may have been due to the principal at school 3 prioritizing other efforts, including standardized test scores and/or possible behavior problems within the student body (57). As a result of these issues, this principal may have had fewer opportunities to engage with his InPACT teachers and support their participation in the program. These findings suggest teachers and principals in low socioeconomic schools may encounter additional barriers to implementation compared with teachers and principals in higher socioeconomic schools. Hence, classroom-based interventions may need to be tailored to meet the needs of lower socioeconomic schools to effectively promote physical activity in children of all backgrounds.

We also observed significantly higher implementation rates in the third- and fourth-grade classrooms in comparison with sixth-grade classrooms. To date, the majority of classroom-based physical activity interventions have been tested at elementary schools in fifth-grade and under. To our knowledge, this is one of the few studies that has attempted to test activity breaks in sixth-grade classrooms where we observed lower student enjoyment of activity breaks as well as lower teacher implementation. Student enjoyment of activity breaks in sixth-grade students was lower than the other grades; however, this finding was not significant likely due to a low sample size. This finding points to the need of future studies to gain a better understanding of what activities sixth-grade students enjoy to modify and tailor to the preferences of older children if this is to be a useful form of activity in this age-group.

Student participation was also significantly lower in the sixth-grade classrooms in comparison with the third-, fourth-, and fifth-grade classrooms. A potential strategy to increase student participation at a moderate to vigorous intensity could be to incorporate a gamelike competition between classrooms and grades with student-appropriate incentives for participation. Patel et al. (58) examined the results of placing participants in a game where participants competed based on the number of step counts accomplished each day. They concluded that the participants in the “gamelification” group had a significantly greater proportion of days where they achieved their step count goals as well as a significant increase in mean daily steps compared with the control group. A similar system of rewarding student participation at the MVPA intensity level could potentially motivate students to participate at higher intensity levels.

Strengths and Limitations
A strength of this study was that researchers from multiple distinct fields, including kinesiology, architecture, education, public health, and medicine, came together at each stage of the research process to design an interdisciplinary intervention to provide structured physical activity opportunities to children in their schools and classrooms. A few limitations to this study should also be noted. First, funding limitations resulted in a subset of the physical activities to be tested using adult research staff, rather than children, to determine whether the activities elicited the correct moderate to vigorous heart rate response. Second, although we compensated teachers before the start of the intervention and communicated with the teachers that this was a feasibility study, we recognize that social desirability may have influenced teacher response on the end-of-study questionnaire. Finally, the use of our end-of-study questionnaire being a retrospective questionnaire was a limitation. Future research should measure teacher responses during the study to assess teacher enthusiasm throughout the intervention to improve intervention implementation.

CONCLUSIONS
InPACT enhances children’s natural physical activity patterns through the implementation of short bouts of activity throughout the school day (59). This intervention was also designed to minimize teacher burden by providing a range of teacher resources for enhanced implementation. Although teachers were unable to implement ten 3-min activity breaks due to time constraints, they were able to safely and effectively implement five activity breaks per day on average. This accumulation of health-enhancing physical activity in the classroom is an important public health message given the 30-min in school physical activity agenda (1). InPACT also provides teachers with the opportunity to accrue health-enhancing physical activity at work, thereby helping them meet the daily recommendations of physical activity (60). Teaching is rated as one of the most stressful occupations in the country (61); hence, organizational-level interventions such as InPACT may help to minimize the negative effects of teacher stress through increased physical activity participation. Nevertheless,
InPACT has the potential to create a culture of health in schools by increasing structured physical activity opportunities in the classroom for both students and teachers. It is important to note that there were significant differences in intervention implementation by socioeconomic status, and thus future research should continue to develop intervention supports to enhance InPACT implementation as well as quantify the potential health benefits associated with implementing multiple activity breaks in the classroom.

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REFERENCES


